Pöyry Tecnologia Ltda.
Av. Alfredo Egídio de Souza Aranha, 100
Bloco B - 7° andar
04726-170 São Paulo - SP
BRASIL
Tel. +55 11 3472 6955
Fax +55 11 3472 6980
E-mail: forest.br@poyry.com

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

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Pulp Mill, River Port, Transmission Line and Electrical Substation in Concepción – Paraguay

VOLUME II – Book II – ENVIRONMENTAL DIAGNOSIS OF THE BIOTIC ENVIRONMENT

Content 9 ENVIRONMENTAL DIAGNOSIS

Annex

Distribution
PARACEL E
PÖYRY -

Orig.	05/08/20 – hbo	05/08/20 – bvv	05/08/20 – hfw	05/08/20 – hfw	For information
Rev.	date/Author	Date/Verified	Date/Aproved	Date/Authorized	Observation
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b	31/07/21 - hbo	31/07/21 - bvv	31/07/21 - hfw	31/07/21 - hfw	For information

CONTENT

9 ENVIRONMENTAL DIAGNOSIS....18
9.2 Biotic Environment....18
9.2.1 Flora....18
9.2.2 Fauna....133
9.2.3 Protected Areas....329
Bibliographic References....336

FIGURE LIST

Figure 1 – Detail of the registration with the use of binoculars type Solognac 10x42 series 100. 20
Figure 2 – Detail of the photographic record of the species found. 20
Figure 3 – Map of Paraguay's Forestry Stratum (2016). Source: Sistema Nacional de Monitoreo Terrestre Resultados del Sistema Satelital de Monitoreo Terrestre (2016). 22
Figure 4 – Map of Paraguay's eco-regions (2011). Source: Proyecto "Desarrollo de Metodologías de Monitoreo de Carbono almacenado en los Bosques para la REDD+ en el Paraguay" (2011). 24
Figure 5 – Image with the location of the Indirect Influence Area of the pulp mill. Image obtained in Google Earth February/2018. Cartographic base: Map of the Ecoregions of Paraguay (Proyecto "Desarrollo de Metodologías de Monitoreo de Carbono almacenado en los Bosques para la REDD+ en el Paraguay", 2011). 25
Figure 6 – The Cerrado's physiognomy profile. Source: Mereles, 2005 (adapted). 26
Figure 7 – Map of physiognomy of the IIA. 34
Figure 8 – Aerial image with the location of the mill's DIA. Image: Google Earth feb/2021. 35
Figure 9 – Transmission Line Sections 1/5 (from the mill). Image: Google Earth jul/2021. 36
Figure 10 – Transmission Line Sections 2/5 (from the mill). Image: Google Earth jul/2021. 36
Figure 11 – Transmission Line Sections 3/5 (from the mill). Image: Google Earth jul/2021. 37
Figure 12 – Transmission Line Sections 4/5 (from the mill). Image: Google Earth jul/2021. 37
Figure 13 – Transmission Line Sections 5/5 (from the mill). Image: Google Earth jul/2021. 38
Figure 14 – Camp 1, 3 and 11 location. Image: Google Earth jul/2021. 38
Figure 15 – Camp 9 location. Image: Google Earth jul/2021. 39
Figure 16 – Camp 7 and Camp 6 location. Image: Google Earth jul/2021. 39
Figure 17 – Image with location of the Savannah (SAV-1). Image: Google Earth feb/2018 (Coordinates UTM 21K - midway point : 448922.15 E/ 7429694.55 S). 40
Figure 18 – Aerial image of the area with Savannah (SAV-1), in contact extensive cattle farming. 41
Figure 19 – General view of the area with Savannah (SAV-1). Coordinates UTM 21K 448922.15 E/ 7429694.55 S. 41
Figure 20 – Detail of the spaced trees and bushes grouped in "capones", which occur in sandy soils. 42
Figure 21 – Another point of view of the spaced trees and bushes grouped in "capones", which occur in sandy soils. 42
Figure 22 – Detail of the groupings formed by terrestrial bromeliads and palm trees of the species*Butia paraguayensis* (jatai). 42
Figure 23 – Detail of the dense stratum formed by terrestrial bromeliads between tree and shrub spacings. 42
Figure 24 – View of the sample of the species *Schinopsis balansae* (quebracho). 43
Figure 25 – Detail of the fruit of the species *Schinopsis balansae* (quebracho). 43
Figure 26 – View of specie sampling *Duguetia furfuracea*. 43
Figure 27 – Detail of the fruit of *Duguetia furfuracea*. 43
Figure 28 – View of Sampling *Prosopis rubriflora* (algarrobillo). 44
Figure 29 – (A) Detail of the fruit of fruit; (B) Details of the inflorescences of the species *Prosopis rubriflora* (algarrobillo). 44
Figure 30 – View of the sample of the species *Randia* sp. 44
Figure 31 – Detail of the fruit of the species *Randia* sp. 44
Figure 32 – View of the sample of the species *Bromelia balansae*. 45

Figure 33 – Detail of the fruits of the species *Bromelia balansae*. 45
Figure 34 – Image with the location of the Savannah (SAV-2). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 450492.83 E/ 7427479.93 S). 46
Figure 35 – Aerial image of the Savanna (SAV-2), view of shrub individuals sometimes grouped in capones or isolated within a dense stratum of grass. 46
Figure 36 – General view of the Savannah portion (SAV-2) where shrub individuals are grouped together, giving an "island" aspect to these formations. 47
Figure 37 – General view of the portion of the Savannah (SAV-2) where shrub individuals are separated within a dense stratum of grass. 47
Figure 38 – View of a sample of the species *Annona spinescens*. 48
Figure 39 – Detail of the species' fruit *Annona spinescens*. 48
Figure 40 – View of a sample of the species *Acacia* sp. 48
Figure 41 – D Detail of the species' fruit *Acacia* sp. 48
Figure 42 – View of a sample of the species *Ipomoea carnea*. 49
Figure 43 – Flower detail of the species *Ipomoea carnea*. 49
Figure 44 – View of a sample of the species *Borreria* sp. 49
Figure 45 – Flower detail of the species *Malvastrum* sp. 49
Figure 46 – View of a sample of the species *Piriqueta* sp. 50
Figure 47 – Flower detail of the species *Senna* sp. 50
Figure 48 – Image with the location of the floodable Savannah (SAVi-1). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 448269.33 E/ 7430154.83 S). 51
Figure 49 – Aerial image of the area with flooded Savannah (SAVi-1). 51
Figure 50 – Flooding Savannah Area Overview(SAVi-1). Coordenadas UTM 21K 448269.33 E/ 7430154.83 S. 52
Figure 51 – Another angle of the area with the flooded savannah (SAVi-1), detail of the dense stratum formed by herbs and grasses. Coordinates UTM 21K 448269.33 E/ 7430154.83 S. 52
Figure 52 – View of a sample of the species *Heteropterys* sp. 53
Figure 53 – Detail of the fruits of the species *Heteropterys* sp. 53
Figure 54 – View of a sample of the species *Mimosa* sp. 53
Figure 55 – Detail of the fruits of the species *Mimosa* sp. 53
Figure 56 – View of a sample of the species *Cnidoscolus* sp. 54
Figure 57 – Detail of the fruits of the species *Cnidoscolus* sp. 54
Figure 58 – View of a sample of the species *Melochia* sp. 54
Figure 59 – Detail of the fruits of the species *Melochia* sp. 54
Figure 60 – View of a sample of the species *Eleocharis elegans*. 54
Figure 61 – Detail of the fruits of the species *Eleocharis elegans*. 54
Figure 62 – Image with the location of the Semideciduous Forest (FS-1). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 448509.78 E/ 7429971.58 S). 55
Figure 63 – General view of the area with semi decidual forest (FS-1). Coordinates UTM 21K 448509.78 E/ 7429971.58 S. 56
Figure 64 – View of the vegetation inside the remaining semi decidual forest - FS-1. 56
Figure 65 – Another angle of vegetation within the remaining semi decidual forest - FS-1. 56
Figure 66 – Detail of the large tree found after cutting down the tree. 57
Figure 67 – Another angle of the large tree sample found that was cut into the remaining FS-1. 57
Figure 68 – Sample view of the species *Maytenus ilicifolius* (cangorosa). 57
Figure 69 – Detail of the edges of the leaves, often with thorns, characteristic of the species *Maytenus ilicifolius* (cangorosa). 57
Figure 70 – Sample view of the species *Campomanesia xanthocarpa* (guavira). 58
Figure 71 – Detail of the fruits of the species *Campomanesia xanthocarpa* (guavira). 58

Figure 72 – Sample view of the species *Microlobius foetidus* (yvyra ne)...................................58
Figure 73 – Detail of the fruits and seeds of the species *Microlobius foetidus* (yvyra ne)..........58
Figure 74 – Image with the location of the Semideciduous Forest (FS-2). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 448187.50 E / 7428636.95 S).....................59
Figure 75 – Aerial image of the area with Semideciduous Forest (FS-2), the remnant that forms the continuum of the Ciliary Forest of the Paraguay River, however, part of it borders on areas destined for cattle ranching....59
Figure 76 – General view of the area with semideciduous forest (FS-2), contact portion of the grazing area. Coordinates UTM 21K 448187.50 E / 7428636.95 S. 60
Figure 77 – General view of the margins of the Paraguay river, part of contact with the Semideciduous forest (FS-2). Coordinates UTM 21K 447963.45 E / 7428368.50 S...................60
Figure 78 – View of the vegetation within the remaining Semideciduous Forest - FS-2...........61
Figure 79 – Another view of the vegetation within the remaining Semideciduous Forest - FS-2. 61
Figure 80 – View of a specimen of the species *Tabebuia aurea* (lapacho blanco)......................61
Figure 81 – Detail of winged seeds characteristics gives species*Tabebuia aurea* (lapacho blanco)...61
Figure 82 – View of a specimen of the species *Caesalpinia paraguariensis* (guajakan).............62
Figure 83 – Detail of the fruits of the species*Caesalpinia paraguariensis* (guajakan). 62
Figure 84 – View of an epiphytic specimen of the genus *Tillandsia* sp., presented in the area. 62
Figure 85 – Detail of the inflorescences of the genus *Tillandsia* sp. 62
Figure 86 – View of a specimen of the species *Pacourina edulis*. 63
Figure 87 – Detail of the inflorescences of the species *Pacourina edulis*...................................63
Figure 88 – Aerial image with the location of the Semideciduous Forest (FS-3). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 450389.17 E/ 7426715.95 S). 64
Figure 89 – Aerial image of the area with Semideciduous Forest (FS-3), which forms the continuous forest on the banks of the Paraguay River. 65
Figure 90 – Another angle of the area with semideciduous forest (FS-3), the remnant that forms the riparian forest continuum of the Paraguay River. 65
Figure 91 – General view of the area with Semideciduous Forest (FS-3). Coordinates UTM 21K - 450389.17 E/ 7426715.95 S....66
Figure 92 – Overview of the Paraguay River contact portion of the Semideciduous Forest (FS-3). Coordinates UTM 21K 449815.00 E/ 7426174.00 S....66
Figure 93 – Another angle of the portion in contact with the Paraguay River of the Semideciduous Forest (FS-3). Coordinates UTM 21K 449815.02 E/ 7426174.05 S...................67
Figure 94 – General view of the portion in contact with the areas intended for cattle (Semideciduous Forest - FS-3). Coordinates UTM 21K 450056.03 E/ 7426879.76 S. 67
Figure 95 – View of the vegetation inside the Semideciduous Forest (FS-3)............................67
Figure 96 – Another angle of vegetation inside the Semideciduous Forest (FS-3)...................67
Figure 97 – View of the terrestrial bromeliad groups present in the interior of the remnant (Semideciduous forest - FS-3). 68
Figure 98 – Detail of the terrestrial bromeliads present in the interior of the remnant (Semideciduous forest - FS-3). 68
Figure 99 – View of the wooden species *Pyrostegia venusta*. 68
Figure 100 – Details of the inflorescences of the species *Pyrostegia venusta*.............................68
Figure 101 - View of a sample of the species *Samanea tubulosa* (manduvira)..........................69
Figure 102 – Details of the inflorescences of the species *Samanea tubulosa* (manduvira). 69
Figure 103 - View of a sample of the species *Acrocomia aculeata* (mbokaja)...........................69
Figure 104 – Detail of the fruits of the species *Acrocomia aculeata* (mbokaja). 69

Figure 105 – Detail of a sample of the epiphyte *Philodendron tweedianum*.......70
Figure 106 – Image with the location of the Semideciduous Forest (FS-4). Image: Google Earth feb/2018 (Coordinates UTM 21K - midway point: 451179.24 E/ 7431285.43 S).......71
Figure 107 – Aerial image of the area with Semideciduous Forest (FS-4), the remainder occupies a large portion in the DIA. 71
Figure 108 – General view of the area with Semideciduous Forest (FS-4), bordering portion with rural property.......72
Figure 109 – View of an emergent individual specimen of the species *Aspidosperma polyneuron* (guatambu sayju).......72
Figure 110 – View of an emergent individual specimen of the species *Balfourodendron riedelianum*.......72
Figure 111 – View of the vegetation inside the Semideciduous Forest (FS-4). 73
Figure 112 – Another angle of vegetation inside the Semideciduous Forest (FS-4). 73
Figure 113 – View of the existing roads inside the Semideciduous Forest (FS-4). 73
Figure 114 – Another angle of the existing trails within the Semideciduous Forest (FS-4).......73
Figure 115 – Detail of a sample of the species *Balfourodendron riedelianum* (guatambu).......74
Figure 116 – Detail of the fruits of the species *Balfourodendron riedelianum* (guatambu).......74
Figure 117 – Detail of a sample of the species *Tabernaemontana catharinensis* (sapirangy). 74
Figure 118 – Detail of the fruits of the species *Tabernaemontana catharinensis* (sapirangy).......74
Figure 119 – Detail of a sample of the species *Gleditsia amorphoides* (espina de corona).......75
Figure 120 – Detail of the characteristic spines of the species *Gleditsia amorphoides* (crown spine). 75
Figure 121 – Detail of a sample of the species *Xylosma pseudosalzmannii*. 75
Figure 122 – Detail of the characteristic spines of the species *Xylosma pseudosalzmannii*. 75
Figure 123 – Detail of a sample of the species *Capsicum* cf. *chacoense*. 76
Figure 124 – Detail of the fruits of the species *Capsicum* cf. *chacoense*.......76
Figure 125 – Image with the location of the wide area with Chaco physiognomy present in the DIA of the PARACEL pulp mill. Image: Google Earth feb/2018.......77
Figure 126 – Aerial view of the extensive area with the physiognomy of the Chaco. UTM - 21k 447302.78 E/ 7426631.89 S (reference point). 77
Figure 127 – Image with the location of the sampling points. Imag: Google Earth feb/2018. 78
Figure 128 – General view of a rural property present in the DIA. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).......79
Figure 129 – View of the unpaved access present in the DIA. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).......79
Figure 130 – Another unpaved access angle present in DIA. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).......79
Figure 131 – General view of the surroundings of the rural property. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).......79
Figure 132 – Another angle of the rural property environment. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).......79
Figure 133 – Overview of a rural property in DIA. Coordinates UTM - 21k 449202.10 E/ 7431096.85 S (P2).......80
Figure 134 – View of the unpaved access present in DIA. Coordinates UTM - 21k 449202.10 E/ 7431096.85 S (P2). 80
Figure 135 – General view of surroundings of the rural property. Coordinates UTM - 21k 449202.10 E/ 7431096.85 S (P2).......80
Figure 136 – Overview of a rural property in DIA. Coordinates UTM - 21k 450673.02 E/ 7432212.86 S (P3).......80

Figure 137 – General view of the surroundings of the rural property. Coordinates UTM - 21k 450673.02 E/ 7432212.86 S (P3). 81
Figure 138 – General view of the sampling point located at the coordinates UTM - 21k 451657.45 E/ 7433121.34 S (P4). 81
Figure 139 – Other angle of the sampling point in the coordinates UTM - 21k 451657.45 E/ 7433121.34 S (P4). 81
Figure 140 – Image with the location of the DAA of the pulp mill. Imag: Google Earth feb/2018. 82
Figure 141 – Image with the location of the DAA of the PARACEL pulp mill. Image: Google Earth feb/2018. 83
Figure 142 – View of the sampling point (P1) in the DAA (water intake) in the Paraguay River. Coordinates UTM - 21k 449817.46 E/ 7426175.07 S. 83
Figure 143 – Another angle of the sampling point in the DAA (water intake). UTM coordinates - 21k 449817.46 E/ 7426175.07 S. 83
Figure 144 – View of the sampling point in the DAA (water intake) and the Paraguay River in the background. UTM coordinates - 21k 449839.72 E/ 7426218.47 S. 84
Figure 145 – Another angle of the sampling point in the DAA (water intake). UTM coordinates - 21k 449839.72 E/ 7426218.47 S. 84
Figure 146 – View of the sampling point in the DAA (flooded area) UTM coordinates - 21k 449905.03 E/ 7428488.03 S. 84
Figure 147 – Another angle of the sampling point in the DAA (flooded area). UTM coordinates - 21k 449905.03 E/ 7428488.03 S. 84
Figure 148 – View of the sampling point in the DAA (pasture area). Coordinates UTM - 21k 449786.71 E/ 7428464.56 S. 84
Figure 149 – Another angle of the sampling point in the DAA (pasture area), in the background the headquarters of the Farmhouse Zapatero Cue. Coordinates UTM - 21k 449786.71 E/ 7428464.56 S. 84
Figure 150 – View of the sampling point in the DAA (pasture area). Coordinates UTM - 21k 449262.98 E/ 7429329.73 S. 85
Figure 151 – View of the sampling point in the DAA (pasture area) with isolated trees. Coordinates UTM - 21k 449443.88 E/ 7429583.74 S. 85
Figure 152 – Another angle of the sampling point in the DAA (pasture area) with isolated trees. Coordinates UTM - 21k 449443.88 E/ 7429583.74 S. 85
Figure 153 – Image with the location of the Savannah (SAV-1). Imag: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 450483.74 E/ 7428462.29 S). 86
Figure 154 – Aerial image of the Savannah area (SAV-1), surrounded by a large area with field vegetation and areas for cattle farming. 87
Figure 155 – General view of the savannah area (SAV-1), part in contact with the cattle farming area. 87
Figure 156 – View of the vegetation inside the savannah (SAV-1). 88
Figure 157 – Another angle of vegetation in the interior of the Savannah (SAV-1). 88
Figure 158 – Detail of a sample of the species *Psidium guajava* (arasa). 88
Figure 159 – Detail of the species' fruit *Psidium guajava* (arasa). 88
Figure 160 – Image with the location of the Savannah (SAV-2). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 449509.25 E/ 7429567.11 S). 89
Figure 161 – Aerial image of the Sabana area (SAV-2). 89
Figure 162 – Overview of the Savannah area (SAV-2). 90
Figure 163 – View of the vegetation inside the Savannah (SAV-2). 90
Figure 164 – Another angle inside the Savannah (SAV-2). 90
Figure 165 – Detail of a sample of specie *Ziziphus mistol* (mistol). 91

Figure 166 – Detail of inflorescences and fruits of specie *Ziziphus mistol* (mistol)...................91
Figure 167 – Detail of a sample of specie *Erythroxylum cuneifolium*........................................91
Figure 168 – Detail of fruit of specie (*Erythroxylum cuneifolium*). 91
Figure 169 – Detail of a sample of specie *Cereus* sp. 92
Figure 170 – Detail of fruit of specie *Cereus* sp. 92
Figure 171 – Detail of a sample of specie *Monvillea* sp...92
Figure 172 – Detail of fruit of specie *Monvillea* sp. 92
Figure 173 – Detail of a sample of specie *Bromelia balansae*. 93
Figure 174 – Detail of inflorescence of specie *Bromelia balansae*. 93
Figure 175 – Detail of a sample of the specie *Tillandsia duratii*. 93
Figure 176 – – Detail of inflorescence of specie *Tillandsia duratii*...93
Figure 177 – Map of DIA and DAA features...101
Figure 178 – Image with the location of the intervention areas in the protective forest of the Paraguay River (100m). 102
Figure 179 – Aerial image of the intervention area – water intake and discharge of treated effluents...103
Figure 180 – Natural and Modified Habitat at Mill site. 104
Figure 181 – Natural and Modified Habitat at Transmission line easement lane..................105
Figure 182 – The assembly of the plots/units..107
Figure 183 – Detail of measurements....107
Figure 184 – Measurement of the CAP (circumference at breast height - 1.30m from the ground)...107
Figure 185 – Measurement detail....107
Figure 186 – Image with the location of the plots in the DIA and DAA of the future mill site. Image: Google Earth feb/2018. 110
Figure 187 – View of the vegetation in the DAA. 110
Figure 188 – Another angle of the vegetation in the DAA 110
Figure 189 – Detail of the dense stratum formed by bushes and grasses present in the areas sampled in the ADA...111
Figure 190 – Another angle of the dense stratum formed by bushes and grasses sampled in the ADA....111
Figure 191 – View of the vegetation in the AID...111
Figure 192 – Another angle of the vegetation in the AID...111
Figure 193 – Comparative table between the number of individuals, species and families found in the sample...112
Figure 194 – Graph showing the distribution of the structural parameters of the 10 species with the highest IVI value. Legend: FrRel: Relative Frequency; DeRel: Relative Density; DoRel: Relative Dominance. 113
Figure 195 – Representative graphics of the number of individuals per sampled plot...........114
Figure 196 – Graph showing the distribution of the structural parameters related to the IVI of the points sampled. Legend: FrRel: Relative Frequency; DeRel: Relative Density; DoRel: Relative Dominance. 115
Figure 197 – Distribution of diameter classes (DAP) of individuals sampled in the ADA.......116
Figure 198 – Distribution of height classes of individuals sampled in the ADA......................116
Figure 199 – Bray-Curtis similarity dendrogram in the sampled areas Legend: P: plot (20x10 m)...118
Figure 200 – Pielou Equitability Diagram (J'). Legend: P – plot (20 x10m).............................119
Figure 201 – Random accumulation curve of observed and expected species by the Jackknife estimator. 119

Figure 202 – Comparative table between the number of individuals, species and families found in the sample. 120
Figure 203 – Graph showing the distribution of the structural parameters of the 10 species with the highest IVI. Legend: FrRel: relative frequency; DeRel: Relative Density; DoRel: relative Dominance. 121
Figure 204 – A representative chart of the number of individuals per plot sampled. 122
Figure 205 – Graph showing the distribution of the structural parameters related to the IVI of the points sampled. Legend: FrRel: Relative frequency; DeRel: Relative density; DoRel: Relative dominance. 124
Figure 206 – Distribution of diameter classes (DBH) of individuals sampled in the ADA. 125
Figure 207 – Distribution of height classes of individuals sampled in the ADA. 125
Figure 208 – Bray-Curtis similarity dendrogram between sampled areas. Legend: P: plot (20x10 m). 128
Figure 209 – Diagram Pielou (J'). Legend: P - parcela (20 x10m). 129
Figure 210 – Random accumulation curve of observed and expected species by the Jackknife estimator. 129
Figure 211 – Design of sampling for terrestrial and aquatic fauna in the areas of influence (DIA and DAA) of the pulp mill. 177
Figure 212 – Indirect recording of the mammal (tracks). 178
Figure 213 – Indirect recording method (tracks) 178
Figure 214 – Installing the Camera Trap. 179
Figure 215 – Camera trap in the study area. 179
Figure 216 – Aerial image indicating transect 01. 180
Figure 217 – Transect overview 01. 180
Figure 218 - Aerial image indicating transect 02. 180
Figure 219 – Transect overview 02. 180
Figure 220 – Aerial image indicating transect 02. 181
Figure 221 – Transect overview 02. 181
Figure 222 – Aerial image indicating transect 03. 181
Figure 223 – Transect overview 03. 181
Figure 224 – Aerial image indicating transect 03. 181
Figure 225 – Transect overview 03. 181
Figure 226 Aerial image indicating transect 04. 182
Figure 227 – Transect overview 04. 182
Figure 228 – Aerial image indicating transect 04. 182
Figure 229 – Transect overview 04. 182
Figure 230 – Aerial image indicating transect 05. 182
Figure 231 – Transect overview 05. 182
Figure 232 Bird sampling by transect census. 185
Figure 233 – Notes on bird observations in notebook. 185
Figure 234 – Aerial image indicating the transect 01. 186
Figure 235 – Overview of the transect 01. 186
Figure 236 – Aerial image indicating the transect 02. 186
Figure 237 – Overview of the transect 02. 186
Figure 238 – Aerial image indicating the transect 03. 186
Figure 239 – Overview of the transect 03. 186
Figure 240 – Aerial image indicating the transect 04. 187
Figure 241 – Overview of the transect 04. 187
Figure 242 – Aerial image indicating the transect 05. 187
Figure 243 – Overview of the transect 05. 187

Figure 244 – Twilight search active 190
Figure 245 – Twilight search active 190
Figure 246 – Biologist doing the registration of the daytime fauna. 190
Figure 247 – Biologist making the recording of the nocturnal fauna. 190
Figure 248 – Biologist doing the registration of the daytime fauna. 190
Figure 249 – Biologist conducting an active search during the day. 190
Figure 250 – Aerial image with visual representation of the point H_01. 192
Figure 251 – Overview of the Point H_01. 192
Figure 252 – Aerial image with visual representation of the point H_02. 193
Figure 253 – Overview of the Point H_02. 193
Figure 254 Aerial image with visual representation of the point H_03. 193
Figure 255 – Overview of the Point H_03. 193
Figure 256 – Aerial image with visual representation of the point H_04. 193
Figure 257 – Overview of the Point H_04. 193
Figure 258 – Aerial image with visual representation of the point H_05. 194
Figure 259 – Overview of the Point H_05. 194
Figure 260 – Aerial image with visual representation of the point H_06. 194
Figure 261 – Overview of the Point H_06. 194
Figure 262 – Aerial image with visual representation of the point H_07. 194
Figure 263 – Overview of the Point H_07 194
Figure 264 – Aerial image with visual representation of the point H_08. 195
Figure 265 – Overview of the Point H_08 195
Figure 266 – Aerial image with visual representation of the point H_09. 195
Figure 267 – Overview of the Point H_09 195
Figure 268 – Aerial image with visual representation of the transect T_01. 195
Figure 269 – Transect Overview T_01 195
Figure 270 – Aerial image with visual representation of the transect T_02. 196
Figure 271 – Transect Overview T_02 196
Figure 272 – Aerial image with visual representation of the transect T_03. 196
Figure 273 – Transect Overview T_03 196
Figure 274 – Aerial image with visual representation of the transect T_04. 196
Figure 275 – Transect Overview T_04 196
Figure 276 – Aerial image with visual representation of the transect T_05. 197
Figure 277 – Transect Overview T_05 197
Figure 278 – Withdrawal from the waiting trap. 199
Figure 279 – Cage trap is being installed near the macrophytes on the river bank. 199
Figure 280 – Individual processing (metric analysis and photographic recording). 199
Figure 281 – Cage trap being removed. 199
Figure 282 – Aerial image with visual representation of the point P_01. 200
Figure 283 – Aerial image with visual representation of the point P_02 200
Figure 284 – Species richness of the mammal fauna recorded during the first and second sampling campaigns. SD - secondary data. 202
Figure 285 – Absolute abundance of mammals recorded during the first and second sampling campaigns. 203
Figure 286 – Rarefaction curve and Jackknife estimator for the first and second sampling campaign. 204
Figure 287 – Sample efficiency curve for the mammal group. 205
Figure 288 – Shannon Diversity Index (A) and Equivalence (B) for the mammal group during the first and second sampling campaigns. 206

Figure 289 – Distribution of species by period of activity and habitat preference: D - daytime; N - nighttime; C/N - twilight/night; D/N - day/night. 210
Figure 290 – Eating habits of mammal species. 211
Figure 291 – Ecological value of mammal species diagnosed in the study area. 215
Figure 292 – tracks of *Cerdocyon thous*. 216
Figure 293 – *Didelphis aurita*. 216
Figure 294 – tracks of *Didelphis aurita*. 216
Figure 295 –*Guerlinguetus ignitus*. 216
Figure 296 – *Didelphis aurita*. 216
Figure 297 – *Leopardus pardalis*. 216
Figure 298 – *Lycalopex gymnocercus* 217
Figure 299 – *Mazama gouazoubira* 217
Figure 300 – *Dasypus novemcinctus* 217
Figure 301 – tracks of *Procyon cancrivorus*. 217
Figure 302 – *Dasypus novemcinctus*. 217
Figure 303 – *Hydrochoerus hydrochaeris*. 217
Figure 304 – *Mazama gouazoubira*. 218
Figure 305 – *Lontra longicaudis*. 218
Figure 306 – track of *Leopardus pardalis* 218
Figure 307 – *Alouatta caraya* 218
Figure 308 – *Cerdocyon thous*. 218
Figure 309 – *Pecari tajacu*. 218
Figure 310 – *Eira barbara* 219
Figure 311 – *Myrmecophaga tridactyla* 219
Figure 312 – *Myocastor coypus* 219
Figure 313 – *Leopardus tigrinus*. 219
Figure 314 – *Tapirus terrestres* 219
Figure 315 – *Sylvilagus brasiliensis*. 219
Figure 316 – Bird species richness registered in the DIA and DAA of the PARACEL pulp mill. DS - secondary data. 221
Figure 317 – Frequency of occurrence of bird species in DIA and DAA samples from the pulp mill. 223
Figure 318 – Rarefaction curve and Jackknife estimator for the first and second sampling campaigns of the present study. 223
Figure 319 – Rarefaction curve and Jackknife estimator for the total species recorded in this study. 224
Figure 320 – Shannon Index (left) and Pielou Equitability (right) for the birdlife registered in the DIA and DAA of PARACEL pulp mill. 225
Figure 321 – Distribution of bird species by habitat preference SD - secondary data. 226
Figure 322 – Distribution of bird species by guild SD - secondary data. 227
Figure 323 – Distribution of bird species by degree of sensitivity to environmental changes S.I - no information. 228
Figure 324 – Amazona Frentiazul (*Amazona aestiva*). 244
Figure 325 – Pato Brasileño (*Amazoneta brasiliensis*). 244
Figure 326 – Cotara Ipacaá (*Aramides ypecaha*). 244
Figure 327 – Aratinga Ñanday (*Aratinga nenday*). 244
Figure 328 – Garza Cuca (*Ardea cocoi*). 244
Figure 329 – Correlimos Batitú (*Bartramia longicauda*). 244
Figure 330 – Cacique Aliamarillo (*Cacicus chrysopterus*). 245
Figure 331 – Cacique Lomirrojo (*Cacicus haemorrhous*). 245

Figure 332 – Picamaderos Barbinegro (*Campephilus melanoleucos*). 245
Figure 333 – Carancho meridional (*Caracara plancus*). 245
Figure 334 – Martín Pescador Verde (*Chloroceryle americana*). 245
Figure 335 – Milano Picogarfio (*Chondrohierax uncinatus*). 245
Figure 336 – Tortolita Azulada (*Claravis pretiosa*). 246
Figure 337 – Chara Morada (*Cyanocorax cyanomelas*). 246
Figure 338 – Suirirí Piquirrojo (*Dendrocygna autumnalis*). 246
Figure 339 – Hornero Común (*Furnarius rufus*). 246
Figure 340 – Busardo Sabanero (*Heterospizias meridionalis*). 246
Figure 341 – Zafiro Bronceado (*Hylocharis chrysura*). 246
Figure 342 – Jacana Suramericana (*Jacana jacana*). 247
Figure 343 – Mosquero Pirata (*Legatus leucophaius*). 247
Figure 344 – Trepatroncos Chico (*Lepidocolaptes angustirostris*). 247
Figure 345 – Sinsonte Calandria (*Mimus saturninus*). 247
Figure 346 – Bienteveo Rayado (*Myiodynastes maculatus*). 247
Figure 347 – Cormorán Biguá (*Nannopterum brasilianus*). 247
Figure 348 – Buco Durmilí (*Nystalus striatipectus*). 248
Figure 349 – Chachalaca Charata (*Ortalis canicollis*). 248
Figure 350 – Anambé grande (*Pachyramphus validus*). 248
Figure 351 – Paloma Colorada (*Patagioenas cayennensis*). 248
Figure 352 – Espinero Común (*Phacellodomus rufifrons*). 248
Figure 353 – Nido de *Phimosus infuscatus* 248
Figure 354 – Espátula Rosada (*Platalea ajaja*). 249
Figure 355 – Chorlito Dorado Americano (*Pluvialis dominica*). 249
Figure 356 – Cacique Solitario (*Procacicus solitarius*). 249
Figure 357 – Aratinga Ojiblanca (*Psittacara leucophthalmus*). 249
Figure 358 – Mosquero Silbador (*Sirystes sibilator*). 249
Figure 359 – Batará Variable (*Thamnophilus caerulescens*). 249
Figure 360 – Aratinga Cabeciazul (*Thectocercus acuticaudatus*). 250
Figure 361 – Bandurria Común (*Theristicus caudatus*). 250
Figure 362 – Titira Colinegro (*Tityra cayana*). 250
Figure 363 – Trogón Curucuí (*Trogon curucui*). 250
Figure 364 – Monjita Blanca (*Xolmis irupero*). 250
Figure 365 – Trepatroncos Colorado (*Xiphocolaptes major*). 250
Figure 366 – Tordo Músico (*Agelaioides badius*). 251
Figure 367 – Garcita Verdosa (*Butorides striata*). 251
Figure 368 – Halcón Murcielaguero (*Falco rufigularis*). 251
Figure 369 – Cernícalo Americano (*Falco sparverius*). 251
Figure 370 – Pirincho (*Guira guira*). 251
Figure 371 – Cardenilla Crestada (*Paroaria coronata*). 251
Figure 372 – Carpintero Verdiamarillo (*Piculus chrysochloros*). 252
Figure 373 – Lechuzón de Anteojos (*Pulsatrix perspicillata*). 252
Figure 374 – Tucán Toco (*Ramphastos toco*). 252
Figure 375 – Ñandú Común (*Rhea americana*). 252
Figure 376 – Fiofío Suirirí (*Suiriri suiriri*). 252
Figure 377 – Paloma Picazuró (*Patagioenas picazuro*). 252
Figure 378 – Species richness of the herpetofauna recorded during the first and second sampling campaigns. SD - Secondary data. 254
Figure 379 – Abundance of amphibian species recorded during the first and second sampling campaigns. 255

Figure 380 - Abundance of reptile species recorded during the first and second sampling campaigns. 256
Figure 381 – Efficiency curve of the species sample and estimated richness (Jackknife 1) of the herpetofauna, based on 1000 randomized. 257
Figure 382 – Diversity and Equitability of the herpetofauna recorded during the first and second sampling campaigns. 258
Figure 383 – *Melanophryniscus fulvoguttatus* 263
Figure 384 – *Rhinella major* 263
Figure 385 – *Rhinella diptycha* 263
Figure 386 – *Dendropsophus minutus* 263
Figure 387 – *Dendropsophus sanborni* 263
Figure 388 – *Boana albopunctata* 263
Figure 389 – *Boana punctata* 264
Figure 390 – *Pithecopus azurea*) 264
Figure 391 – *Phyllomedusa sauvagii* 264
Figure 392 – *Lysapsus limellum* 264
Figure 393 – *Scinax acuminatus* 264
Figure 394 – *Trachycephalus typhonius* 264
Figure 395 – *Physalaemus biligonigerus* 265
Figure 396 – *Leptodactylus bufonius* 265
Figure 397 – *Leptodactylus elenae* 265
Figure 398 – *Leptodactylus fuscus* 265
Figure 399 – *Leptodactylus latrans* 265
Figure 400 – *Elachistocleis bicolor* 265
Figure 401 – *Chelonoidis carbonaria* 266
Figure 402 – *Caiman yacare* 266
Figure 403 – *Chironius quadricarinatus* 266
Figure 404 – *Micrurus pyrrhocryptus* 266
Figure 405 – *Bothrops diporus* 266
Figure 406 – *Leptodeira annulata* 266
Figure 407 – *Mussurana bicolor* 267
Figure 408 – *Pseudoboa nigra*. 267
Figure 409 – Fish species richness recorded during the first monitoring campaign. 268
Figure 410 – Relative order richness of ichthyofauna recorded during the first sampling campaign. 269
Figure 411 – Rarefaction curve of ichthyofauna species recorded during the first sampling campaign. 271
Figure 412 – *Acestrorhynchus pantaneiro* 280
Figure 413 – *Gymnogeophagus balzanii* 280
Figure 414 – *Hypostomus cf. boulengeri* 280
Figure 415 – *Oxydoras kneri* 280
Figure 416 – *Myloplus levis*. 280
Figure 417 – *Creagrutus meridionalis* 280
Figure 418 – *Loricaria sp.* 281
Figure 419 – *Pterygoplichthys ambrosettii* 281
Figure 420 – *Pygocentrus nattereri* 281
Figure 421 – *Thoracocharax stellatus* 281
Figure 422 – *Plagioscion squamosissimus* 281
Figure 423 – *Psectrogaster curviventris* 281

Figure 424 – Sampling network of the aquatic biota in the Paraguay River and its tributary. 290
Figure 425 – Measuring transparency with the Secchi disk. 291
Figure 426 – Measurement of depth. 291
Figure 427 – The 20 µm network for qualitative sampling. 292
Figure 428 – Horizontal phytoplankton dragging. 292
Figure 429 – Conservation of the quantitative phytoplankton sample. 292
Figure 430 – Phytoplankton sample conditioning. 292
Figure 431 – Utermöhl camera sample. 292
Figure 432 – Identification and quantification of phytoplankton. 292
Figure 433 – The Petersen dredger used to collect benthic invertebrates. 294
Figure 434 – The washing of the sediments on a sieve with an aperture of 250 µm. 294
Figure 435 – Analysis of benthic organisms. 294
Figure 436 – Identification with the stereomicroscope. 294
Figure 437 - Point P01: Paraguay river, upstream from PARACEL pulp mill, in campaign 1. 298
Figure 438 – Point P01: Paraguay river, upstream from PARACEL pulp mill, in campaign 2. 298
Figure 439 – Point P02: Paraguay river, downstream from PARACEL pulp mill, in campaign 1. 298
Figure 440 – Ponto P02: Paraguay river, downstream from PARACEL pulp mill, in campaign 2. 299
Figure 441 – Phytoplankton richness by taxonomic group in the Paraguay river - 1st C (October/2019) and 2nd C (Mar/20). 300
Figure 442 – Phytoplankton richness by sampling point in the Paraguay River - 1st C (Oct/2019) and 2nd C (Mar/20). 302
Figure 443 – Chlorophycea - *Monoraphidium contortum*. 303
Figure 444 – Mediophyceae *Thalassiosira* sp. 303
Figure 445 – Phytoplankton density in the Paraguay river – 1stC (Oct/19) and 2ndC (Mar/20). 307
Figure 446 – Relative abundance of phytoplankton in Paraguay river – 1stC (Oct/19) and 2ndC (Mar/20). 308
Figure 447 – Density of cyanobacteria in the Paraguay River – 1stC (Oct/19) and 2ndC (Mar/20). 309
Figure 448 – Phytoplankton diversity and equity indices in the Paraguay river - 1stC (Oct/19) and 2ndC (Mar/20). 311
Figure 449 – Phytoplankton similarity in Paraguay River - 1st C (Oct/19) and 2ndC (Mar/20). 312
Figure 450 – Principal Component Analysis (PCA) of the phytoplankton community and abiotic variables in the Paraguay River - 1stC (Oct/19) and 2ndC (Mar/20). 313
Figure 451 – Relative richness of benthic invertebrates in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20). 314
Figure 452 – Benthic invertebrate taxon richness by sampling point in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20). 316
Figure 453 – *Limnoperna fortunei*. 318
Figure 454 – *Chironomideae*. 318
Figure 455 – Diptera from the family *Ceratopogonidae*. 318
Figure 456 – Anelid *Oligochaeta*. 318
Figure 457 – Benthic invertebrate density per sampling point - 1stC (Oct/2019) and 2ndC (Mar/20). 322

Figure 458 – Relative abundance of benthic invertebrates in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20). 323
Figure 459 – Diversity and equitability of benthic invertebrates in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20). 323
Figure 460 – Similarity of benthic invertebrates in Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20). 324
Figure 461 – BMWP Index in Paraguay River - 1stC (Oct/2019) and 2nd C (Mar/20). 325
Figure 462 – Principal Component Analysis among Benthic Invertebrate Communities and Sediment Characteristics - 1stC (Oct/2019) and 2ndC (Mar/20). 327
Figure 463 – Map of Protected Areas. 331
Figure 464 – Map of Ramsar areas in Paraguay. Source: Ramsar Sites Information Service (Available at: https://rsis.ramsar.org/). 333
Figure 465 – Map of Priority Conservation Areas (2018). Source: MADES/DGPCB (2019). In red is the location of the PARACEL pulp mill. 334

TABLE LIST

Table 1 – Parameters for the establishment of protective forests for water channels in the eastern region of Paraguay. 19
Table 2 – List of plant species that may appear in the mill's IIA. 28
Table 3 – List of species sampled in the DIA and DAA of the future pulp mill. 95
Table 4 – Intervention in protective forests for the implementation of raw water and discharge of treated effluents. 103
Table 5 – Vegetation cover and PS 6 Type in TL DIA 106
Table 6 – UTM coordinates of the vertices of the plots in the DAA and DIA of the future PARACEL pulp mill. 111
Table 7 – General characteristics of the stratum of trees and bushes sampled in the plots 113
Table 8 – Native forest strata of Paraguay and the species found in the most 114
Table 9 – Phytosociological parameters of the tree community. NInd – number of individuals; NAm – sample number; AbsDe – Absolute Density; RelDe – Relative Density; AbsFr – Absolute frequency; RelFr – Relative frequency; AbsDo – Absolute Dominance; RelDo – Relative Dominance; IVI – Importance value index; IVC – Coverage value index 117
Table 10 – General characteristics of the stratum of trees and shrubs sampled in the plots 121
Table 11 – Strata of native forest in Paraguay and the species found in the sampling 122
Table 12 – Phytosociological parameters of the tree community NInd - Number of individuals; NAm - Number of samples; AbsDe - Absolute density; RelDe - Relative density; AbsFr - Absolute frequency; RelFr - Relative frequency; AbsDo - Absolute dominance; RelDo - Relative dominance; IVI - Importance value index; IVC - Coverage value index 126
Table 13 – Vegetation cover and PS 6 Type in pulp mill property 132
Table 14 – Future Vegetation cover and PS 6 Type in pulp mill property 132
Table 15 – List of mammal species likely to be found in the IIA of PARACEL pulp mill 134
Table 16 – List of probable bird species for the IIA of PARACEL's pulp mill 142
Table 17 – List of herpetofauna species likely to be found in IIA in PARACEL pulp mill 158
Table 18 – List of ichthyofauna species likely to be found in the IIA of the pulp mill 165
Table 19 – UTM coordinates of the camera traps for the sampling of mammals in the DIA and DAA of PARACEL pulp mill 179
Table 20 – Abundance class distribution by frequency of occurrence as proposed by Linsdale (1928) 188
Table 21 – Description and location of the herpetofauna survey sampling points 191
Table 22 – UTM coordinates of the ichthyofauna collection points in the first sampling campaign. 200
Table 23 – Species diversity indices of the species diagnosed by transect during the first and second sampling season 205
Table 24 – List of species of mammal fauna recorded during the first and second sampling period, in October/2019 and March/2020, respectively. 207
Table 25 – List of mammal species bioindicators of environmental quality. 212
Table 26 – List of mammal species threatened with extinction. 213
Table 27 – Relationship with the environmental quality of the species of the registered mammal fauna Legend: red - high; orange - medium; green - low. 214
Table 28 – Shannon Diversity Index (H') and Pielou Equitability Index (J') in the DIA and DAA of the PARACEL pulp mill in the first and second sampling campaigns 225
Table 29 – Registered bird species threatened with extinction in the DIA and DAA of the Pulp Mill. 230

Table 30 – List of bird species recorded during the first and second sampling campaigns in October/2019 and March/2020. 231
Table 31 – Indexes obtained for registered herpetofauna during the first and second sampling campaigns. 257
Table 32 – List of herpetofauna species recorded during the first and second sampling campaigns in October/2019 and March/2020 respectively. 260
Table 33 – Results of relative abundance of ichthyofauna registered during the first sampling campaign. 269
Table 34 – List of ichthyofauna species recorded during the first sampling campaign in March/2020. 273
Table 35 – Taxonomic composition of phytoplankton in the Paraguay River and tributaries 284
Table 36 – Taxonomic composition of benthic invertebrates in the Paraguay River and tributaries. 288
Table 37 – Network for sampling aquatic biota in the Paraguay River and its tributary. 290
Table 38 – Field records and *in-situ* monitoring on the Paraguay River 297
Table 39 – Spatial distribution and frequency of phytoplankton emergence in the Paraguay River - 1st C (Oct/2019) and 2nd C (Mar/20). 304
Table 40 – Density and relative abundance of phytoplankton in the Paraguay River - 1stC (Oct/19) and 2ndC (Mar/20). 309
Table 41 – Spatial distribution and frequency of occurrence of benthic invertebrates in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20). 318
Table 42 – Density and relative abundance of benthic invertebrates per sampling point in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20). 321

9 ENVIRONMENTAL DIAGNOSIS

9.2 Biotic Environment

The diagnosis of the biotic environment provides the opportunity to observe the current state of flora and fauna (mammals, birds, herpetofauna, ichthyofauna and aquatic organisms) in the areas of influence of the region and thus obtain an adequate evaluation of the environmental impacts related to the construction and operation of the PARACEL pulp mill.

For the collection of primary and secondary data, the areas of influence were considered, as following:

- IIA (Indirect Influence Area) – The ecoregions that the Department of Concepción intercepts and, in part, the Aquidabán and Pilcomayo river basins, namely the Cerrado, Alto Paraná, Chaco Húmedo and Chaco Seco ecoregions. The systematization of information by ecoregions in the available bibliography justified the choice of this criterion;
- DIA (Direct Influence Area) – 5 km radius is being considered in the surroundings of PARACEL pulp mill and 25 meters range of transmission line. The impacts of port, wood transportation and accommodation camps on the Direct Influence Area were also considered, although they are not included in the map. The DIA was determined based on atmospheric dispersion study, water effluent discharge (the distance of effluent is smaller than boundary) and industrial noise impacts (in 5 km the noise emitted by the mill will be practically the same as the environment).
- DAA (Directly Affected Area) - It includes the internal area owned by PARACEL, where the industrial unit will be properly established, in addition to the water intake system and the emissary for treated effluents disposal. It includes the accesses roads and support areas (port and transmission line) and also 6 accommodation camps.

9.2.1 Flora

The studies of vegetation carried out as part of the diagnosis aim to present the current situation of the flora at the areas of indirect, direct and directly affected influence of the pulp mill through the study of primary and secondary data, serving as a reference to evaluate the effects of the implantation and operation of the mill. In this sense, the aim of this diagnosis was to highlight the types of plant formations existing in the region, indicating the state of conservation of the most significant areas and the configuration of the biotic conditions of the Direct Influence Area (DIA) and the Directly Affected Area (DAA) of PARACEL pulp mill.

9.2.1.1 Methods

The methodology used for the mapping of land use and vegetation cover consisted of the use of visual interpretation techniques of the products of the analysis of satellite images of the study area (satellite images) and the integrated analysis of the information extracted from these products; the data obtained in the field work and the existing digital databases.

For the diagnosis, secondary data were obtained from sources such as: An approximation of knowledge of plant formations in the Chaco Boreal, Paraguay (Mereles, 2005); GIS/CIF/FCA/UMA Laboratory Technical Report (Map of Coverage of Paraguay, 2011); Servicio Paz y Justicia Paraguay (SERPAJ PY 2013), Reference Level of Forest Emissions from Deforestation in the Republic of Paraguay (2015), National Land Monitoring System Results of the Satellite Land Monitoring System (2016), and other studies in the area of influence.

For the digital bases of the vegetation insertion maps, data from the project "Development of Methodologies for Monitoring Carbon Stored in Forests for REDD+ in Paraguay" (GIS/CIF/FCA/UMA Laboratory Technical Report, 2011) and from the Paraguayan Ecoregions - definition of conservation priorities (LIFE, 2016) were used.

Based on this analysis, sampling points were selected, including in forests that protect watercourses, to verify the existence of the characteristic aspects of the vegetation complexes in Paraguay. These areas in the AID were identified on maps, with its UTM (Universal Transverse Mercator) coordinates in the Datum SIRGAS 2000 system. The protective forests of watercourses in Paraguay are defined according to the Table as following.

Table 1 – Parameters for the establishment of protective forests for water channels in the eastern region of Paraguay.

Channel width	Minimum width of protective forest on each river margin
Greater or equal to 100m	100 m
50 to 99 m	60 m
20 to 49 m	40 m
5 to 19 m	30 m
1.5 to 4.9 m	20 m
Less than 1.5 m	10 m
River rising in area of influence	In each case, provision shall be made for the following types of headwater (with a minimum of 30 m)

Source: Manual Técnico para la administración y aplicación of Law n. 4241/10 "On the re-establishment of forests protecting watercourses within the national territory" and its Decree 9,824/12.

The following documents were consulted for the identification of endangered plant species: SEAM Resolution n. 524/2006 (List of Endangered Flora and Fauna Species of Paraguay), SEAM Resolution n. 2,243/2006 - List of Endangered Wildlife Species, as amended by Resolution n. 2,531/2006, and the Taxonomic List of Endemic Flora of Paraguay (Chocarro & Egea, 2018).

For the qualitative & quantitative investigation of the flora present in the areas of influence of the PARACEL mill, carried out from October 17 to 21, 2019 and March 4 to 8, 2020, the walking method was used (Filgueiras et al., 1994) and the Rapid Ecological Assessment method (Sayre et al., 2000), which consists of the description of the vegetation of the sampled area, listing the species found (Figure 1 and Figure 2).

For the quantitative study, the phytosociological study was carried out, which has as its main objective the knowledge of the ecological importance of each species and the degree of floristic diversity of the area studied. The botanical material that was not identified in the field was collected with the help of pruning shears, herborized and pressed into newsprint and cardboard, for subsequent identification with consultation of the specialized literature. The material was classified according to the botanical nomenclature of the classification system: Angiosperm Phylogeny Group - APG IV (2016).

Figure 1 – Detail of the registration with the use of binoculars type Solognac 10x42 series 100.

Figure 2 – Detail of the photographic record of the species found.

9.2.1.2 Flora in Paraguay

Paraguay is a geographically located in the heart of the South American continent, with two main regions of different topography and geology; to the east is the eastern region, also known as the Paraná region (which represents 39% of the total area and is home to over 90% of the population) and to the west is the Chaco (which represents 61% of the total area and is home to less than 10% of the population) (Chocarro and Aegean, 2018).

According to Chocarro and Aegean (2018), Paraguay's floristic richness has been attributed to the confluence of different ecoregions, the mosaic of habitat types that occur throughout the country, and the geographical position of Paraguay near the Tropic of Capricorn, or which divides the country in two, resulting in many tropical plants being found in their most southern distributions and temperate plants in the south being found in their most northern distributions. Huang and others (2009 apud Chocarro & Egea, 2018) also noted that Paraguay is an ecologically unique country, located at the confluence of five ecoregions: Mata Atlántica, Chaco Húmedo, Bosque Chaco, Pantanal and Cerrado, which contributes to its floral richness, while Spichiger and others (2009 apud Chocarro & Egea, 2018) referred to the richness of its flora. (2011 apud Chocarro & Egea, 2018) and Bueno and others (2017 apud Chocarro & Egea, 2018) state that Paraguay can be considered a huge and diverse ecotone in South America, where diverse flora is mixed: Chaco, Parana, Cerrado and Pampa.

The total number of vascular plant species in Paraguay is estimated to be between 6500-7000 species (Mereles, 2007). Zuloaga et al. (2008) mention a total of 5099 species, 103 subspecies, 375 varieties and 20 forms, distributed among 201 families and 1231 genera registered in Paraguay. The official list of species endemic to the country published in 2006 by SEAM (Secretariat of the Environment) presented 25 species, of which only 10 are strictly restricted to Paraguayan territory. The publication of the Catálogo de Plantas Vasculares del Cono Sur in 2008 provided more reliable and updated information, with a list of 399 species endemic to the country (Zuloaga & Belgrano, 2015; Chocarro & Egea, 2018).

Nevertheless, since the 1970s, excessive human activity has drastically accelerated the destruction of natural vegetation, mainly through the establishment of extensive agricultural activity aimed primarily at promoting high-yield monocultures (Spichiger et al., 2011).

According to the National Land Monitoring System Results of the Satellite Land Monitoring System (2016) regarding forest cover, the country can be divided into five major eco-areas or bio-geographic regions (Figure 3): Bosque Húmedo de la Región Oriental (BHRO), Bosque Sub humedo del Cerrado (BSHC), Bosque Sub humedo Inundable del Río Paraguay (BSIRP), Bosque Seco Chaqueño (BSCH) and Bosque Palmar (BP), and the Plantaciones Forestales (PF) that have been considered as forest cover, but are not native.

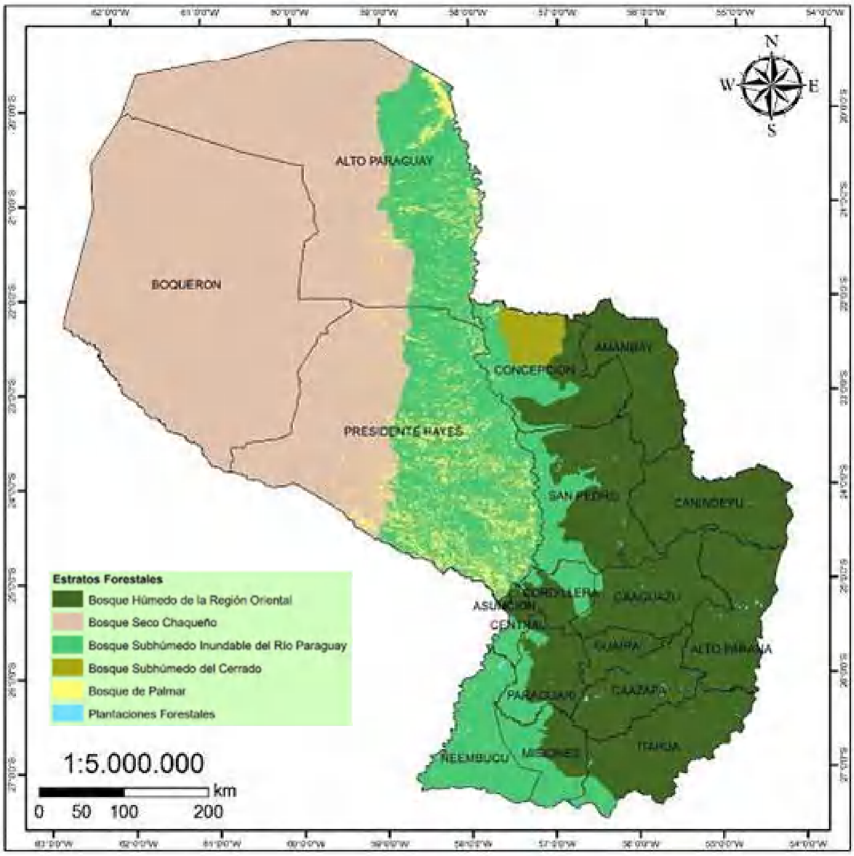


Figure 3 – Map of Paraguay's Forestry Stratum (2016). Source: Sistema Nacional de Monitoreo Terrestre Resultados del Sistema Satelital de Monitoreo Terrestre (2016).

According to INFONA (2011) the identification of these ecozones or biogeographic regions was done considering biophysical variables, such as climate, temperature and soil type, and they have the following characteristics:

Bosque Húmedo de la Región Oriental - BHRO

This formation includes the high native forests of the eastern region of Paraguay classified as subtropical rainforest (Hueck, 1978 apud INFONA, 2011), warm temperate rainforest of Holdridge (1969 apud INFONA, 2011) and high forest of the Paraná de Tortorelli (1966 apud INFONA, 2011), with heights that can reach 30 or 40 meters and whose structure has three vertical layers and an understory, considered the most biodiverse in the country, in the floristic composition predominate *Cedrela* spp, *Tabebuia* spp, *Apuleia leiocarpa*, *Balfourodendron riedelianum*, *Myrocarpus frondosus*, *Peltophorum dubium*, *Pterogine nitens*, *Nectandra* spp, *Ocotea* spp, *Patagonula americana*, *Enterolobium contortisiliquum*, *Albizia hassleri*, *Cabralea* sp, *Aspidosperma polyneuron*, Among others, the forest also has a high number of species of lianas, epiphytes, tree ferns and palms (*Syagrus romanzofianna* y *Euterpe edulis*). The natural communities are made up of swamps, gallery forests, tall and medium semi-deciduous forests, bamboo groves, savanna (cerrado), caves, rocky areas and cliffs. The soils are well-drained and predominantly derived from basalt and sandstone (INFONA, 2011).

Bosque Subhúmedo del Cerrado - BSHC

It includes the native woods of the Concepción ravine, whose structure has 2 vertical strata and an understory with a predominance of grasses, the floristic composition includes *Amburana cearensis*, *Peltophorum dubium*, *Anadenanthera colubrina*, *Enterolobium contortisiliquum*, *Schinopsis balansae*, *Calycophillum multiflorum*, *Phyllostylon rhamnoides*, *Astronium urundeuva*, *Anadenanthera peregrina*, *Guibourtia rhodatiana*, *Butia yatay*, *Axonopus affinis*, *Psidium arasa*, *Andropogon lateralis y Elyonorus latiflorus*, among others. The natural communities are made up of gallery forests, caves, medium and low semi-deciduous forests, enclosures, wooded savannas and cliffs. The soils are predominantly derived from granite and limestone (INFONA, 2011).

Bosque Subhúmedo Inundable del Río Paraguay - BSHIRP

It includes forests in islets, forests associated with palm groves throughout the plain of the Paraguay River, the floristic composition includes *Peltophorum dubium*, *Tabebuia sp.*, *Holocalyx balansae*, *Ficus sp.*, *Nectandra sp.*, *Ocotea sp.*, *Sapium hematospermum*, *Pithecellobium scalare*, *Gleditzia amorphoides*, *Erithrina crista-galli*, *Salix humboldtiana*, *Diplokeleba floribunda*, *Schinopsis balansae*, *Handroanthus heptaphyllus*, *Syagrus romanzoffiana*, *Copernicia alba y Enterolobium contortisiliquum*, among others. The natural communities are made up of gallery forests, palm savannas, medium and low semi-deciduous forests. The soils are predominantly derived from marine and alluvial sediments, generally flooded, or poorly or imperfectly drained (INFONA, 2011).

Bosque Seco Chaqueño - BSCH

It covers the open forests of the Central Chaco up to the Bolivian border. The floristic composition includes *Ceiba insignis*, *Schinopsis quebracho-colorado*, *Aspidosperma quebracho-blanco*, *Prosopis alba*, *Prosopis nigra*, *Ruprechtia triflora*, *Quiabentia pflanzii*, *Ziziphus mistol* y *Ximenia americana*, among others. The natural communities are made up of semi-deciduous xerophytic forest, paleo-corrugated savannahs with esparto grass and cerrado. The soils are predominantly derived from wind sediments (INFONA, 2011).

Bosque Palmar - BP

It includes palm-dominated forests distributed throughout the floodplain of the Paraguay River basin, with different densities and degrees of disturbance. The dominant palm species is *Copernicia alba* (INFONA, 2011).

Plantaciones Forestales - PF

Forest plantations are characterized when predominantly (more than 50%) of the area is composed of trees established through the deliberate planting and/or sowing of native and/or exotic species, in areas of afforestation and reforestation, for production or conservation or other purposes (INFONA, 2011).

9.2.1.3 Regional Characterization (IIA)

The territory of Paraguay can be further subdivided into five ecoregions (Figure 4). According to Dinnerstein et al. (1995) an ecoregion can be defined as a set of geographically distinct natural communities that share most of their species, dynamics and ecological processes, as well as similar environmental conditions, and are so named:

"Ecorregión del Bosque Atlántico del Alto Paraná" (BAAPA), "Ecorregión Chaco Húmedo", "Ecorregión Chaco Seco", "Ecorregión Cerrado y Ecorregión Pantanal" (Dinerstein *et al.*, 1995 *apud* Encinas *et al.*, 2019) all of those with significative biodiversity (Cartes, 2006; Salas-Dueñas & Facetti 2007 *apud* Encinas *et al.*, 2019).

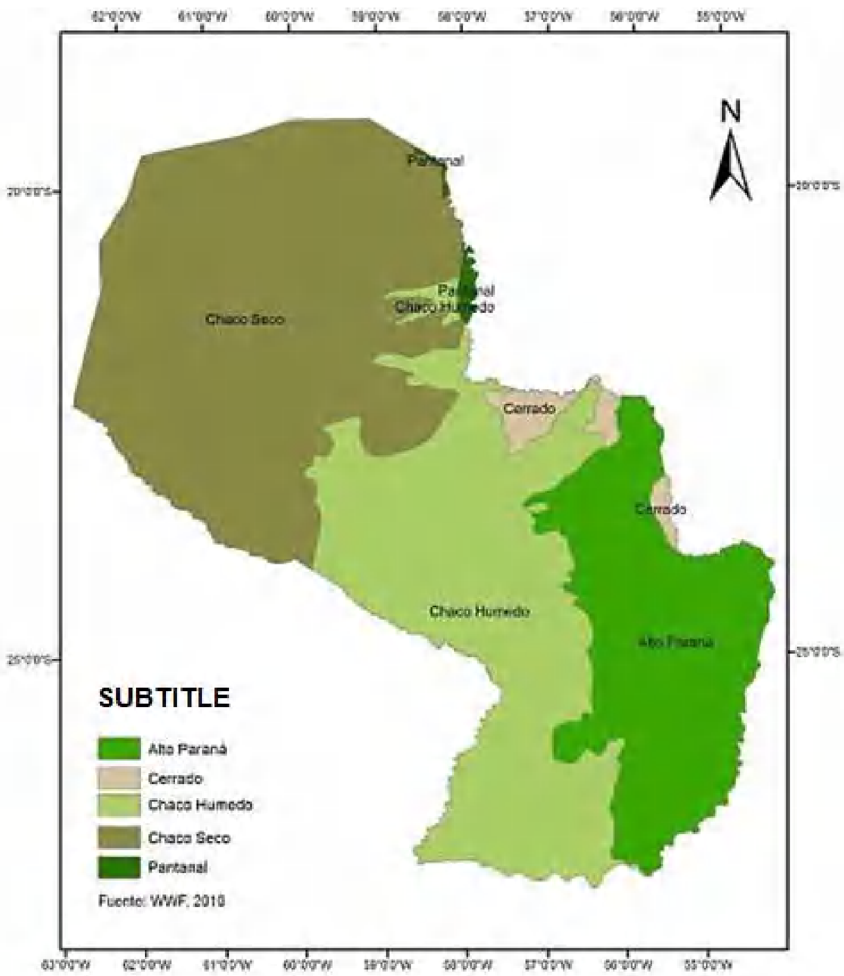


Figure 4 – Map of Paraguay's eco-regions (2011). Source: Proyecto "Desarrollo de Metodologías de Monitoreo de Carbono almacenado en los Bosques para la REDD+ en el Paraguay" (2011).

The indirect influence area (Figure 5) is located within the Department of Concepción, the second largest department in the eastern region of Paraguay, with approximately 14% of the entire forest area of the eastern region (SERPAJ PY, 2013). This department is located in the Cerrado, Atlantic Forest of the Upper Paraná and Humid Chaco ecoregions (GIS/CIF/FCA/UMA Laboratory Technical Report, 2011; LIFE Institute 2016).

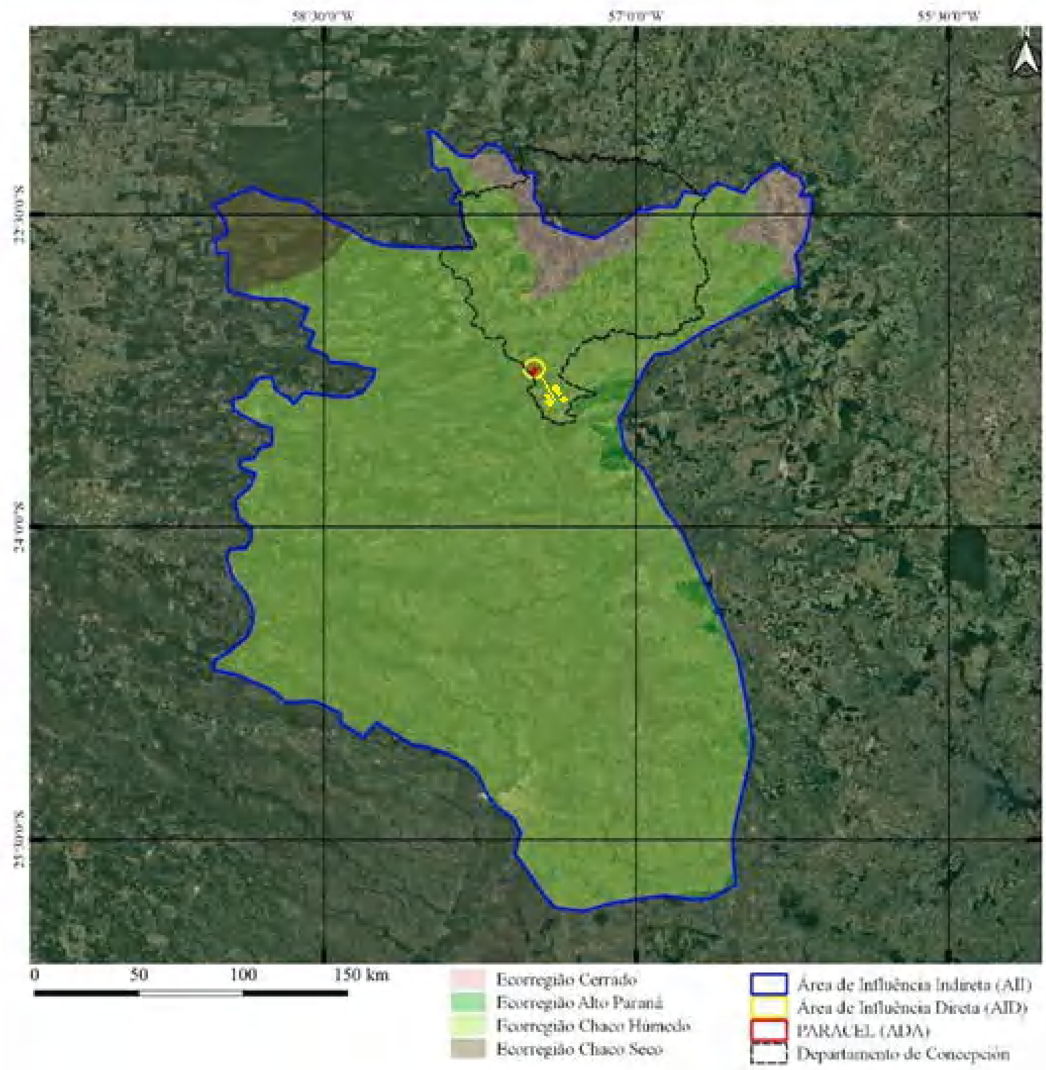


Figure 5 – Image with the location of the Indirect Influence Area of the pulp mill. Image obtained in Google Earth February/2018. Cartographic base: Map of the Ecoregions of Paraguay (Proyecto "Desarrollo de Metodologías de Monitoreo de Carbono almacenado en los Bosques para la REDD+ en el Paraguay", 2011).

Cerrado Eco-region (Brazilian Savana)

The plant formations present in this physiognomy are characterized by a transition from forests with extensive natural fields influenced by climate (Figure 6). In this ecoregion the trees are sometimes grouped into capons, which allows the appearance of extensive areas occupied by grasses, generally rhizomatous, and frequently some palms, without caules or not. In these capons the trees and shrubs, which generally do not exceed 3 or 4 m in height, can be exceptionally dense, forming the so-called Cerradón or Cerrados in transition with the forest formations, where the tree vegetation dominates the fields, or more open, forming the so-called Campos Cerrados, where the grass fields dominate the woody vegetation (Technical Report GIS/CIF/FCA/UMA Laboratory, 2011; LIFE Institute 2016; Mereles, 2005; 2007).

Figure 6 – The Cerrado's physiognomy profile. **Source: Mereles, 2005 (adapted).**

In this plant formation, the herbaceous species have xylopods, rhizomes, bulbs and other underground organs, and the trees and shrubs have suberose bark and tortuous trunks, which help the species to withstand high temperatures during savannah fires. The natural communities are composed of: lagoons, estuaries, baths, forests on saturated soils, rivers, streams, springs, caves, medium and low semi-deciduous forests, wooded savannas and rocky areas (GIS/CIF/FCA/UMA Laboratory Technical Report, 2011; LIFE Institute 2016; Mereles, 2005; 2007).

Eco-region of "Bosque Atlántico del Alto Paraná" (Alto Parana Atlantic Forest)

This ecoregion is composed mainly of tropical and subtropical forest, also described as tropical temperate rainforest. It has the following communities: peatlands, forests on saturated soils, rivers, streams, springs, waterfalls, high and medium semi-deciduous forests, Araucaria and Cerrado forests. It is undoubtedly the ecoregion with the greatest diversity of fauna in Paraguay, with more than 80% of the fauna of the eastern region concentrated in this ecoregion. (GIS/CIF/FCA/UMA Laboratory Technical Report, 2011; LIFE Institute 2016).

Eco-región of "Chaco Húmedo" (Wet Chaco)

This ecoregion is located in the western (west) and eastern (east) regions and has the following vegetation types: sub-humid and semi-deciduous forests, savannas and swamps. The fauna that occurs in general is not very different from that of other ecoregions associated with wetlands and is distinguished from the others by the abundance of aquatic species.

According to the GIS/CIF/FCA/UMA Laboratory Technical Report (2011), it is considered that in Ecorregión del Chaco Húmedo the ground cover can be categorized into: Savannah, Flooded Savannah, Forest Cover, Cultivated Land (agricultural areas - annual, perennial and mixed crops; livestock - established pastures and in combination with small wooded areas; land prepared for cultivation, fallow land and deforested areas), water bodies and urban areas. The categories of land cover vegetation considered in this study are described below:

Sabana (Savana)

According to the description by Huespe, et al., (1994 apud Informe Técnico Mapa de cobertura del Paraguay, 2011; Spichiger et al. 2011), the savannah forms a naturally formed landscape dominated by grasses and legumes with trees scattered to a lesser extent. It is distributed in places of high topography, above maximum flood levels.

This category also includes formations of the type ¨Cerrado¨ and areas with extensive livestock use (Eastern region), as well as grassland and vegetation dominated by bushes and forests. The former correspond to a type of vegetation that is found mainly in the Chaco's clogged paleo-corridors, composed predominantly of grasses and scattered trees, such as “paratodo” (*Tabebuia aurea*), “jacarandá (*Jacaranda puberula*), “algarrobo” (*Prosopis rubriflora*), “urunde’y” (*Astronium fraxinifolium* var. *glabrum*) and “quebracho colorado” (*Schinopsis lorentzii*) (Huespe, *et al.*, 1994 *apud* “Informe Técnico Mapa de cobertura del Paraguay” - Technical Report Coverage Map of Paraguay, 2011; Spichiger *et al.* 2011).

Sabana inundada (Flooded Savannah)

This is a type of low topography land vegetation, characterized by soils with superficial phreatic levels and affected by flood waters, almost permanently throughout the year. In the Eastern region, the flooded savannah includes extensive wetlands, reservoirs and marshes, resulting from the overflowing of water courses (rivers and streams), on hydromorphic soils formed by the dragging of sediments. While in the Western region, this category includes marshes, swamps and reservoirs, which are the characteristic vegetation of these lowlands affected by flood water almost all year round, which are colonized by hydrophilic herbaceous species of cyperaceous, grasses, chamottes and others (Huespe et al., 1994 apud Technical Report Map of Coverage of Paraguay, 2011).

Sabana inundable (Possibly Flooded Savannah)

The vegetation is generally called herbaceous located in places with both flat topography and in the valleys affected by flood water during a certain time of the year. In this respect, it is generally distributed on soils with a superficial water table and slow drainage. In this natural formation also converges a type of combined vegetation of grasses and palms, which includes Karanda'y palms, sporadically alternating species such as Prosopis sp. (Huespe, et al., 1994 apud Technical Report Map of Coverage of Paraguay, 2011).

Cobertura forestal (Forestry Cover)

According to FAO (2009), forest is defined as areas equal to or greater than 0.5 ha; with a percentage (%) of tree crown cover equal to or greater than 10. The height of mature trees is equal to or greater than 5 m, and according to Huespe, et al. (1994 apud Technical Report Cover Map of Paraguay, 2011) the category Forest cover includes: Continuous forest cover, which consists of intermittently distributed forest stands and comprises the most important forest associations in the country; Residual forest cover, represented by fragments of non-continuous forest cover; Gallery forest cover, associated with the orientation of permanent or intermittent runoff from watercourses; and Forested and Reforested land, refers to forest cover composed predominantly of trees established by planting and/or deliberate seeding. Includes undergrowth from trees that were originally planted or seeded.

According to the secondary data obtained for the areas of influence of the PARACEL pulp mill and its surroundings, the following data are collected with the species of occurrence characteristic of the phytophysiology present in the region.

Table 2 – List of plant species that may appear in the mill's IIA.

Family	Scientific Nomenclature	Common name in Paraguay	End.	SEAM 524/06
Acanthaceae	*Justicia* sp.			
	Ruellia woolstonii C. Ezcurra		x	
Amaranthaceae	*Froelichia paraguayensis* Chodat		x	
Amaryllidaceae	*Habranthus caaguazuensis* Ravenna		x	
Anacardiaceae	*Anacardium humile* A.St.-Hil.			
	Astronium fraxinifolium Schott	Urunde'y para		
	Schinus weinmannifolius Engl.	Molle'i		
	Schinus weinmannifolius Endl. var. *hassleri* (F.A. Barkley) F.A. Barkley		x	
Anemiaceae	*Anemia tomentosa* (Savigny) Sw.			
Annonaceae	*Annona calophylla* R.E.Fr.		x	
	Annona dioica A.St.-Hil.	Aratiku ñu		
	Annona glaucophylla R.E.Fr.		x	
	Annona nutans (R.E.Fr.) R.E.Fr.	Aratiku ñu		
	Annona paraguayensis R.E.Fr			
	Annona phaeoclados Mart.			
	Duguetia furfuracea (A.St.-Hil.) Saff.	Aratiku		
	Rollinia emarginata Schltdl.	Aratiku'i		
	Xylopia aromatica (Lam.) Mart.			
Apocynaceae	*Aspidosperma australe* Müll.Arg.	Kirandy		
	Aspidosperma cylindrocarpon Müll. Arg.			
	Aspidosperma pyrifolium Mart.	Palo rosa		
	Aspidosperma quebracho-blanco Schltdl.			
	Aspidosperma tomentosum Mart.			
	Forsteronia glabrescens Müll. Arg.			
	Hancornia speciosa Gomes			
	Macrosiphonia longiflora (Desf.) Müll. Arg.			
	Mandevilla petraea (A.St.-Hil.) Pichon	Eiruzu ka'a		
	Mandevilla pohliana (Stadelm.) A.H. Gentry	Jaguarova		
	Mandevilla spigeliiflora (Stadelm.) Woodson			
	Marsdenia altissima (Jacq.) Dugand supsp. faucinuda Dugand		x	
	Marsdenia guaranitica Malme		x	
	Mesechites sanctae-crucis (S. Moore) Woodson			

Family	Scientific Nomenclature	Common name in Paraguay	End.	SEAM 524/06
	Oxypetalum brachystephanum (Malme) Malme		x	
	Prestonia acutifolia (Müll. Arg.) K. Schum.			
	Prestonia tomentosa R. Br.			
	Rauvolfia mollis S. Moore			
	Rhabdadenia pohlii Müll. Arg.			
	Rhabdadenia ragonesei Woodson			
	Tabernaemontana catharinensis A. DC.			
	Thevetia bicornuta Müll. Arg.			
	Thevetia peruviana (Pers.) K. Schum.			
Araceae	*Anthurium paraguayense* Engl.			
	Dracontium margaretae Bogner			
	Philodendron undulatum Engl.	Guembe		
	Taccarum weddellianum Brongn.			
Arecaceae	*Acrocomia aculeata* (Jacq.) Lodd. ex Mart.	Mbokaja		
Arecaceae	*Allagoptera leucocalyx* (Drude) Kuntze			
Arecaceae	*Butia paraguayensis* (Barb.Rodr.) L.H. Bailey	Yatai		EP
Arecaceae	*Syagrus romanzoffiana* (Cham.) Glassman	Pindo		
Aristolochiaceae	*Aristolochia* sp.	Patito		
Asparagaceae	*Herreria* sp.	Zarzaparrilla		
Aspleniaceae	*Asplenium* sp.			
Asteraceae	*Baccharis* sp.	Chirca		
	Calea formosa Chodat		x	
	Calea rojasiana Chodat		x	
	Lessigianthus concepcionis M.B. Angulo & Dematteis		x	
	Mesanthophora brunneri H.Rob		x	
	Pectis guaranitica Chodat		x	
	Porophyllum hasslerianum Chodat		x	
	Senecio sp.			
	Stevia apensis B.L. Rob.		x	
	Verbesina guaranitica Chodat		x	
Begoniaceae	*Begonia obovatistipula* C.DC.		x	
Bignoniaceae	*Arrabidaea* sp.			
	Jacaranda micrantha Cham.	Caroba		
	Jacaranda mimosifolia D. Don	Jacaranda		
	Dolichandra unguis-cati (L.) L.G. Lohmann	Mbarakaja pyape		

Family	Scientific Nomenclature	Common name in Paraguay	End.	SEAM 524/06
	Tabebuia aurea (Silva Manso) Benth. & Hook.f. ex S. Moore	Paratodo		
	Handroanthus heptaphyllus (Vell.) Mattos	Lapacho rosado		EP
	Handroanthus pulcherrimus (Sandwith) S.O. Grose	Lapacho amarillo		EP
Boraginaceae	*Cordia glabrata* (Mart.) A.DC.	Peterevy moroti		EP
	Cordia trichotoma (Vell.) Arráb. ex Steud.	Peterevy hu		
	Cordia americana (L.) Gottschling & J.S. Mill.	Guajayvi		
	Euploca margaritensis (I.M. Johnst.) J.I.M. Melo & R. Degen		x	
Bromeliaceae	*Aechmea* sp.			
	Bromelia balansae Mez	Karaguata		
	Ananas sagenaria (Arruda) Schult. & Schult.f.	Karaguarta'i		
	Tillansia sp.	Clavel del aire		
	Dyckia affinis Baker		x	
	Dyckia insignis Hassl.		x	
	Dyckia vestita Hassl.		x	
Cactaceae	*Cereus stenogonus* K. Schum.	Cactus		
	Discocactus heptacanthus subsp. *magnimammus* (Buining & Brederoo) N.P. Taylor & Zappi	Tuna pe		EP
	Rhipsalis sp.	Suelda con suelda		
	Cereus sp		x	
	Harrisia hahniana (Backeb.) Kimnach & Hutchison		x	
Cannabaceae	*Celtis iguanaea* (Jacq.) Sarg.	Juasy'y		
	Trema micrantha (L.) Blume	Kurundi'y		
Celastraceae	*Maytenus ilicifolia* Mart. ex Reissek	Cangorosa		EP
Combretaceae	*Terminalia argentea* Mart.	Yvyra hu		
Commelinaceae	*Commelina erecta* L.	Santa lucia hovy		
Convolvulaceae	*Evolvulus hasslerianus* Chodat		x	
Cyperaceae	*Scleria* sp.			
Erythroxylaceae	*Erythroxylum paraguariense* (Chodat & Hassl.) O.E. Schulz		x	
Euphorbiaceae	*Cnidoscolus albomaculatus* (Pax) I.M. Johnst.		x	
	Croton sp.			
	Euphorbia argillosa Chodat & Hassl		x	
	Manihot anomala Pohl subsp. *glabrata* (Chodat & Hassl.) D.J. Rogers & Appan		x	

Family	Scientific Nomenclature	Common name in Paraguay	End.	SEAM 524/06
	Manihot populifolia Pax, Pflanzenr.		x	
	Sapium haematospermum Müll.Arg.	Kurupika'y		
	Stillingia scutellifera D.J. Rogers			
Fabaceae	*Aeschynomene histrix* Poir. var. apana Rudd, J. Wash.		x	
	Aeschynomene magna Rudd		x	
	Albizia niopoides var. *niopoides*	Yvyra ju		
	Amburana cearensis (Allemao)A.C.Sm.	Trébol		EP
	Anadenanthera colubrina (Vell.) Brenan	Kurupa'y		
	Anadenanthera peregrina (L.) Speg.	Kurupa'y kuru		
	Arachis hassleri Krapov., Valls & C.E. Simpson		x	
	Bauhinia sp.			
	Calliandra brevicaulis Micheli	Niño azote		
	Chamaecrista desvauxii (Collad.) Killip var. *peribebuiensis* (Chodat & Hassl.) H.S. Irwin & Barneby		x	
	Copaifera laevis Dwyer		x	
	Copaifera sp.	Quina		
	Galactia sp.			
	Holocalyx balansae Micheli	Yvyra pepe		
	Hymenaea courbaril L.	Jatay'va		
	Macroptilium chacoensis (Hassl.) S.I. Drewes & R.A. Palacios		x	
	Mimosa centurionis Barneb		x	
	Mimosa fiebrigii Hassl.		x	
	Mimosa monadelpha Chodat & Hassl. var. *glabrata* (Hassl.) Barneby		x	
	Myroxylon peruiferum L.f.	Incienso colorado		EP
	Parapiptadenia rigida (Benth.) Brenan	Kurupa'y ra		
	Parkinsonia praecox (Ruiz & Pav.) Hawkins	Verde olivo		
	Peltophorum dubium (Spreng.) Taub.	Yvyra pyta		
	Prosopis sp.			
	Pterogyne nitens Tul.	Yvyra'ro		
	Senegalia polyphylla (DC.) Britton & Rose	Jukeri guasu		
Iridaceae	*Sisyrinchium igatimiense* Ravenna		x	
Lamiaceae	*Leonotis nepetifolia* (L.) R.Br.	Cordón de fraile		
	Hyptis pachyarthra Briq.		x	

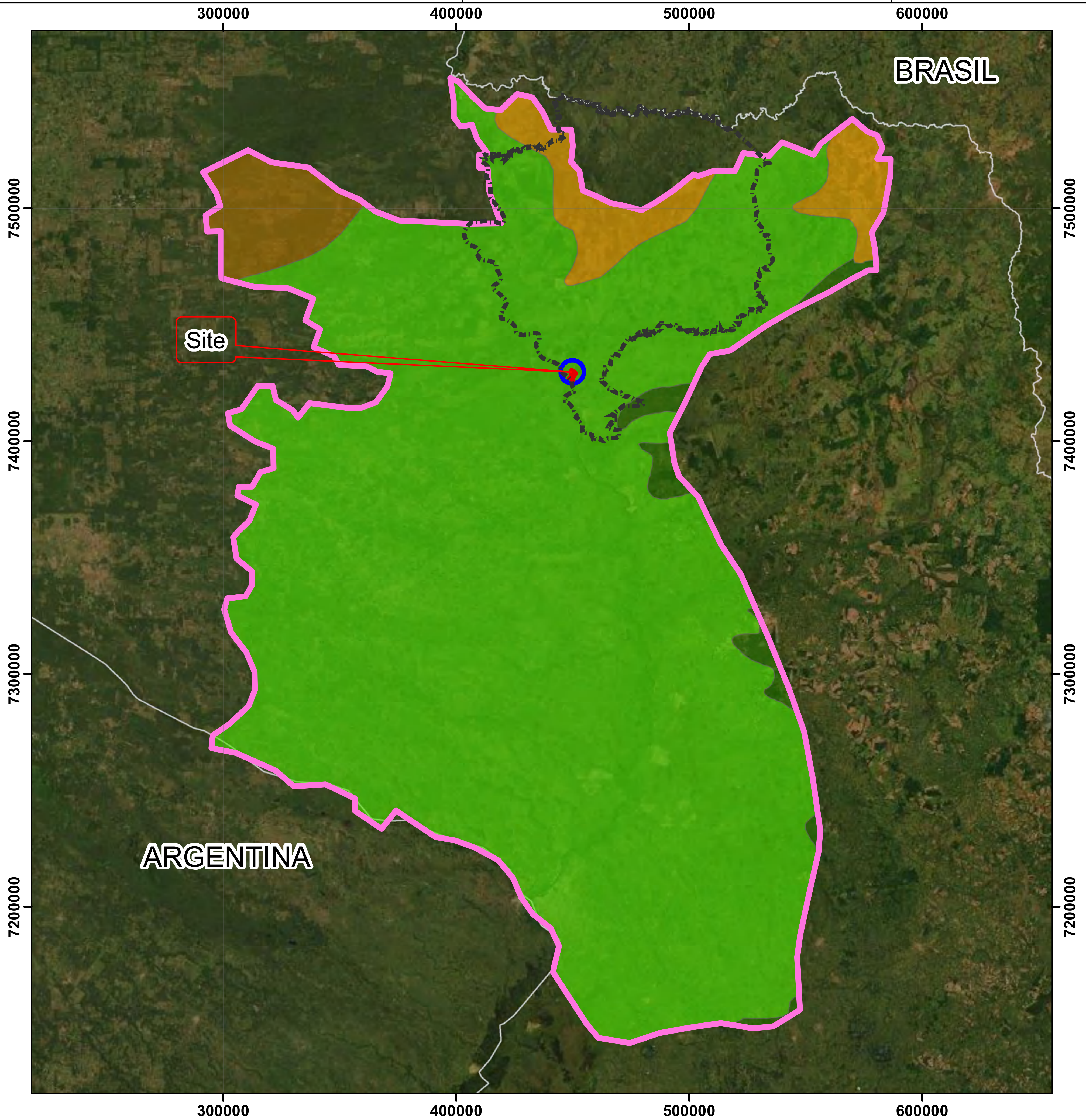
Family	Scientific Nomenclature	Common name in Paraguay	End.	SEAM 524/06
Lygodiaceae	*Lygodium* sp.			
Lythraceae	*Cuphea corisperma* Koehne subsp. *hexasperma* (Koehne) Duré & Molero		x	
Malpighiaceae	*Heteropterys cultriformis* Chodat		x	
	Tetrapterys hassleriana Nied.		x	
Malvaceae	*Ceiba speciosa* (A.St.-Hil.) Ravenna	Samu'u		
	Pseudobombax sp.			
	Ayenia spinulosa R.E.Fr.		x	
	Luehea microcarpa R.E.Fr. var. *polymorpha* Hassl.		x	
	Malvastrum sp.	Typycha hu		
	Sida gracillima Hassl.		x	
	Sida pseudocymbalaria (Hassl.) Hassl.		x	
	Sida sp.			
	Guazuma ulmifolia Lam.	Kamba aka guasu		
	Sterculia striata A. St.-Hil. & Naudin	Manduvi guasu		
	Luehea candicans Mart.	Ka'a oveti		
	Luehea grandiflora Mart.	Ka'a oveti		
Melastomataceae	*Miconia* sp.		x	
Meliaceae	*Cedrela fissilis* Vell.	Cedro o ygary		
	Trichilia sp.	Cedrillo		
Moraceae	*Dorstenia* sp.	Taropé		
	Ficus enormis (Miq.) Miq.	Guapo'y		
	Maclura tinctoria (L.) D. Don ex Steud.	Tatajyva		
Myrtaceae	*Campomanesia pubescens* (Mart. ex DC.) O. Berg	Guavirami		
	Eugenia sp.			
Nyctaginaceae	*Guapira paraguayensis* (Heimerl) Lundell		x	
Orchidaceae	*Campylocentrum neglectum* (Rchb.f. & Warm.) Cogn.	Vandita		
	Cyrtopodium sp.	Tamanakuna		
	Pelexia collocaliae Szlach.		x	
Orobanchaceae	*Agalinis linarioides* (Cham. & Schltdl.) D'Arcy subsp. *rojasii* Barringer		x	
Passifloraceae	*Passiflora* sp.	Mburukuja'i		
	Turnera grandidentata (Urb.) Arbo		x	
Piperaceae	*Piper amalago* L.	Tuja renymy'a		
Plantaginaceae	*Angelonia integerrima* Spreng.			
Poaceae	*Andropogon* sp.			

Family	Scientific Nomenclature	Common name in Paraguay	End.	SEAM 524/06
	Axonopus sp.			
	Elionurus sp.	Espartillo		
Polygalaceae	*Polygala guaranitica* Chodat		x	
Polypodiaceae	*Microgramma* sp.	Anguja nambi		
Rubiaceae	*Calycophyllum multiflorum* Griseb.	Palo blanco		
	Genipa americana L.	Ñandypa		
	Spermacoce verticillata L.	Typycha corredor		
	Spermacoce viridiflora (Chodat & Hassl.) Govaerts		x	
Rutaceae	*Balfourodendron riedelianum* (Engl.) Engl.	Guatambu		EP
	Helietta apiculata Benth.	Yvyra ovi		
	Pilocarpus pennatifolius Lem.	Yvyra ta'i		
Salicaceae	*Banara arguta* Briq.	Mbavy		
Sapindaceae	*Allophylus edulis* (A.St.-Hil., A. Juss. & Cambess.) Radlk.	Koku		
	Melicoccus lepidopetalus Radlk.	Yvapovo		
	Serjania sp.			
	Talisia esculenta (A. St.-Hil.) Radlk.	Karaja bola		
Sapotaceae	*Chrysophyllum gonocarpum* (Mart. & Eichler ex Miq.) Engl.	Aguai		
Selaginellaceae	*Selaginella* sp.			
Smilacaceae	*Smilax goyazana* A.DC.			
Solanaceae	*Solanum granuloso-leprosum* Dunal			
	Solanum sisymbriifolium Lam.	Ñuati pyta		
Urticaceae	*Cecropia pachystachya* Trécul	Amba'y		
Verbenaceae	*Lippia lupulina* Cham.			
Vochysiaceae	*Qualea grandiflora* Mart.			

Source: Management Plan of the Natural Reserve Tagatiya mi (2008-2012); Ramella & Perret (2011). Legend: End.: endemic; Resolution SEAM 524/06 approving the list of endangered species of flora and fauna in Paraguay: EP – endangerous.

The physiognomy map of the Indirect Influence Area (IIA) (Figure 7) below identifies the types of vegetation found.

Figure 7 – Map of physiognomy of the IIA.



Sistema de Coordenadas: SIRGAS 2000 - UTM Zona 23S
Proyección: UTM - Transversal de Mercator
Datum: SIRGAS 2000

- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos). Informe Técnico Mapa de cobertura del Paraguay año 2011

Subtitle

- Departamento de Concepcíón
- DAA
- DIA
- IIA
- Ecorregión Alto_Parana
- Ecorregión Chaco Húmedo
- Ecorregión Chaco_Seco
- Ecorregión Cerrado

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PARACEL PÖYRY

TÍTULO DEL MAPA: IIA Physiognomy Map	
TÍTULO DEL PROYECTO: BIOTIC ENVIRONMENT - IIA	
PROCESO DE LICENCIA: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT	
TIPO DE LICENCIA: ENVIRONMENT PROCESS PERMIT	
UBICACIÓN: CONCEPCIÓN-PY	UGHRI: CIH8 Aquidaban y CIH18 Rio Pilcomayo

ESCALA:	REVISIÓN:	RESPONSABLE TÉCNICO:	CRBio Nº:
1:1.750.000	25/05/2020	EDUARDO MARTINS Biologo	26.063/01-D

9.2.1.4 Local Characterization – Direct Influence Area and Directly Affected Area

Direct Influence Area (DIA)

In a generalized way, DIA is represented by a matrix in which the flora is strongly anthropized, with suppression of native phytophysiology for the use of cattle rising, being formed by different typologies of plants interspersed by anthropic zones.

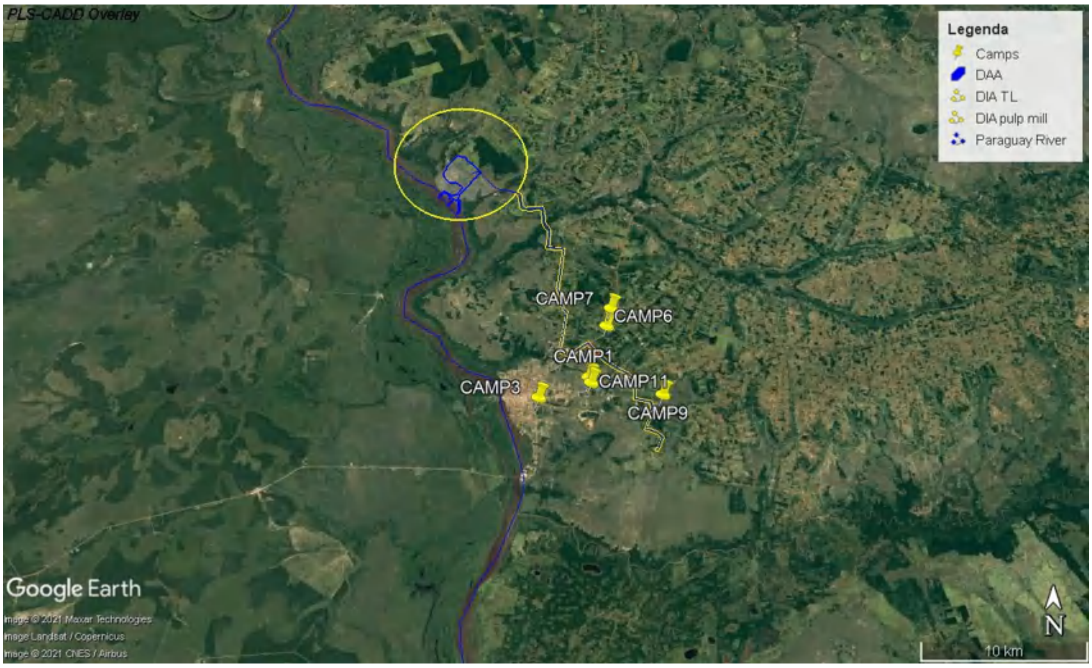


Figure 8 – Aerial image with the location of the mill's DIA. Image: Google Earth feb/2021.

It should be noted that from the 23,10 ha Transmission Line DIA only 3,5 ha is vegetation area, being most of the area composed by roads and pasture lands, as it is shown the figure below (Figure 9-13). Other than that most of the camps are located in the urban area (Figure 14, 15 and 16), therefore the vegetation analysis took place specially within the 5 km radius of the mill influence area. Hightlighting that the vegetation found in the TL DIA and camps doesn't differ much from the ones found within the 5 km radius.

Figure 9 – Transmission Line Sections 1/5 (from the mill). Image: Google Earth jul/2021.

Figure 10 – Transmission Line Sections 2/5 (from the mill). Image: Google Earth jul/2021.

Figure 11 – Transmission Line Sections 3/5 (from the mill). **Image: Google Earth jul/2021.**

Figure 12 – Transmission Line Sections 4/5 (from the mill). **Image: Google Earth jul/2021.**

Figure 13 – Transmission Line Sections 5/5 (from the mill). **Image: Google Earth jul/2021.**

Figure 14 – Camp 1, 3 and 11 location. **Image: Google Earth jul/2021.**

Figure 15 – Camp 9 location. **Image: Google Earth jul/2021.**

Figure 16 – Camp 7 and Camp 6 location. **Image: Google Earth jul/2021.**

Thus, it can be said that the DIA region is represented by a complex where the vegetation layer is made up of varied communities, which appear in the landscape forming a heterogeneous mosaic, where the phytophysiological features are very close to each other, in such a way that elements of different types of vegetation are interrelated, making it difficult to delimit them exactly. Thus, it is possible to recognize basically the following categories for the area's vegetation cover: Savannah, Flooded Savannah and Semideciduous Forest.

Sabana (SAV-1, Savannah)

Located to the northwest of the area where the PARACEL pulp mill is located, about 200 meters away, this portion of vegetation is in contact with extensive areas used for cattle raising.

Figure 17 – Image with location of the Savannah (SAV-1). Image: Google Earth feb/2018 (Coordinates UTM 21K - midway point : 448922.15 E/ 7429694.55 S).

Figure 18 – Aerial image of the area with Savannah (SAV-1), in contact extensive cattle farming.

This plant formation is essentially structured in three layers: an upper part composed mainly of palms, with a Diameter At Breast Height (DBH) varying from 20 to 40 cm and a height of 10 to 12 meters, an intermediate one, with predominance of arboreal individuals and shrubs up to approximately 5 m with a Diameter At Base Height (DAB)[1] with variation between 5 to 20 cm, grouped in "capones" that occur in sandy soils; and a lower stratum consisting mainly of small palms such as the *Butia paraguayensis* (jatai), herbaceous and grass plants.

Figure 19 – General view of the area with Savannah (SAV-1). Coordinates UTM 21K 448922.15 E/ 7429694.55 S.

[1] DAB: Diameter At Base Height (0,50 cm from ground level)

Figure 20 – Detail of the spaced trees and bushes grouped in "capones", which occur in sandy soils.

Figure 21 – Another point of view of the spaced trees and bushes grouped in "capones", which occur in sandy soils.

Figure 22 – Detail of the groupings formed by terrestrial bromeliads and palm trees of the species*Butia paraguayensis* (jatai).

Figure 23 – Detail of the dense stratum formed by terrestrial bromeliads between tree and shrub spacings.

Among the species of trees and shrubs that are: *Schinopsis balansae* (quebracho), *Copernicia alba* (karanda'y), *Butia paraguayensis* (jatai), *Acrocomia aculeata* (mbokaja), *Ziziphus mistol* (mistol), *Duguetia furfuracea*, *Plenckia populnea*, *Cereus* sp (tuna), *Prosopis rubriflora* (algarrobo), *Schinus weinmannifolius* (aguara yva), *Randia* sp. y el *Eugenia involucrata* (ñangapiry), among the terrestrial bromeliads the *Bromelia balansae*, among the subbushes *Waltheria indica*, and among the herbaceous two different genera stand out in abundance: *Aristida* y *Mimosa*.

Figure 24 – View of the sample of the species *Schinopsis balansae* (quebracho).

Figure 25 – Detail of the fruit of the species *Schinopsis balansae* (quebracho).

Figure 26 – View of specie sampling *Duguetia furfuracea*.

Figure 27 – Detail of the fruit of *Duguetia furfuracea*.

Figure 28 – View of Sampling *Prosopis rubriflora* (algarrobillo).

Figure 29 – (A) Detail of the fruit of fruit; (B) Details of the inflorescences of the species *Prosopis rubriflora* (algarrobillo).

Figure 30 – View of the sample of the species *Randia* sp.

Figure 31 – Detail of the fruit of the species *Randia* sp.

Figure 32 – View of the sample of the species *Bromelia balansae*.

Figure 33 – Detail of the fruits of the species *Bromelia balansae*.

Savannah (SAV-2)

Located near the implantation area of the site of the future PARACEL pulp mill, this physiognomy is inserted in an extensive area with pastures and adjacent to the remaining forest that forms the continuous vegetation on the banks of the Paraguay River.

Figure 34 – Image with the location of the Savannah (SAV-2). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 450492.83 E/ 7427479.93 S).

Figure 35 – Aerial image of the Savanna (SAV-2), view of shrub individuals sometimes grouped in capones or isolated within a dense stratum of grass.

This physiognomy presents a predominance of shrubby individuals up to approximately 3 m with DABs (basal diameter height) ranging from 5 to 15 cm, arranged either alone or grouped in a dense stratum formed by the *Elionurus*, *Eragrostis* e *Aristida*.

Figure 36 – General view of the Savannah portion (SAV-2) where shrub individuals are grouped together, giving an "island" aspect to these formations.

Figure 37 – General view of the portion of the Savannah (SAV-2) where shrub individuals are separated within a dense stratum of grass.

Among the species of occurrence are *Annona spinescens*, *Ziziphus mistol* (mistol), *Ximenia americana* (Indian kurupa'y), *Acacia* sp, *Prosopis rubriflora* (algarrobo), *Ipomoea carnea*, *Hyptis* sp, *Schyzachyrium condensatum* (capi'í), *Senecio grisebachii* (agosto poty), *Setaria parvifolia* (pasto), *Borreria* sp, *Malvastrum* sp, *Clhoris polydactyla*, *Cyperus* sp, *Piriqueta* sp and *Senna* sp.

Figure 38 – View of a sample of the species *Annona spinescens.*

Figure 39 – Detail of the species' fruit *Annona spinescens.*

Figure 40 – View of a sample of the species *Acacia* sp.

Figure 41 – D Detail of the species' fruit *Acacia* sp.

Figure 42 – View of a sample of the species *Ipomoea carnea*.

Figure 43 – Flower detail of the species *Ipomoea carnea*.

Figure 44 – View of a sample of the species *Borreria* sp.

Figure 45 – Flower detail of the species *Malvastrum* sp.

Figure 46 – View of a sample of the species *Piriqueta* sp.

Figure 47 – Flower detail of the species *Senna* sp.

Floodable Savannah (SAVi-1)

Located to the northwest of the area of implantation of the future pulp mill of PARACEL at about 1,000 meters, this physiognomy occupies an extensive portion of the Direct Influence Area (DIA), where water and soil factors clearly delimited the border between the forest formations and the floodable Savanna.

Figure 48 – Image with the location of the floodable Savannah (SAVi-1). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 448269.33 E/ 7430154.83 S).

Figure 49 – Aerial image of the area with flooded Savannah (SAVi-1).

This vegetal formation is basically structured in two layers: an upper one formed mainly by the palm tree (*Copernicia alba*) with a DBH varying between 20 and 50 cm and a height between 8 and 20 m and a lower stratum formed by plants of the Poaceae and Cyperaceae families reaching a height of about 50 to 70 cm.

Figure 50 – Flooding Savannah Area Overview(SAVi-1). Coordenadas UTM 21K 448269.33 E/ 7430154.83 S.

Figure 51 – Another angle of the area with the flooded savannah (SAVi-1), detail of the dense stratum formed by herbs and grasses. Coordinates UTM 21K 448269.33 E/ 7430154.83 S.

Among the species that make up the lower stratum are: *Heteropterys* sp., *Mimosa* sp., *Croton* sp, *Eleocharis* sp, *Cnidoscolus* sp, *Melochia* sp, *Cyperus* sp and *Eleocharis elegans*.

Figure 52 – View of a sample of the species *Heteropterys* sp.

Figure 53 – Detail of the fruits of the species *Heteropterys* sp.

Figure 54 – View of a sample of the species *Mimosa* sp.

Figure 55 – Detail of the fruits of the species *Mimosa* sp.

Figure 56 – View of a sample of the species *Cnidoscolus* sp.

Figure 57 – Detail of the fruits of the species *Cnidoscolus* sp.

Figure 58 – View of a sample of the species *Melochia* sp.

Figure 59 – Detail of the fruits of the species *Melochia* sp.

Figure 60 – View of a sample of the species *Eleocharis elegans*.

Figure 61 – Detail of the fruits of the species *Eleocharis elegans*.

Semideciduous Forest (FS-1)

Located in the northwest of the area where the PARACEL pulp mill is located, about 400 meters away, this physiognomy borders on the physiognomy of the floodable Savannah and the areas designated for cattle farming, forming an extensive mosaic of vegetation.

Figure 62 – Image with the location of the Semideciduous Forest (FS-1). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 448509.78 E/ 7429971.58 S).

This plant formation is structured in two layers: a top layer consisting mainly of tree species with DBH of 10 to 50 cm and a height of 8 to 15 meters, and an understory composed mainly of shrubs, bushes and herbaceous, the layer of organic matter when it is present is little decomposed. Inside the remnant there are signs of selective cutting of vegetation.

Figure 63 – General view of the area with semi decidual forest (FS-1). Coordinates UTM 21K 448509.78 E/ 7429971.58 S.

Figure 64 – View of the vegetation inside the remaining semi decidual forest - FS-1.

Figure 65 – Another angle of vegetation within the remaining semi decidual forest - FS-1.

Figure 66 – Detail of the large tree found after cutting down the tree.

Figure 67 – Another angle of the large tree sample found that was cut into the remaining FS-1.

Among the species of occurrence are *Myracrodruon urundeuva* (urunde'y), *Maytenus ilicifolius* (cangorosa), *Balfourodendron riedelianum* (guatambu), *Celtis iguanaea* (juasy'y), *Campomanesia xanthocarpa* (guavira), *Enterolobium contortisiliquum* (oreja de negro), *Anadenanthera colubrina* (kurupa'y kuru), *Chloroleucon tenuiflorum* (tatare), *Guazuma ulmifolia* (kamba akã guasu), *Schinopsis balansae* (quebracho), *Microlobius foetidus* (yvyra ne), *Ficus* sp., *Croton* sp, *Dalbergia frutescens* (ysypo kopi), *Handroanthus heptaphyllus* (lapacho rosado), *Peltophorum dubium* (canafístula).

Figure 68 – Sample view of the species *Maytenus ilicifolius* (cangorosa).

Figure 69 – Detail of the edges of the leaves, often with thorns, characteristic of the species *Maytenus ilicifolius* (cangorosa).

Figure 70 – Sample view of the species *Campomanesia xanthocarpa* (guavira).

Figure 71 – Detail of the fruits of the species *Campomanesia xanthocarpa* (guavira).

Figure 72 – Sample view of the species *Microlobius foetidus* (yvyra ne).

Figure 73 – Detail of the fruits and seeds of the species *Microlobius foetidus* (yvyra ne).

Semi-deciduous Forest (FS-2)

Located southwest of the area where PARACEL's pulp mill is located, about 500 meters away, this area is connected to the Paraguay River's ciliary forest continuum. However, part of it borders on the areas used for cattle raising.

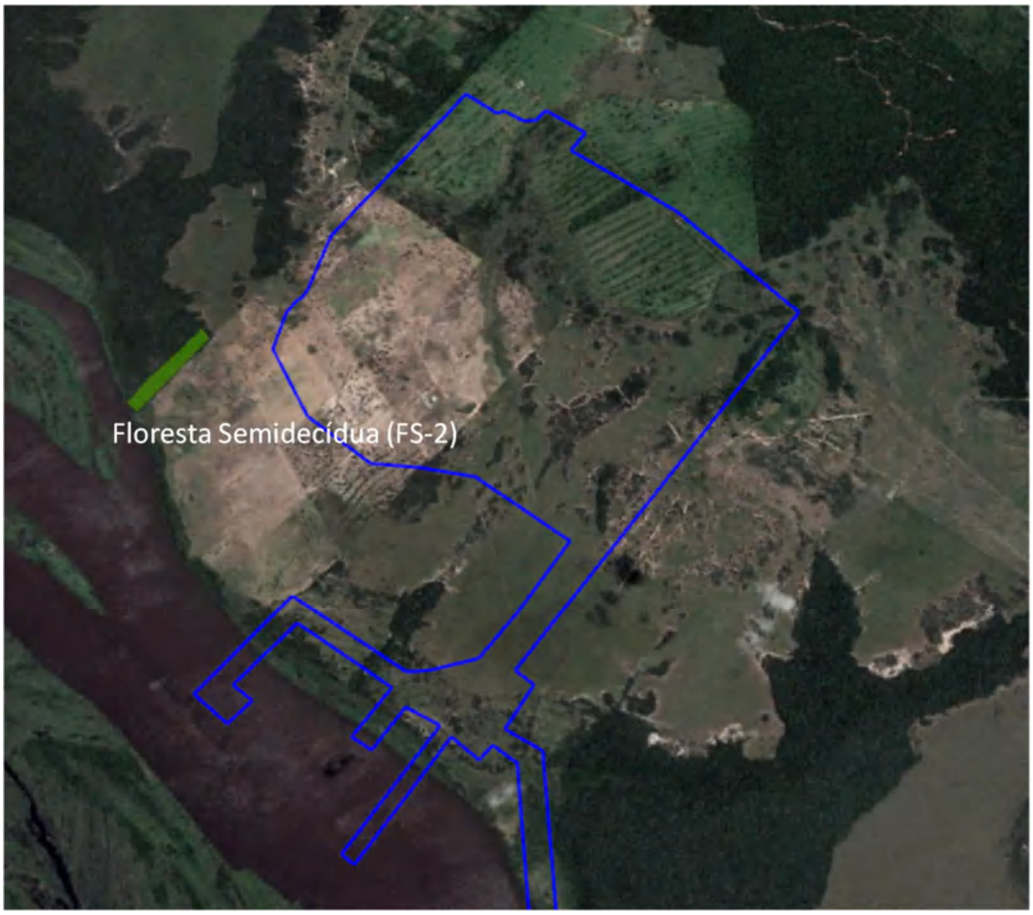


Figure 74 – Image with the location of the Semideciduous Forest (FS-2). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 448187.50 E / 7428636.95 S).

Figure 75 – Aerial image of the area with Semideciduous Forest (FS-2), the remnant that forms the continuum of the Ciliary Forest of the Paraguay River, however, part of it borders on areas destined for cattle ranching.

This area of forest has two strata: an upper stratum composed mainly of tree species with heights between 8 and 10 meters and DBHs that vary between 20 and 40 cm and form a dense canopy, with emerging species that occur between 10 and 15 meters, and an understory that forms shrubs, bushes and herbaceous, the layer of organic matter is little decomposed.

Figure 76 – General view of the area with semideciduous forest (FS-2), contact portion of the grazing area. Coordinates UTM 21K 448187.50 E / 7428636.95 S.

Figure 77 – General view of the margins of the Paraguay river, part of contact with the Semideciduous forest (FS-2). Coordinates UTM 21K 447963.45 E / 7428368.50 S.

Figure 78 – View of the vegetation within the remaining Semideciduous Forest - FS-2.

Figure 79 – Another view of the vegetation within the remaining Semideciduous Forest - FS-2.

Within some of these species, there are *Tabebuia aurea* (lapacho branco), *Anadenanthera colubrina* (kurupa'y kuru), *Handroanthus heptaphyllus* (lapacho rosado), *Enterolobium contortisiliquum* (oreja de negro), *Caesalpinia paraguariensis* (guajakan), *Tapirira guianensis* (ka'ambota), *Guapira* sp., *Chrysophyllum gonocarpum* (aguai), *Zanthoxylum rhoifolium* (tembetary sayju), *Trema micranta* (kurundi'y), *Lithraea molleoides* (molle guasu), *Allophylus edulis* (koku), *Myrsine balansae* (kanelon), *Cordia ecalyculata* (tamana-kuna), *Tabernaemontana catharinensis* (sapirangy), *Bauhinia* sp., *Schinus weinmannifolius* (aguara yva), *Balfourodendron riedelianum* (guatambu), *Sapium haematospermum* (kurupika'y), *Jacaratia spinosa* (jakaratiíh), *Celtis iguanaea* (juasy'y), *Cabralea canjerana* (cancharana) and *Luehea divaricata* (ka'a oveti), among epiphytes *Tillandsia* sp. and among the herbaceous *Pacourina edulis*.

Figure 80 – View of a specimen of the species *Tabebuia aurea* (lapacho blanco).

Figure 81 – Detail of winged seeds characteristics gives species*Tabebuia aurea* (lapacho blanco).

Figure 82 – View of a specimen of the species *Caesalpinia paraguariensis* (guajakan).

Figure 83 – Detail of the fruits of the species*Caesalpinia paraguariensis* (guajakan).

Figure 84 – View of an epiphytic specimen of the genus *Tillandsia* sp., presented in the area.

Figure 85 – Detail of the inflorescences of the genus *Tillandsia* sp.

Figure 86 – View of a specimen of the species *Pacourina edulis*.

Figure 87 – Detail of the inflorescences of the species *Pacourina edulis*.

Bosque Semideciduous (FS-3)

Located to the south of the area of the future pulp mill of PARACEL, at about 300 meters, this physiognomy is connected with the continuous forest of the margin of the Paraguay river, however, part of it limits with the extensive areas destined to the cattle raising.

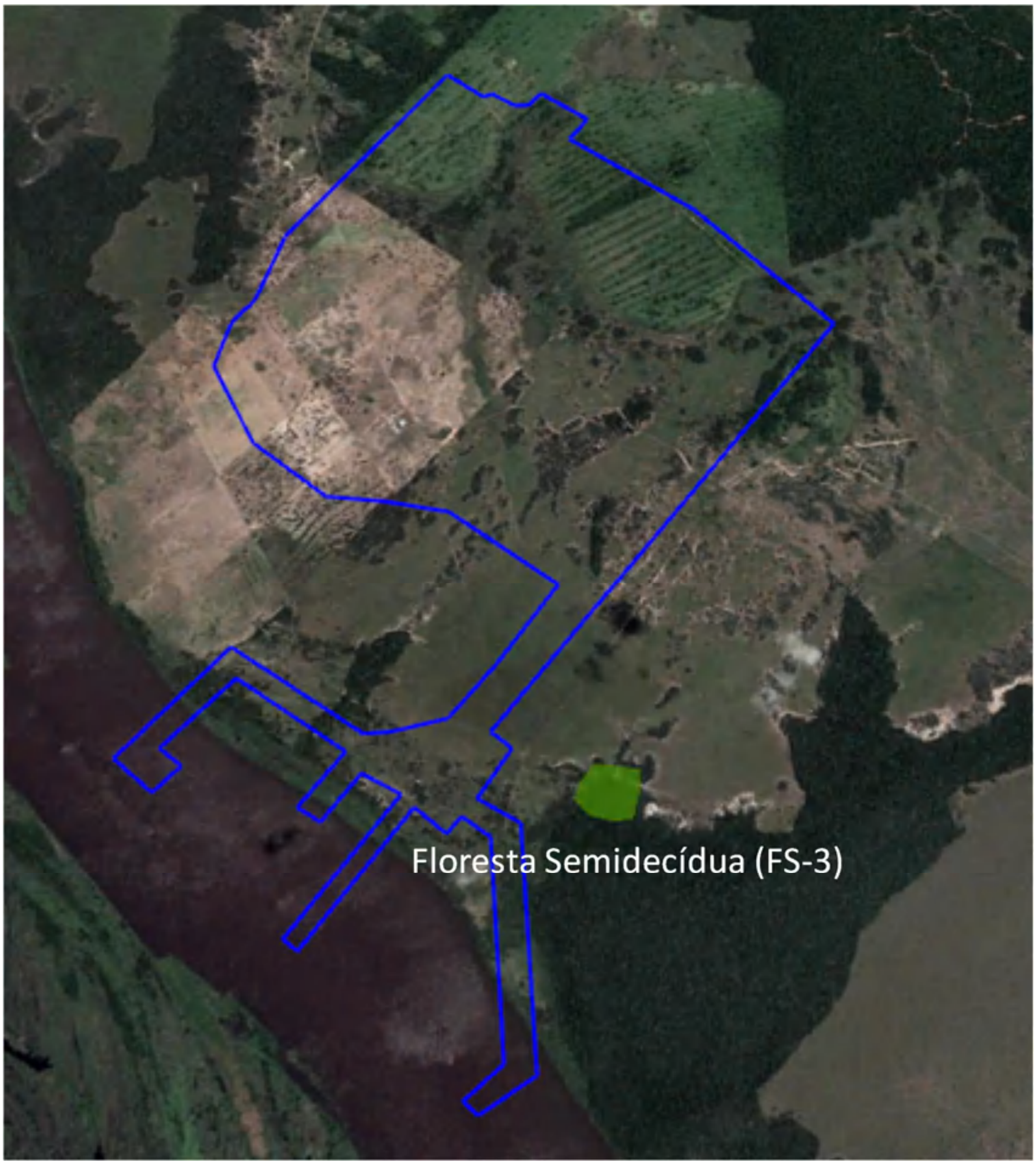


Figure 88 – Aerial image with the location of the Semideciduous Forest (FS-3).
Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 450389.17 E/ 7426715.95 S).

Figure 89 – Aerial image of the area with Semideciduous Forest (FS-3), which forms the continuous forest on the banks of the Paraguay River.

Figure 90 – Another angle of the area with semideciduous forest (FS-3), the remnant that forms the riparian forest continuum of the Paraguay River.

This remnant of forest has two layers: an upper one composed mainly of tree species with heights between 8 and 10 meters, with DBH varying between 15 and 30 cm and forming a dense canopy, with emerging species that present between 10 and 15 meters as *Tabebuia aurea* (lapacho blanco), and an understory made up of shrubs, grasses and dense clumps of terrestrial bromeliads. The layer of organic material when present is slightly decomposed, and the presence of woody creepers is observed on the arboreal individuals.

Figure 91 – General view of the area with Semideciduous Forest (FS-3). Coordinates UTM 21K - 450389.17 E/ 7426715.95 S.

Figure 92 – Overview of the Paraguay River contact portion of the Semideciduous Forest (FS-3). Coordinates UTM 21K 449815.00 E/ 7426174.00 S.

Figure 93 – Another angle of the portion in contact with the Paraguay River of the Semideciduous Forest (FS-3). **Coordinates UTM 21K 449815.02 E/ 7426174.05 S.**

Figure 94 – General view of the portion in contact with the areas intended for cattle (Semideciduous Forest - FS-3). **Coordinates UTM 21K 450056.03 E/ 7426879.76 S.**

Figure 95 – View of the vegetation inside the Semideciduous Forest (FS-3).

Figure 96 – Another angle of vegetation inside the Semideciduous Forest (FS-3).

Figure 97 – View of the terrestrial bromeliad groups present in the interior of the remnant (Semideciduous forest - FS-3).

Figure 98 – Detail of the terrestrial bromeliads present in the interior of the remnant (Semideciduous forest - FS-3).

Figure 99 – View of the wooden species *Pyrostegia venusta*.

Figure 100 – Details of the inflorescences of the species *Pyrostegia venusta*.

Among the species of occurrence are *Schinus weinmannifolius* (aguara yva), *Handroanthus heptaphyllus* (lapacho rosado), *Ziziphus mistol* (mistol), *Maytenus ilicifolius* (cangorosa), *Croton* sp., *Prosopis rubriflora* (algarrobo), *Cabralea canjerana* (cancharana), *Luehea divaricata* (ka'a oveti), *Schinopsis balansae* (quebracho), *Copernicia alba* (karanda'y), *Erythroxylum cuneifolium*, *Samanea tubulosa* (manduvirã), *Tapirira guianensis* (ka'ambota), *Cordia ecalyculata* (tamana-kuna), *Guapira* sp., *Enterolobium contortisiliquum* (oreja de negro), *Anadenanthera colubrina* (kurupa'y kuru), *Acrocomia aculeata* (mbokaja), epiphytes such as *Philodendron tweedianum*.

Figure 101 - View of a sample of the species *Samanea tubulosa* (manduvira).

Figure 102 – Details of the inflorescences of the species *Samanea tubulosa* (manduvira).

Figure 103 - View of a sample of the species *Acrocomia aculeata* (mbokaja).

Figure 104 – Detail of the fruits of the species *Acrocomia aculeata* (mbokaja).

Figure 105 – Detail of a sample of the epiphyte *Philodendron tweedianum*.

Semideciduous Forest (FS-4)

Located to the northeast of the area where the PARACEL pulp mill is located, at about 1,000 meters, this remnant occupies a large portion of the DIA. However, part of its surface is bordered by areas used for agriculture and livestock, and inside it there are several roads used for wood extraction.

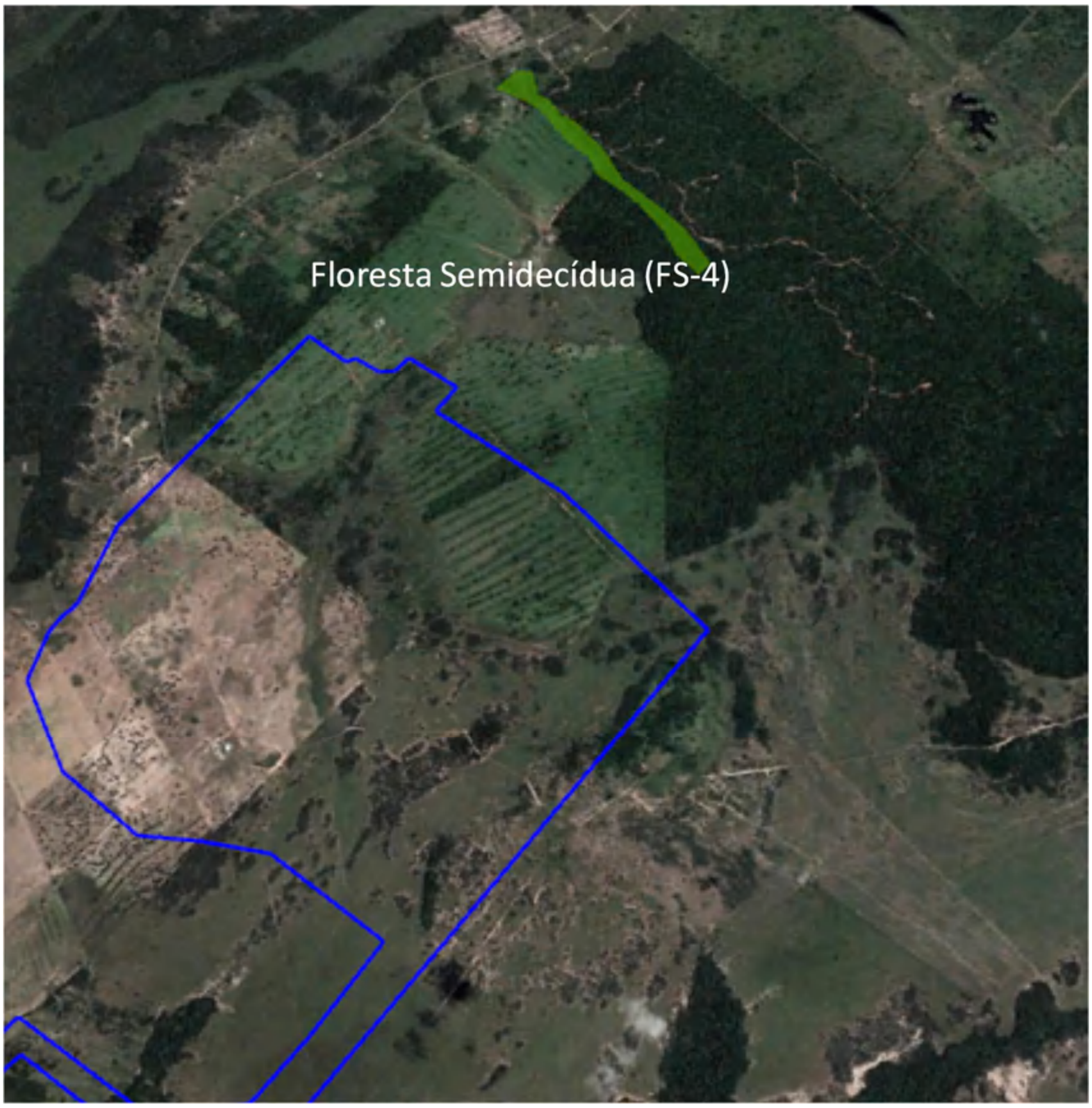


Figure 106 – Image with the location of the Semideciduous Forest (FS-4). **Image: Google Earth feb/2018 (Coordinates UTM 21K - midway point: 451179.24 E/ 7431285.43 S).**

Figure 107 – Aerial image of the area with Semideciduous Forest (FS-4), the remainder occupies a large portion in the DIA.

This remnant of forest has two layers: an upper one composed of tree species that form the canopy and vary in height between 8 and 12 meters and DBH between 15 and 45 cm, where emerging species that present between 10 and 20 meters as *Aspidosperma polyneuron* (guatambu sayju) e *Balfourodendron riedelianum*, and an underbrush formed by the bushes as *Rhamnidium elaeocarpum* (taruma'i)and herbaceous, the litter of organic matter when present is not entirely decomposed.

Figure 108 – General view of the area with Semideciduous Forest (FS-4), bordering portion with rural property.

Figure 109 – View of an emergent individual specimen of the species *Aspidosperma polyneuron* (guatambu sayju).

Figure 110 – View of an emergent individual specimen of the species *Balfourodendron riedelianum*.

Figure 111 – View of the vegetation inside the Semideciduous Forest (FS-4).

Figure 112 – Another angle of vegetation inside the Semideciduous Forest (FS-4).

Figure 113 – View of the existing roads inside the Semideciduous Forest (FS-4).

Figure 114 – Another angle of the existing trails within the Semideciduous Forest (FS-4).

Among the species of occurrence are *Balfourodendron riedelianum* (guatambu), *Schinopsis balansae* (quebracho), *Schinus weinmannifolius* (aguara yva), *Cecropia pachystachya* (amba'y), *Croton* sp., *Tabernaemontana catharinensis* (sapirangy), *Zanthoxylum rhoifolium* (tembetary sayju), *Trema micranta* (kurundi'y), *Anadenanthera colubrina* (kurupa'y kuru), *Lithraea molleoides* (molle guasu), *Allophylus edulis* (koku), *Guazuma ulmifolia* (kamba akã guasu), *Aspidosperma polyneuron* (guatambu sayju), *Handroanthus heptaphyllus* (lapacho rosado), *Myrsine balansae* (kanelon), *Jacaratia spinosa* (jakaratiíh), *Roupala meisneri* (ka'ati ka'e), *Celtis iguanaea* (juasy'y), *Ceiba speciosa* (palo borracho), *Sapium haematospermum* (kurupika'y), *Gleditsia amorphoides* (espina de corona), *Astronium fraxinifolium* (urunde'y pichai), *Xylosma pseudosalzmanii*, *Schinopsis lorentzii* (koronillo), *Tapirira guianensis* (ka'ambota), *Cordia ecalyculata* (tamana-kuna), *Protium heptaphyllum* (yvyra ysy), *Acrocomia aculeata* (mbokaja), *Guapira* sp., *Priogymnanthus hasslerianus* (ka'a vera), *Dalbergia frutescens* (ysypo kopi), *Enterolobium contortisiliquum* (oreja de negro), *Ximenia americana* (indio kurupa'y) y *Capsicum* cf. *chacoense*.

Figure 115 – Detail of a sample of the species *Balfourodendron riedelianum* (guatambu).

Figure 116 – Detail of the fruits of the species *Balfourodendron riedelianum* (guatambu).

Figure 117 – Detail of a sample of the species *Tabernaemontana catharinensis* (sapirangy).

Figure 118 – Detail of the fruits of the species *Tabernaemontana catharinensis* (sapirangy).

Figure 119 – Detail of a sample of the species *Gleditsia amorphoides* (espina de corona).

Figure 120 – Detail of the characteristic spines of the species *Gleditsia amorphoides* (crown spine).

Figure 121 – Detail of a sample of the species *Xylosma pseudosalzmannii*.

Figure 122 – Detail of the characteristic spines of the species *Xylosma pseudosalzmannii*.

Figure 123 – Detail of a sample of the species *Capsicum* cf. *chacoense*.

Figure 124 – Detail of the fruits of the species *Capsicum* cf. *chacoense*.

Chaco

Located west of the PARACEL pulp mill site at approximately 2,000 meters, this site occupies a large portion of the DIA. However, it is on the right riverbank of the Paraguay River, opposite the location of PARACEL's pulp mill project.

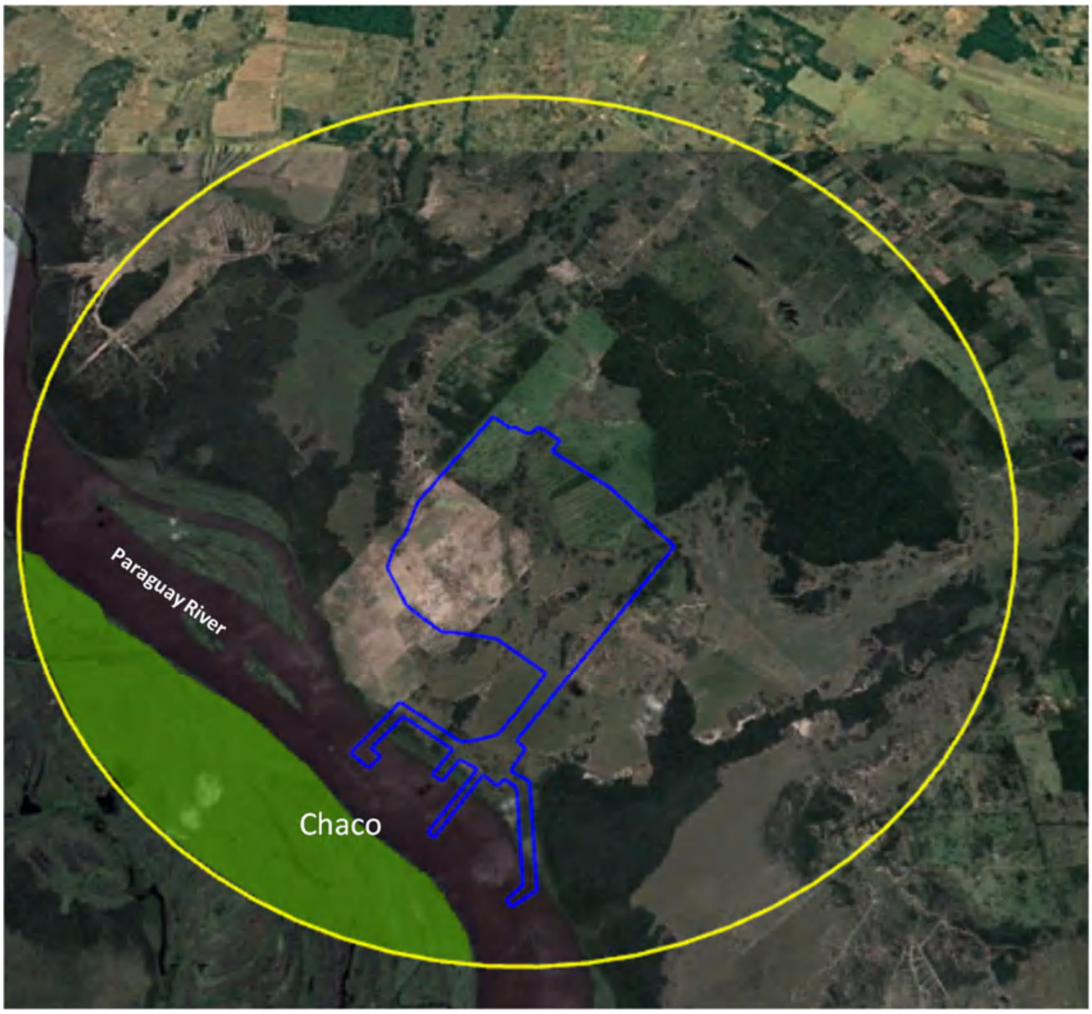


Figure 125 – Image with the location of the wide area with Chaco physiognomy present in the DIA of the PARACEL pulp mill. **Image: Google Earth feb/2018.**

Figure 126 – Aerial view of the extensive area with the physiognomy of the Chaco. UTM - 21k 447302.78 E/ 7426631.89 S (reference point).

The Chacos are physiognomies linked to water, floods or rains; they occur near large rivers such as the Paraguay. In some cases, forests are formed, and these are found in depressions in the terrain, where the soils are generally very rich in clays. The species are characterized by being considerably plastic, since they resist a certain degree of asphyxiation in the soil, caused by the temporary floods to which they are subjected (Mereles, 2007).

According to Mereles (2007) in the areas of the Chaco are common species such as *Albizia inundata* (timbóý), *Phyllanthus chacoensis*, *Calycophyllum multiflorum* (palo blanco), *Celtis iguanaea* (yuasy'y), *Chloroleucon tenuiflorus* (tataré), *Chrysophyllum marginatum* (pycasú rembi'ú), *Croton urucurana* (sangre de drago), *Cynometra bauhinifolia*, *Enterolobium contortisiliquum* (timbó), *Eritrina crista-galli* (ceibo), *Geoffroea decorticans* (chamar), *Geoffroea spinosa*, *Inga uruguensis* (ingá), *Ocotea dyospirifolia* (laurel), *Phyllostylon rhamnoides* (palo lanza), *Prosopis ruscifolia* (vinal), *Salix humboldtiana* var. *martiana* (sauce criollo), *Senna scabriuscula*, *Tabebuia nodosa* (labón), *Tessaria integrifolia* (palo bobo), *Sapium haematospermum* (curupica'y), *Vitex megapotamica* (tarumá) and *Vochysia tucanorum* (cuati'y).

Cultivated land (rural properties)

The so-called Cultivated Lands, which include agricultural and livestock areas, occupy large portions of the DIA of the future pulp mill of PARACEL, and are found around other types of plants, thus forming a heterogeneous mosaic of physiognomies. Considering these aspects, and in order to characterize a wider area, sampling points were made along the unpaved road that gives access to the area of the future pulp mill. In the surroundings of these areas, the savannahs are predominantly made up of a stratum of trees and bushes with the appearance of the genera *Aspidosperma*, *Schinopsis* e *Prosopis*, and a layer of grass formed by the genera *Elionurus*, *Eragrostis*, *Aristid*a, *Cenchrus*, *Stachytarpheta* and *Pfaffia*.

Figure 127 – Image with the location of the sampling points. Imag: Google Earth feb/2018.

Figure 128 – General view of a rural property present in the DIA. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).

Figure 129 – View of the unpaved access present in the DIA. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).

Figure 130 – Another unpaved access angle present in DIA. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).

Figure 131 – General view of the surroundings of the rural property. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).

Figure 132 – Another angle of the rural property environment. Coordinates UTM - 21k 449021.77 E/7430667.35 S (P1).

Figure 133 – Overview of a rural property in DIA. Coordinates UTM - 21k 449202.10 E/ 7431096.85 S (P2).

Figure 134 – View of the unpaved access present in DIA. Coordinates UTM - 21k 449202.10 E/ 7431096.85 S (P2).

Figure 135 – General view of surroundings of the rural property. Coordinates UTM - 21k 449202.10 E/ 7431096.85 S (P2).

Figure 136 – Overview of a rural property in DIA. Coordinates UTM - 21k 450673.02 E/ 7432212.86 S (P3).

Figure 137 – General view of the surroundings of the rural property. Coordinates UTM - 21k 450673.02 E/ 7432212.86 S (P3).

Figure 138 – General view of the sampling point located at the coordinates UTM - 21k 451657.45 E/ 7433121.34 S (P4).

Figure 139 – Other angle of the sampling point in the coordinates UTM - 21k 451657.45 E/ 7433121.34 S (P4).

Directly Affected Area (DAA)

The Directly Affected Area by the project is characterized by the implementation of the PARACEL pulp mill, the river port, water intake and the discharge of treated effluents into the Paraguay River.

Figure 140 – Image with the location of the DAA of the pulp mill. Imag: Google Earth feb/2018.

The area where the pulp mill will be installed is considerably anthropized by the use of cattle and extensive areas with pastures, however, there are remnants formed by the typology of savannah and isolated trees located in this area.

Figure 141 – Image with the location of the DAA of the PARACEL pulp mill. Image: Google Earth feb/2018.

Figure 142 – View of the sampling point (P1) in the DAA (water intake) in the Paraguay River. Coordinates UTM - 21k 449817.46 E/ 7426175.07 S.

Figure 143 – Another angle of the sampling point in the DAA (water intake). UTM coordinates - 21k 449817.46 E/ 7426175.07 S.

Figure 144 – View of the sampling point in the DAA (water intake) and the Paraguay River in the background. UTM coordinates - 21k 449839.72 E/ 7426218.47 S.

Figure 145 – Another angle of the sampling point in the DAA (water intake). UTM coordinates - 21k 449839.72 E/ 7426218.47 S.

Figure 146 – View of the sampling point in the DAA (flooded area) UTM coordinates - 21k 449905.03 E/ 7428488.03 S.

Figure 147 – Another angle of the sampling point in the DAA (flooded area). UTM coordinates - 21k 449905.03 E/ 7428488.03 S.

Figure 148 – View of the sampling point in the DAA (pasture area). Coordinates UTM - 21k 449786.71 E/ 7428464.56 S.

Figure 149 – Another angle of the sampling point in the DAA (pasture area), in the background the headquarters of the Farmhouse Zapatero Cue. Coordinates UTM - 21k 449786.71 E/ 7428464.56 S.

Figure 150 – View of the sampling point in the DAA (pasture area). Coordinates UTM - 21k 449262.98 E/ 7429329.73 S.

Figure 151 – View of the sampling point in the DAA (pasture area) with isolated trees. Coordinates UTM - 21k 449443.88 E/ 7429583.74 S.

Figure 152 – Another angle of the sampling point in the DAA (pasture area) with isolated trees. Coordinates UTM - 21k 449443.88 E/ 7429583.74 S.

Savannah (SAV-1)

Located within the ADA, this group of tree vegetation is surrounded by an extensive area with field vegetation and areas for cattle raising.

Figure 153 – Image with the location of the Savannah (SAV-1). Imag: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 450483.74 E/ 7428462.29 S).

Figure 154 – Aerial image of the Savannah area (SAV-1), surrounded by a large area with field vegetation and areas for cattle farming.

This vegetation formation is structured in three layers: an upper one with predominance of arboreal individuals of up to approximately 14 m emerging, with DBH between 30 and 60 cm; an intermediate one with specimens of between 4.0 and 6.0 m high with DBH ranging between 10 and 70 cm, and a lower gramino-lenous stratum, generally discontinuous and of scarce physiognomic expression.

Figure 155 – General view of the savannah area (SAV-1), part in contact with the cattle farming area.

Figure 156 – View of the vegetation inside the savannah (SAV-1).

Figure 157 – Another angle of vegetation in the interior of the Savannah (SAV-1).

Species of occurrence include *Ziziphus mistol* (mistol), *Croton* sp., *Prosopis ruscifolia y Prosopis rubriflora* (algarrobos), *Erythroxylum cuneifolium*, *Pseudobombax* sp., *Anadenanthera colubrina* (kurupa'y kuru), *Psidium guajava* (arasa), *Parapiptadenia rigida* (kurupa'y rã), *Samanea tubulosa* (manduvirã), *Ximenia americana* (indio kurupa'y) and *Schinopsis balansae* (quebracho).

Figure 158 – Detail of a sample of the species *Psidium guajava* (arasa).

Figure 159 – Detail of the species' fruit *Psidium guajava* (arasa).

Savannah (SAV-2)

Located inside the ADA, this remaining vegetation is inserted in a wide area destined to cattle raising.

Figure 160 – Image with the location of the Savannah (SAV-2). Image: Google Earth feb/2018 (Coordinates UTM 21K – midway point: 449509.25 E/ 7429567.11 S).

Figure 161 – Aerial image of the Sabana area (SAV-2).

In this remaining, the vegetation is structured in two layers: one formed by heterogeneous and dispersed groups of shrubs with heights around 4 to 6 m, interspersed by large and small cactuses, and the other by small and medium trees.

Figure 162 – Overview of the Savannah area (SAV-2).

Figure 163 – View of the vegetation inside the Savannah (SAV-2).

Figure 164 – Another angle inside the Savannah (SAV-2).

Among the species of trees and shrubs that are produced are *Prosopis rubriflora* (algarrobo), *Copernicia alba* (karanda'y), *Ziziphus mistol* (mistol), *Croton* sp., *Myracrodruon urundeuva* (urunde'y), *Prosopis rubriflora* (algarrobo), *Erythroxylum cuneifolium*, *Pseudobombax* sp., *Anadenanthera colubrina* (kurupa'y kuru), *Parapiptadenia rigida* (kurupa'y rã), *Samanea tubulosa* (manduvirã), *Ximenia americana* (indio kurupa'y) e *Schinopsis balansae* (quebracho), among cactuses *Cereus* sp and *Monvillea* sp, among the terrestrial bromeliads *Bromelia balansae* and among the epiphytes *Tillandsia duratii*.

Figure 165 – Detail of a sample of specie *Ziziphus mistol* (mistol).

Figure 166 – Detail of inflorescences and fruits of specie *Ziziphus mistol* (mistol).

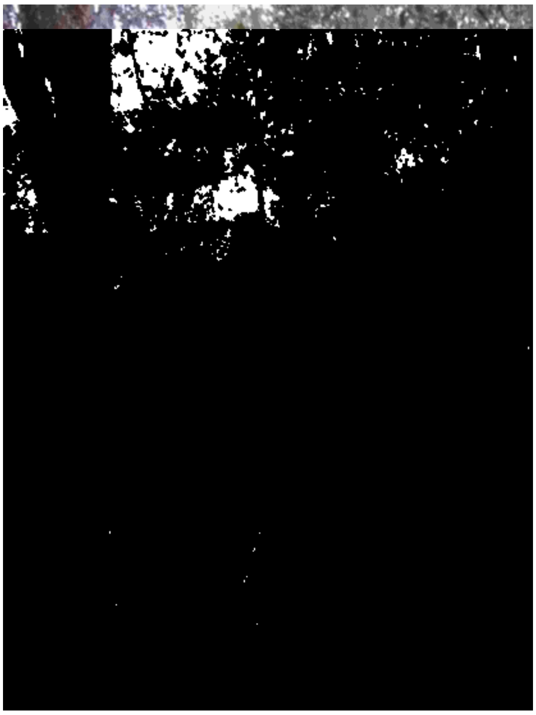


Figure 167 – Detail of a sample of specie *Erythroxylum cuneifolium*.

Figure 168 – Detail of fruit of specie (*Erythroxylum cuneifolium*).

Figure 169 – Detail of a sample of specie *Cereus* sp.

Figure 170 – Detail of fruit of specie *Cereus* sp.

Figure 171 – Detail of a sample of specie *Monvillea* sp.

Figure 172 – Detail of fruit of specie *Monvillea* sp.

Figure 173 – Detail of a sample of specie *Bromelia balansae*.

Figure 174 – Detail of inflorescence of specie *Bromelia balansae*.

Figure 175 – Detail of a sample of the specie *Tillandsia duratii*.

Figure 176 – – Detail of inflorescence of specie *Tillandsia duratii*.

Endangerous species

From the species sampled in this study, five are listed in the lists of flora species in danger of extinction consulted (SEAM Resolution 524/2006 and SEAM Resolution 2,243/2006): the "jatai" *(Butia paraguayensis*),"grapia"*(Apuleia leiocarpa*), "algarrobo" (*Prosopis alba*), "preto carob" (*Prosopis nigra*) and the "guatambu" (*Balfourodendron riedelianum*).

The table below shows the list of species sampled in the DIA and DAA of the future pulp mill.

Then, DIA and DAA physiognomy map locates where the types of vegetation were found.

Table 3 – List of species sampled in the DIA and DAA of the future pulp mill.

Family	Scientific names	Popular name in Paraguay	DIA	DAA	Habit	SEAM n. 524/06	SEAM n. 2,243/06	IUCN
Achatocarpaceae	*Achatocarpus praecox* Griseb.		x	x	Tree			LC
Amaranthaceae	*Pfaffia* sp.		x		Herbaceous			-
Anacardiaceae	*Astronium fraxinifolium* Schott	urunde'y pichai	x		Tree			-
	Lithraea molleoides (Vell.) Engl.	molle guasu	x		Tree			LC
	Myracrodruon urundeuva Allemão	urunde'y	x	x	Tree			-
	Schinopsis balansae Engl.	quebracho	x	x	Tree			LC
	Schinopsis lorentzii (Griseb.) Engl.		x		Tree			-
	Schinus weinmannifolius Engl.	koronillo	x		Tree			-
	Tapirira guianensis Aubl.	ka'ambota	x		Tree			LC
Annonaceae	*Annona spinescens* Mart.		x		Tree			LC
	Duguetia furfuracea (A.St.-Hil.) Saff.	aratiku	x		Bush			LC
	Rollinia salicifolia Schltdl.	aratiku'i	x	x	Tree			-
Apocynaceae	*Aspidosperma quebracho-blanco* Schltdl.	quebracho-branco	x	x	Tree			-
	Aspidosperma polyneuron Müll.Arg.	guatambu sayju	x	x	Tree			EN
	Aspidosperma triternatum N.Rojas		x	x	Tree			NT
	Tabernaemontana catharinensis A.DC.	leiteiro	x	x	Bush			LC
Araceae	*Anthurium* sp.		x	x	Herbaceous			-
	Philodendron undulatum Engl.		x	x	Epiphyte			-
	Philodendron tweedieanum Schott		x		Herbaceous			-
Arecaceae	*Acrocomia aculeata* (Jacq.) Lodd. ex Mart.	mbokaja	x	x	Tree			-
	Butia paraguayensis (Barb.Rodr.) L.H.Bailey	jatai	x	x	Tree	x		-
	Copernicia alba Morong	karanda'y	x	x	Tree			-
	Syagrus campylospatha (Barb.Rodr.) Becc.		x	x	Tree			-
	Syagrus romanzoffiana (Cham.) Glassman	pindo	x	x	Tree			-

Family	Scientific names	Popular name in Paraguay	DIA	DAA	Habit	SEAM n. 524/06	SEAM n. 2,243/06	IUCN
Asteraceae	*Pacourina edulis* Aubl		x		Herbaceous			-
Bignoniaceae	*Handroanthus albus* (Cham.) Mattos	lapacho amarillo	x	x	Tree			LC
	Handroanthus heptaphyllus (Vell.) Mattos	lapacho rosado	x	x	Tree			LC
	Pyrostegia venusta (Ker Gawl.) Miers		x		Herbaceous			-
	Tabebuia aurea (Silva Manso) Benth. & Hook.f. ex S.Moore	paratodo	x		Tree			-
	Tabebuia nodosa (Griseb.) Griseb.		x		Tree			LC
Boraginaceae	*Cordia ecalyculata* Vell.	tamana-kuna	x		Tree			-
Bromeliaceae	*Aechmea distichantha* Lem.		x	x	Epiphyte			-
	Ananas sagenaria (Arruda) Schult. & Schult.f.		x		Herbaceous			-
	Bromelia balansae Mez		x	x	Epiphyte			-
	Tillandsia duratii Vis.		x	x	Epiphyte			-
	Tillandsia sp.		x		Epiphyte			-
Burseraceae	*Commiphora* sp.		x	x	Tree			-
	Protium heptaphyllum (Aubl.) Marchand	yvyra ysy	x		Tree			LC
Cactaceae	*Brasiliopuntia* sp.		x	x	Bush			-
	Cereus sp.		x	x	Bush			-
	Rhipsalis baccifera (J.S.Muell.) Stearn		x	x	Epiphyte			LC
Cannabaceae	*Celtis iguanaea* (Jacq.) Sarg.	juasy'y	x	x	Tree			LC
	Trema micrantha (L.) Blume		x		Tree			LC
Capparaceae	*Anisocapparis speciosa* (Griseb.) Cornejo & Iltis	pajagua naranja	x		Bush			-
	Cappari cordis tweediana (Eichler) Iltis & Cornejo	ñandu apysa	x	x	Tree			-
Caricaceae	*Jacaratia spinosa* (Aubl.) A.DC.	jakaratiíh	x		Tree			LC
Caryocaraceae	*Caryocar brasiliense* A.St.-Hil.		x		Tree			LC
Celastraceae	*Maytenus ilicifolia* Mart. ex Reissek	cangorosa	x	x	Bush			-

Family	Scientific names	Popular name in Paraguay	DIA	DAA	Habit	SEAM n. 524/06	SEAM n. 2,243/06	IUCN
Celastraceae	*Plenckia populnea* Reissek		x	x	Tree			-
	Schaefferia argentinensis Speg		x	x	Tree			LC
Convolvulaceae	*Ipomoea carnea* Jacq.		x		Bush			-
	Ipomea sp.		x	x	Herbaceous			-
Cyperaceae	*Cyperus* sp.		x	x	Herbaceous			-
	Eleocharis elegans (Kunth) Roem. & Schult.		x	x	Herbaceous			-
	Fimbristylis dichotoma (L.) Vahl		x	x	Herbaceous			LC
Erythroxylaceae	*Erythroxylum cuneifolium* (Mart.) O.E.Schulz		x	x	Tree			-
Euphorbiaceae	*Cnidoscolus* sp.		x		Herbaceous			-
	Croton argenteus L.		x	x	Tree			LC
	Croton urucurana Baill.	sangue de drago	x	x	Tree			-
	Croton sp.		x	x	Bush			-
	Jatropha sp.		x	x	Bush			-
	Sapium haematospermum Müll.Arg.	kurupika'y	x	x	Tree			LC
Fabaceae	*Acacia farnesiana* (L.) Willd.		x	x	Tree			LC
	Acacia sp.		x		Bush			-
	Albizia inundata (Mart.)Barneby & J.W.Grimes		x	x	Tree			LC
	Anadenanthera colubrina (Vell.)Brenan	kurupa'y kuru	x	x	Tree			LC
	Apuleia leiocarpa (Vogel) J.F.Macbr.	grapia	x	x	Tree	x		LC
	Bauhinia sp.	pata de buey	x	x	Tree			-
	Bowdichia virgilioides Kunth		x		Tree			LC
	Parkinsonia praecox (Ruiz & Pav.) Hawkins	verde olivo	x	x	Tree			LC
	Caesalpinia paraguariensis (Parodi)Burkart	guajakan,	x		Tree			VU
	Chloroleucon tenuiflorum (Benth.)Barneby & J.W.Grimes	tatare	x	x	Bush			LC

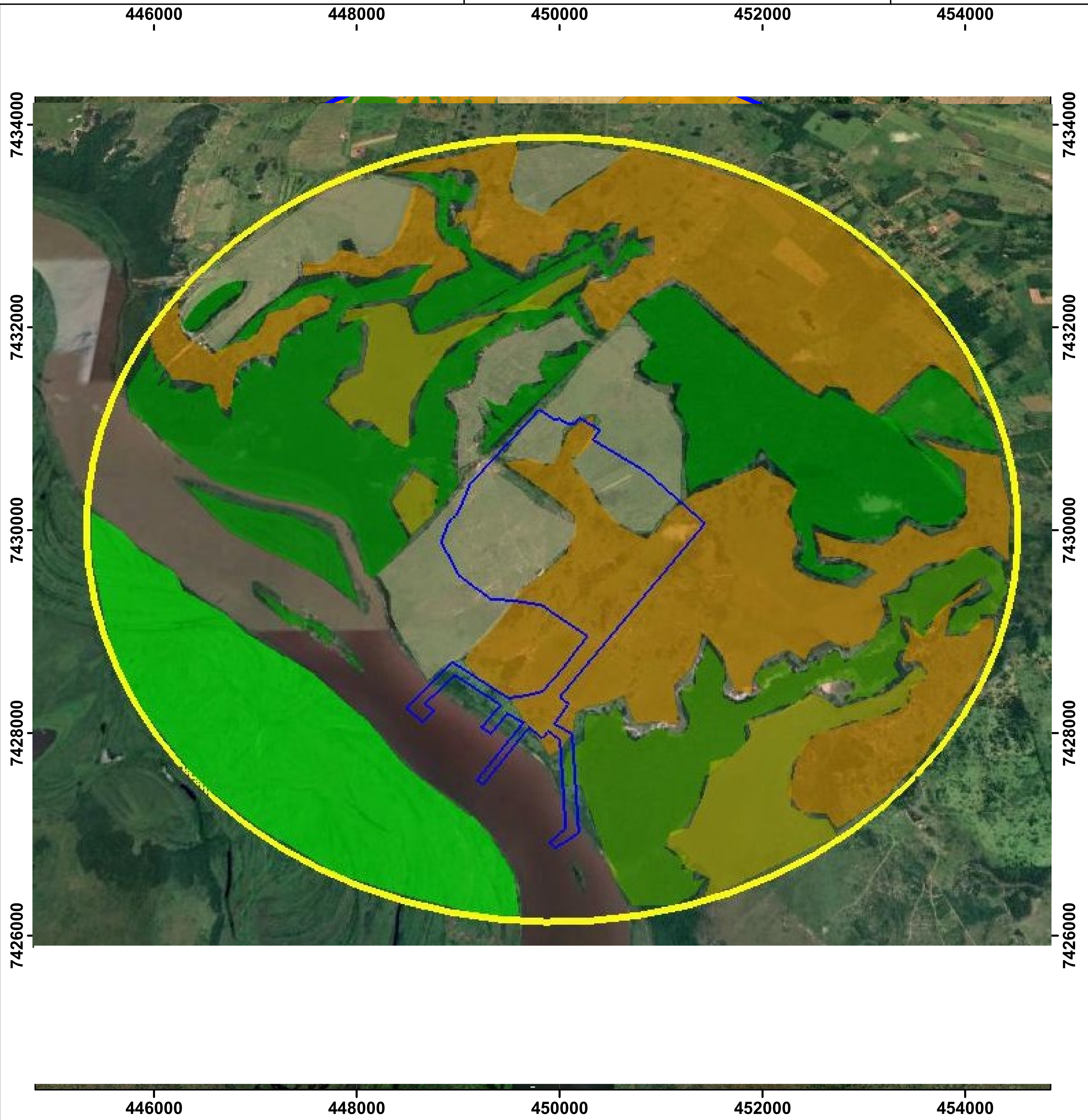
Family	Scientific names	Popular name in Paraguay	DIA	DAA	Habit	SEAM n. 524/06	SEAM n. 2,243/06	IUCN
	Dalbergia frutescens (Vell.)Britton	ysypo kopi	x	x	Tree			-
	Enterolobium contortisiliquum (Vell.)Morong	oreja de negro	x	x	Tree			LC
	Gleditsia amorphoides (Griseb.) Taub.	espina de corona	x		Tree			-
	Microlobius foetidus (Jacq.)M.Sousa & G.Andrade	yvyra ne	x		Tree			-
	Mimosa sp.		x	x	Bush			-
	Peltophorum dubium (Spreng.) Taub.	yvyra pytã	x	x	Tree			LC
	Prosopis alba Griseb.	algarrobo	x	x	Tree	x		NT
	Prosopis nigra Hieron.	algarrobo	x	x	Tree	x		DD
	Prosopis rubriflora Hassl.	algarrobo	x	x	Tree			-
	Prosopis ruscifolia Griseb.	algarrobo	x	x	Tree			LC
	Pterocarpus santalinoides DC.	pajaguá manduví	x	x	Tree			LC
	Samanea tubulosa (Benth.)Barneby & J.W.Grimes	manduvirã	x	x	Tree			LC
	Senegalia martii (Benth.) Seigler & Ebinger		x	x	Bush			LC
	Senna sp.		x		Bush			-
	Sesbania virgata (Cav.)Pers.		x	x	Tree			LC
	Zygia inaequalis (Willd.)Pittier	guara pepe	x	x	Tree			LC
Lamiaceae	*Hyptis* sp.		x	x	Herbaceous			-
Malpighiaceae	*Heteropterys* sp.		x		Bush			-
Malvaceae	*Ceiba pubiflora* (A.St.-Hil.) K.Schum.	palo borracho	x	x	Tree			-
	Ceiba speciosa (A.St.-Hil.) Ravenna	samu'u	x		Tree			-
	Ceiba sp.		x	x	Tree			-
	Guazuma ulmifolia Lam.	kamba akã guasu	x	x	Tree			LC
	Luehea divaricata Mart.	ka'a oveti	x	x	Tree			DD
	Malvastrum sp.		x	x	Herbaceous			-

Family	Scientific names	Popular name in Paraguay	DIA	DAA	Habit	SEAM n. 524/06	SEAM n. 2,243/06	IUCN
	Melochia sp.		x		Herbaceous			-
	Waltheria indica L.		x		Subarbust			-
Meliaceae	*Cabralea canjerana* (Vell.) Mart.	cancharana	x		Tree			LC
	Trichilia catigua A.Juss	katigua pytã	x	x	Tree			-
Moraceae	*Ficus enormis* (Miq.) Miq.	guapoy moroti	x	x	Tree			LC
	Ficus sp.		x		Tree			-
Myrtaceae	*Campomanesia xanthocarpa* (Mart.) O.Berg	guavira	x		Tree			-
	Eugenia involucrata DC.	ñangapiry	x		Tree			LC
	Eugenia pitanga (O.Berg) Nied.		x	x	Bush			-
	Eugenia sp.		x		Tree			-
	Psidium striatulum DC.		x	x	Tree			LC
Nyctaginaceae	*Guapira* sp.		x		Tree			-
Olacaceae	*Priogymnanthus hasslerianus* (Chodat) P.S.Green	ka'a vera	x	x	Tree			-
Passifloraceae	*Turnera* sp.		x		Herbaceous			-
	Piriqueta sp.		x		Herbaceous			-
Poaceae	*Aristida* sp.		x	x	Herbaceous			-
	Cenchrus sp.		x	x	Herbaceous			-
	Chloris virgata Sw.		x		Herbaceous			-
	Elionurus muticus (Spreng.) Kuntze	capim-carona	x	x	Herbaceous			-
	Elionurus sp.		x	x	Herbaceous			-
	Eragrostis sp.		x	x	Herbaceous			-
	Schizachyrium condensatum (Kunth) Nees		x		Herbaceous			-
	Setaria palmifolia (J.Koenig) Stapf		x		Herbaceous			-
Polygonaceae	*Coccoloba* sp.		x	x	Tree			-
Portulacacee	*Portulaca* sp.		x	x	Herbaceous			-
Primulaceae	*Myrsine balansae* (Mez) Otegui	kanelon	x		Tree			-

Family	Scientific names	Popular name in Paraguay	DIA	DAA	Habit	SEAM n. 524/06	SEAM n. 2,243/06	IUCN
Proteaceae	*Roupala meisneri* Sleumer	ka'ati ka'e	x		Tree			LC
Rhamnaceae	*Rhamnidium elaeocarpum* Reissek	taruma'i	x		Bush			LC
	Ziziphus mistol Griseb.	mistol	x	x	Tree			DD
Rubiaceae	*Calycophyllum multiflorum* Griseb.	palo-blanco	x	x	Tree			-
	Randia sp.		x		Bush			-
Rutaceae	*Balfourodendron riedelianum* (Engl.) Engl.	guatambu	x	x	Tree		x	EN
	Zanthoxylum rhoifolium Lam.	tembetary sayju	x	x	Tree			LC
Salicaceae	*Casearia sylvestris* Sw.	mbavy guasu	x	x	Tree			LC
	Xylosma pseudosalzmanii Sleumer		x		Tree			-
Sapindaceae	*Allophylus edulis* (A.St.-Hil., A.Juss. & Cambess.) Radlk.	koku	x		Tree			LC
Sapotaceae	*Chrysophyllum gonocarpum* (Mart. & Eichler ex Miq.) Engl.	aguai	x		Tree			LC
	Pouteria torta (Mart.) Radlk.	aguai guasu	x	x	Tree			LC
	Sideroxylon obtusifolium (Roem. & Schult.) T.D.Penn.	guajayvi rai	x	x	Tree			LC
Solanaceae	*Brunfelsia australis* Benth.	manaka	x	x	Bush			LC
	Capsicum chacoense Hunz.		x		Bush			-
	Solanum sp.		x	x	Bush			-
Ulmaceae	*Phyllostylon rhamnoides* (J.Poiss.) Taub.	juasy'y guasu	x	x	Tree			LC
Urticaceae	*Cecropia pachystachya* Trécul	amba'y	x	x	Tree			-
Verbenaceae	*Lantana* sp.		x	x	Herbaceous			-
	Lippia sp.		x	x	Herbaceous			-
	Stachytarpheta sp.		x	x	Herbaceous			-
Ximeniaceae	*Ximenia americana* L.	indio kurupa'y	x	x	Tree			LC

Subtitle: DIA: Direct Influence Area; ADA: Area Directly Affected; SEAM n 524/06 - Species of Native Flora Threatened with Extinction in Paraguay; SEAM n 2.243/06 - Species of Native Flora Threatened with Extinction in Paraguay.

Figure 177 – Map of DIA and DAA features.



Sistema de Coordenadas: SIRGAS 2000 - UTM Zona 21K
Proyección: UTM - Transversal de Mercator
Datum: SIRGAS 2000

- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos). Informe Técnico Mapa de cobertura del Paraguay año 2011

Subtitle

DAA
DIA
Departamento de Concepcíón
Anthropic Area
Chaco
Floodable Savannah
Savannah
Semideciduous Forest

N
0 500 1,000 2,000 3,000 Meter0s

PARACEL PÖYRY

TÍTULO DEL MAPA: DAA and DIA Physiognomy Map	
TÍTULO DEL PROYECTO: BIOTIC ENVIRONMENT - DAA and DIA	
PROCESO DE LICENCIA: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT	
TIPO DE LICENCIA	
UBICACIÓN: CONCEPCiÓN-PY	UGHRI: CIH8 Aquidaban y CIH18 Rio Pilcomayo

ESCALA:	REVISIÓN:	RESPONSABLE TÉCNICO:	CRBio Nº:
		EDUARDO MARTINS Biologo	26.063/01-D

Form the total 7.785ha of the DIA area about 33,10% is Savannah, 27,80% is Semideciduous Forest, 13,96% is antropic area, 10,57% corresponds the Paraguay river, 9,17% is the Chaco in the other margin of the river and 5,4% is Floodable Savannah.

Intervention in forests protecting watercourses

For the implementation of the water intake system and the treated effluent emissary, as well as for the river port, it will be necessary to intervene in the protective forests of the Paraguay River, considering the 100 m limit established in Decree 9,824/12, which regulates Law 4,241/10.

Figure 178 – Image with the location of the intervention areas in the protective forest of the Paraguay River (100m).

Figure 179 – Aerial image of the intervention area – water intake and discharge of treated effluents.

The following table lists the area, civil structure and vegetation that will be removed for the implementation of the project.

Table 4 – Intervention in protective forests for the implementation of raw water and discharge of treated effluents.

Structure	Area (ha) of intervention	Vegetation
Water intake system	0,62	Semideciduous Forest
	0,31	Savannah
Emissary of treated effluents	0,87	Semideciduous Forest
River port	2,50	Semideciduous Forest

Natural and modified areas

The figure below shows the satellite image of the mill site property, identifying modified and natural existing areas. These area total approximately 1,206 ha. About 83% of the area is modified and 17% is natural forest and bodies of water.

Figure 180 – Natural and Modified Habitat at Mill site.

As mentioned, the implementation of the pulp mill will require the suppression of approximately 3.99 ha of remaining vegetation of the Semideciduous Forest and 0.31 ha of remaining vegetation of the Savannah at riparian area for the implantation of the water intake system and the terrestrial emissary of treated effluents. Knowing that DAA has 150 ha, so the suppression will correspond only to 2,86% of the existing native forest. Paracel has committed to compensate the suppression by increasing the native area in relation to the current situation, specially enlarging the riparian areas, with approximately 250 ha, so that the total area will represent approximately 400 ha. The implementation of the project will determine a native forest coverage in 30% of the mill site, compared to the 12% that it currently occupies. This compensation measure thus determines an increase in the native area of approximately 150% in relation to the current situation.

Moreover that 30% will also regenerate the riparian forest, now highly fragmented, and also connect the native areas of the neighbouring properties to the NW and SE acting as a biological corridor, now non-existent. Therefore, **it can be said that the positive impact on biodiversity would be well over 150% in relation to the current situation**.

<u>Transmission Line</u>

Likewise the figure below shows the image of the transmission line easement lane, identifying modified and natural existing areas. These area total approximately 23,1 ha. About 84,3% of the area is modified and 15,7% is natural forest and bodies of water.

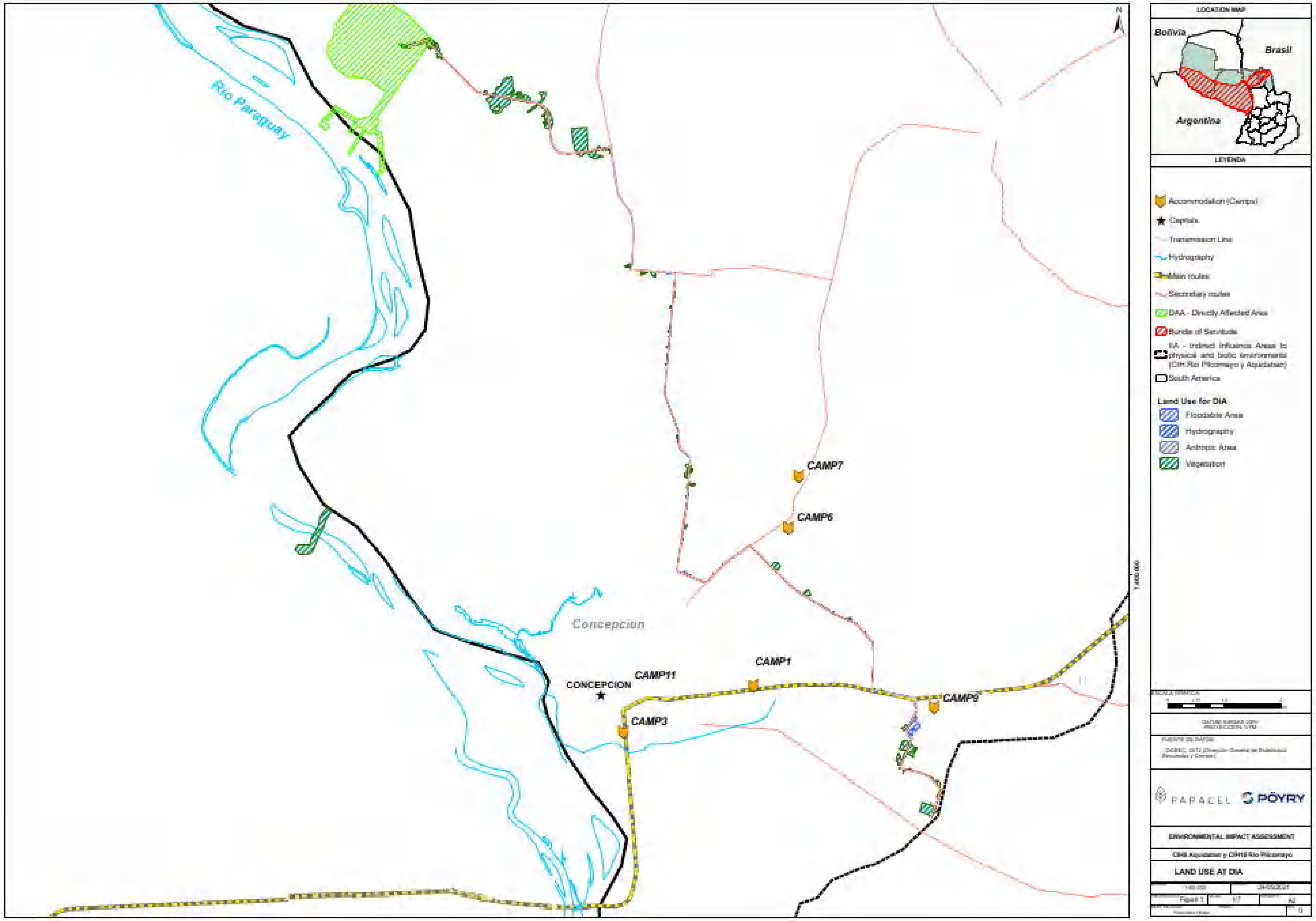


Figure 181 – Natural and Modified Habitat at Transmission line easement lane

Vegetation cover and PS 6 Type in Transmission Line DIA is divided in 3 classes type: native forest, Floodable/Waterland area, Grassland/Pasture/Roads area. The percentage of vegetation cover in DIA is presented at the table and figure below:

Table 5 – Vegetation cover and PS 6 Type in TL DIA

Class ID	Class type	Area (ha)	Percentage	Nat/ Mod	Area (ha)	Percentage
1	Native forest	3,53	15.3%	Natural	3,63	15.7%
2	Floodable/ Waterland	0,10	0.40%			
3	Grassland/Pasture/Roads	19,47	84.3%	Modified	19,47	84.3%
Total		**23,10**	**100%**		**23,10**	

Phytosociological study

The phytosociological study is one of the tools of plant ecology that allows the description of a plant community or association. Its objective is to characterize these communities through their composition, quantitative measures of their attributes (density, dominance, frequency and cover), spatial distribution and interrelations between their populations.

Methods

For the phytosociological study, the segmentation method was adopted, which consists of the establishment in the field of small sampling units distributed throughout the study area, allowing for an adequate representation of local diversity (Durigan, 2003). Twenty-three stationary units were installed, systematically distributed in both the DIA (15 plots) and the DAA (8 plots), with dimensions of 20 x 10 m with an area of 200 m² each, totaling 4,600 m² sampled.

In the plots all individuals of the trees with a CAP ≥ were sampled 15 cm (CAP = circumference at breast height - 1.30 m from the ground), measured and the CAP was later converted using the formula (DAP = CAP/π) into DAP (diameter at breast height). For profiled individuals, they were included when at least one of the branches met the minimum inclusion diameter. For bush formation, due to the highly branched character of the individuals, the CAB (Circumference at Base Height) and not the CAP (Circumference at Breast Height) were used to measure the perimeter, being sampled the bush and tree individuals inserted with a CAB greater or equal to 10 cm and a height of 2m or more. In the case that one of the branches of a tree had the adopted criterion, the other branches were measured. For each individual sampled, the CAP and/or CAB values, the height (estimated by comparison of known heights) and the dead individuals were recorded.

Figure 182 – The assembly of the plots/units

Figure 183 – Detail of measurements.

Figure 184 – Measurement of the CAP (circumference at breast height - 1.30m from the ground).

Figure 185 – Measurement detail.

When necessary, field material was obtained for identification. Identification keys, original descriptions, specialized bibliography and comparison with herbarium materials available in online archives were used to identify the plants. Botanical material not identified in the field was collected with pruning shears, herborized and pressed into cardboard paper for later identification.

The classification system used APG IV (2016) and the correct spelling of the names was checked on the websites “TROPICOS” (https://www.tropicos.org/home) and “The Plant List” (http://www.theplantlist.org/).

With the data, the quantitative parameters proposed by Mueller-Dombois and Ellenberg (1974): absolute density, absolute frequency, absolute dominance expressed by basal area, relative density, relative frequency, relative dominance, importance value and coverage value. The Shannon diversity (H') and Pielou equitability (J') indices were also calculated. For the construction of the species-area curve (accumulation and rarefication curve) the data on species richness and the Jackknife estimator were used.

The data was analyzed using the FITOPAC2 (G.J. Shepherd – UNICAMP, 2010); EstimateSWin910 and the Past3. The following is a description of the quantitative parameters and the diversity indices calculated:

Abundance (n): is the number of individuals sampled per species or for the community;

Density (D): is the number of individuals per unit area (ind.ha-1);

Absolute Density (DA): is the number of individuals (n) of a given species in the area:

AD = n/area

Measurement unit: ind.ha^{-1}

Relative Density (DR): is the relationship between the number of individuals of a species (n) and the total number of individuals sampled (N)

RD = (n/N) x 100
Measurement unit: %

Frequency (F): is the number of plots where a given species is found and indicates the average dispersion of each species;

Absolute frequency (FA): the relationship between the number of plots on which a given species is found and the total number of plots sampled:

AF = (Pi / P) x 100
Pi: n. of plots in which the species takes place
P: n. total plots sampled
Unit of measurement: %

Relative frequency (FR): relationship between FA of a certain species with the sum of FA of all species sampled:

FR = (FAi / ∑ FA) x 100
FAi: absolute frequency of a specie
Unit of measurement: %

Dominance (Do): is the rate of occupation of the environment by the individuals sampled. It is calculated from the basal area (AB):

AB = π / 4 x d^2
d: single diameter...
Unit of measurement: cm^2 or m^2 (divide by 10.000)

Absolute dominance (DoA): is the basal area (AB) of a species per area:

DoA = AB / area
Unit of measurement: m^2.ha-1

Relative Dominance (DoR): is the relationship between the basal area (AB) of a species and the total basal area (AB) of the species sampled.

DoR = (AB/ ∑AB) x 100
Unit of Measurement: %

Importance Value Index (IVI): provides an idea of the density, spatial dispersion and size reached by a species, reflecting its ecological importance.

VI = DR + DoR + FR
VI = maximum value of 300
VI % = maximum value 100, expressed in %

Index of Coverage Value (IVC): provides information related to the number of individuals and the biomass of each species.

VC = DR + DoR
VC = Maximum value of 200

VC % = maximum value 100, expressed in %

Diversity Index: The Shannon diversity index (H') assumes that individuals are randomly sampled from an infinitely large population, also assuming that all species are represented in the sampling. It is an index based on the proportional abundance of species in the community.

Equitability or Pielou Index (J): represents the distribution of the number of individuals in relation to the species. It varies between 0 and 1.0, and the value 1.0 represents the situation in which all species have the same abundance, i.e. the same number of individuals.

For each phytophysiognomy sampled, a species cumulative curve was made according to the number of sample units (collection curve), a procedure that is indicative of the sufficiency of the sample.

The characterization of the vegetation was based on the descriptions established by the: Informe Técnico del Laboratorio SIG/CIF/FCA/UMA (Mapa de cobertura del Paraguay, 2011), Flora del Paraguay (2011) y del Manual de Familias y Géneros de Árboles del Paraguay (2015). For the presence of rare, endemic or endangered species, it was based on SEAM Resolution 524/06 (approving the list of endangered flora and fauna species of Paraguay), SEAM Resolution 2,243/06 (updating the list of protected endangered wildlife species) (Chocarro & Egea, 2018).

Characterization of the sampled areas

The sample units were installed in both the DIA and the DAA. In the plots installed in the Directly Affected Area (DAA), the savannah is characterized by heterogeneous and scarce groupings of shrubs with heights between 4 and 6 m, interspersed with large and small cactus and small trees. In the Direct Influence Area (DIA), the savannah is structured in three strata: an upper stratum, with a predominance of tree individuals up to approximately 14 m, with DBHs between 30 and 60 cm; an intermediate stratum with specimens between 4.0 and 6.0 m high with DBHs varying between 10 and 70 cm, and a lower stratum of woody grasses, generally discontinuous and of scarce physiognomic expression. The following table lists the UTM coordinates of the vertices of the sampling units.

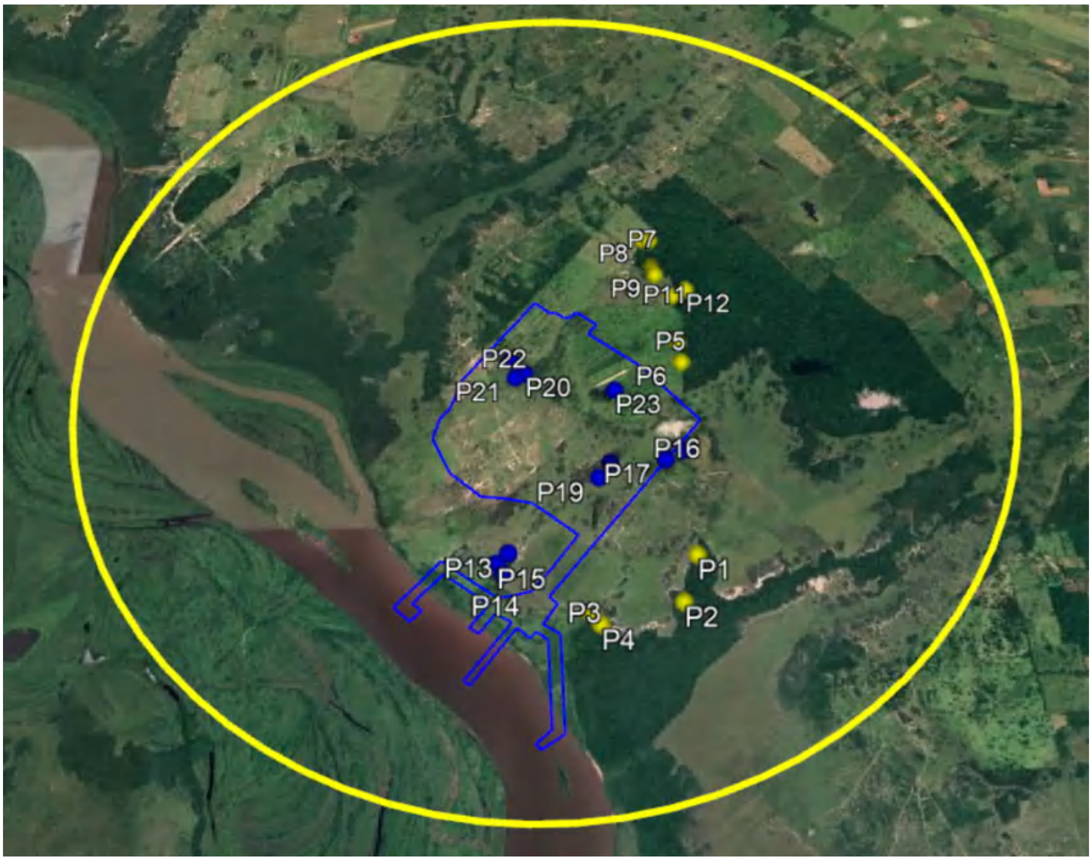


Figure 186 – Image with the location of the plots in the DIA and DAA of the future mill site. Image: Google Earth feb/2018.

Figure 187 – View of the vegetation in the DAA.

Figure 188 – Another angle of the vegetation in the DAA

Figure 189 – Detail of the dense stratum formed by bushes and grasses present in the areas sampled in the ADA.

Figure 190 – Another angle of the dense stratum formed by bushes and grasses sampled in the ADA.

Figure 191 – View of the vegetation in the AID.

Figure 192 – Another angle of the vegetation in the AID

Table 6 – UTM coordinates of the vertices of the plots in the DAA and DIA of the future PARACEL pulp mill.

Location	Plots	WGS 84 - 21K (UTM)	
		E	S
DIA	1	451437,00	7427356,00
	2	451285,00	7426866,00
	3	450347,00	7426688,00
	4	450402,00	7426646,00
	5	451343,00	7429958,00
	6	451363,00	7429712,00
	7	451021,00	7431361,00
	8	451012,00	7431308,00
	9	451082,00	7430888,00
	10	451051,00	7431010,00
	11	451290,00	7430561,00

Location	Plots	WGS 84 - 21K (UTM)	
		E	S
	12	451437,00	7430665,00
DAA	13	449460,00	7427375,00
	14	449451,00	7427258,00
	15	449382,00	7427162,00
	16	451336,00	7428602,00
	17	451091,00	7428462,00
	18	450545,00	7428460,00
	19	450410,00	7428334,00
	20	449660,00	7429513,00
	21	449509,00	7429543,00
	22	449417,00	7429696,00
	23	449345,00	7429715,00

Results

Directly Area Affected (DAA)

In the phytosociological study, 167 individuals belonging to nine families and 17 species were sampled. Of the total number of individuals sampled, three were found dead and one species was identified to the genus only. The absolute values of density and basal area obtained for 1600 m2 of sampling were, respectively, 1043.75 ind/ha and 1.12 m²/ha. The average diameter recorded was 8.25 cm, the average height corresponded to 4.28 m and the Shannon diversity index calculated for this study was 1.94.

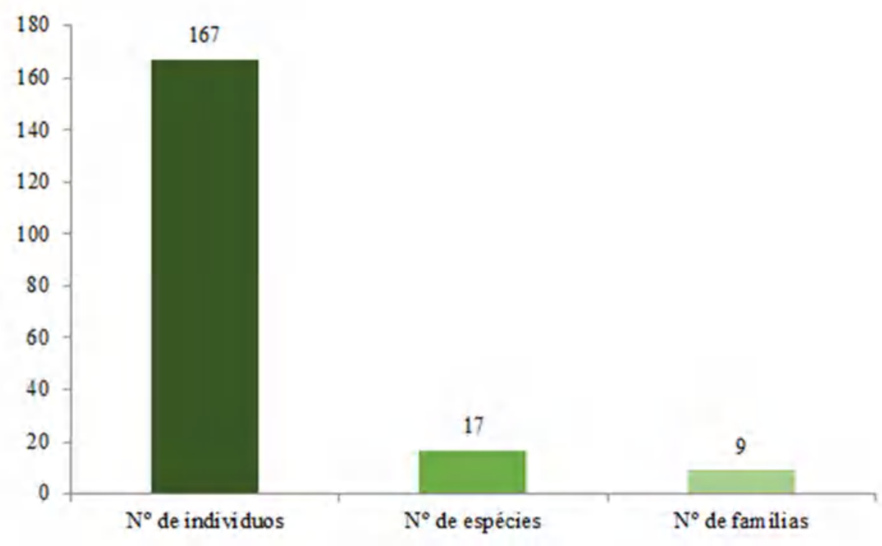


Figure 193 – Comparative table between the number of individuals, species and families found in the sample.

Table 7 – General characteristics of the stratum of trees and bushes sampled in the plots

Parameters	
Number of individuals	167
Number of species	17
Number of families	9
Absolute density (ind/ha)	1.043,75
Total basal area (m2/ha)	1,12
Diameter - average	8,25
Height - medium	4,28
Shannon-Wiener (H')	1,94
Equitability (J')	0,67

The species with the highest Importance Value Index - IVI in descending order are: *Prosopis rubriflora* (92,58%), *Schinopsis balansae* (82,16%), *Ziziphus mistol* (20,87%), *Plenckia populnea* (14,12%) and *Chloroleucon chacoense* (9,39%), however, the dead samples found represent 12.17% of the sample.

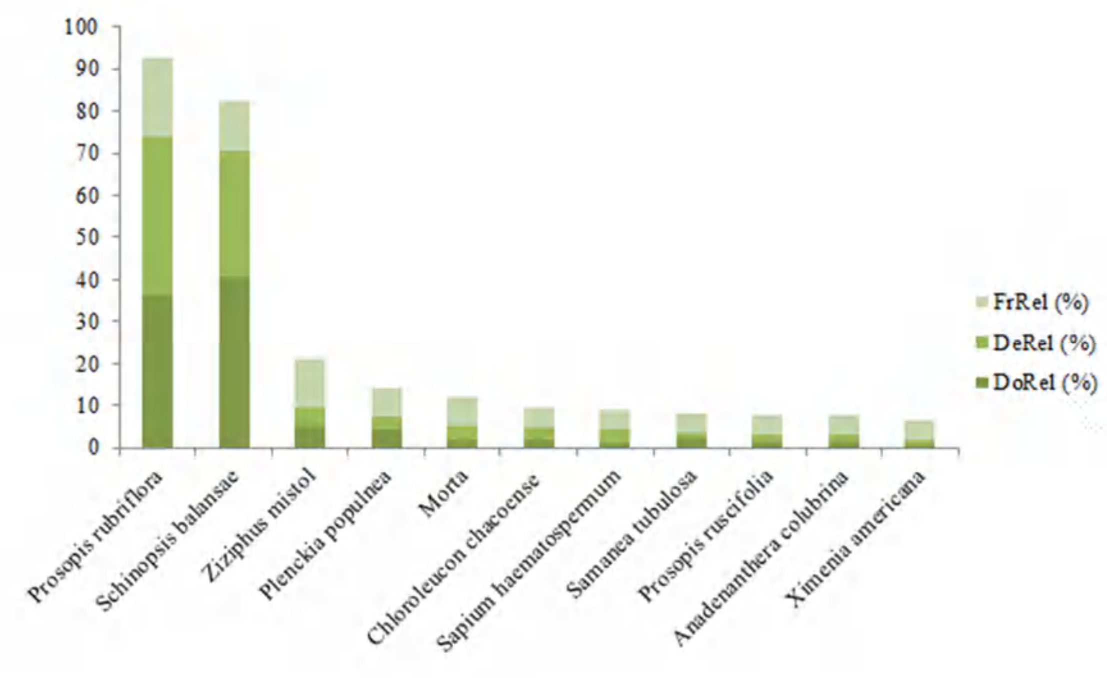


Figure 194 – Graph showing the distribution of the structural parameters of the 10 species with the highest IVI value. Legend: FrRel: Relative Frequency; DeRel: Relative Density; DoRel: Relative Dominance.

With regard to the species sampled in this study, the *Prosopis rubriflora* was the most abundant, represented by 63 individuals, and was present in all sample units, however, the *Schinopsis balansae* and *Schaefferia argentinensis* have been presented as the highest average height (5.41 m and 4.88 m, respectively) and the *Samanea tubulosa* is presented as the one with the largest average diameter (12.17 cm).

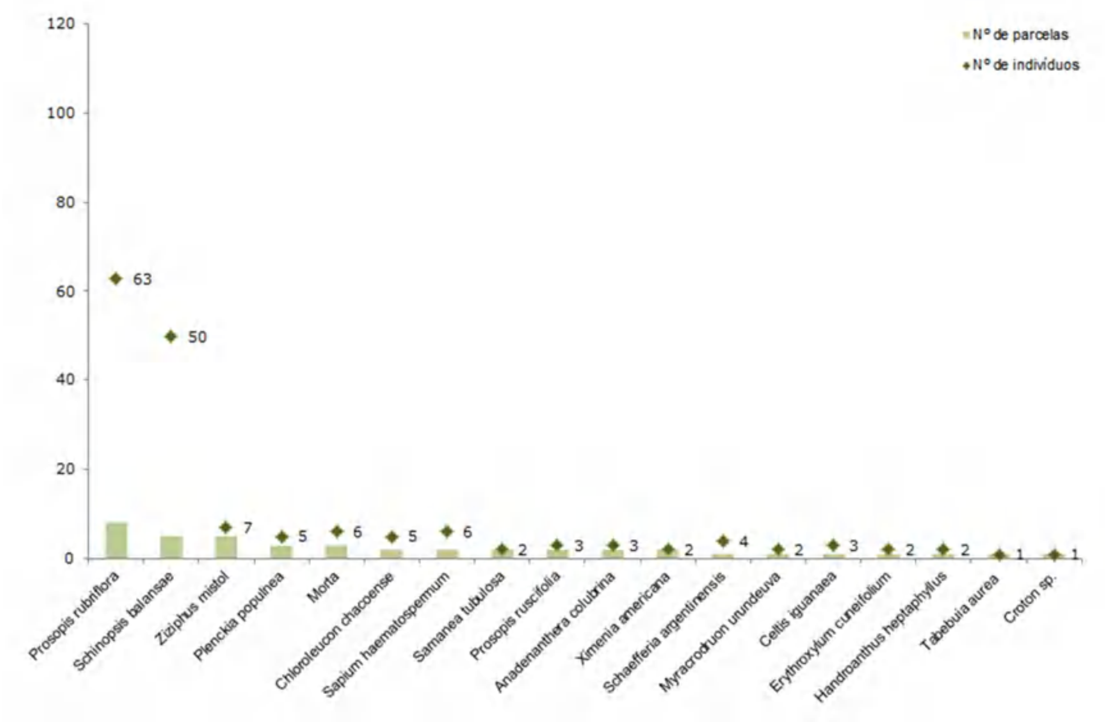


Figure 195 – Representative graphics of the number of individuals per sampled plot.

Among the 17 species sampled in this study, none is found exclusively in the physiognomy of the savannah, being identified in other biogeographic regions as the table below.

Table 8 – Native forest strata of Paraguay and the species found in the most

Species	BHRO	BSHC	BSHIRP	BSCH	BP
Prosopis rubriflora			x	x	x
Schinopsis balansae	x	x	x	x	
Ziziphus mistol	x		x	x	
Plenckia populnea	x	x	x	x	
Chloroleucon chacoense			x	x	x
Sapium haematospermum	x	x		x	x
Samanea tubulosa	x	x	x		

Species	BHRO	BSHC	BSHIRP	BSCH	BP
Prosopis ruscifolia			x	x	x
Anadenanthera colubrina	x		x	x	
Ximenia americana			x	x	
Schaefferia argentinensis			x	x	
Myracrodruon urundeuva	x	x	x	x	
Celtis iguanaea	x		x	x	
Erythroxylum cuneifolium	x	x	x		
Handroanthus heptaphyllus	x		x	x	
Tabebuia aurea	x	x	x	x	x
Croton sp.					

Source: Manual de Familias y Géneros de Árboles del Paraguay (2015). **BHRO**: Bosque Húmedo de la Región Oriental; **BSHC**: Bosque Subhúmedo del Cerrado; **BSHIRP**: Bosque Subhúmedo Inundado del Río Paraguay; **BSCH**: Bosque Seco del Chaco; **BP**: Bosque Palmar. (The text used native names).

The families with the highest IVC (index of coverage value) values were Fabaceae (87,93) and Anacardiaceae (72,70). Of the nine families sampled, the Fabaceae with five species (27,78 %) represents the richest species, followed by Anacardiaceae, Celastraceae, Euphorbiaceae y Bignoniaceae (11,11%), the other families were represented by one species each. Considering dominance, density and relative frequency, the following figure presents the IVI (Importance Value Index) of the most representative families of the sampling.

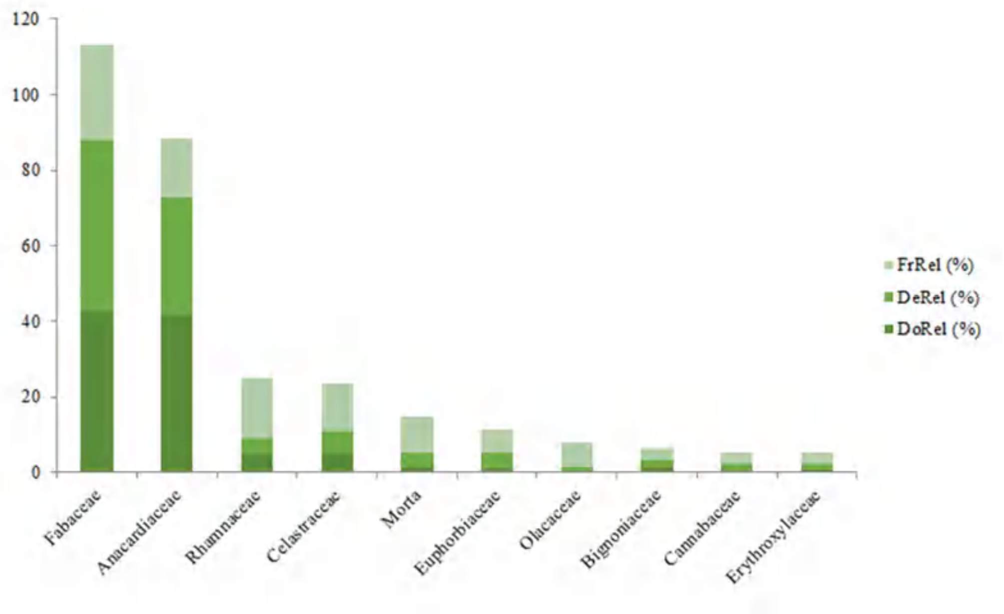


Figure 196 – Graph showing the distribution of the structural parameters related to the IVI of the points sampled. Legend: FrRel: Relative Frequency; DeRel: Relative Density; DoRel: Relative Dominance.

Regarding the structure, this phytophysiology has an average diameter of 8.25 cm. The diametric distribution indicates that this phytophysiology is composed of small trees with a high concentration of individuals between 3 and 7 cm in trunk diameter (63.5%).

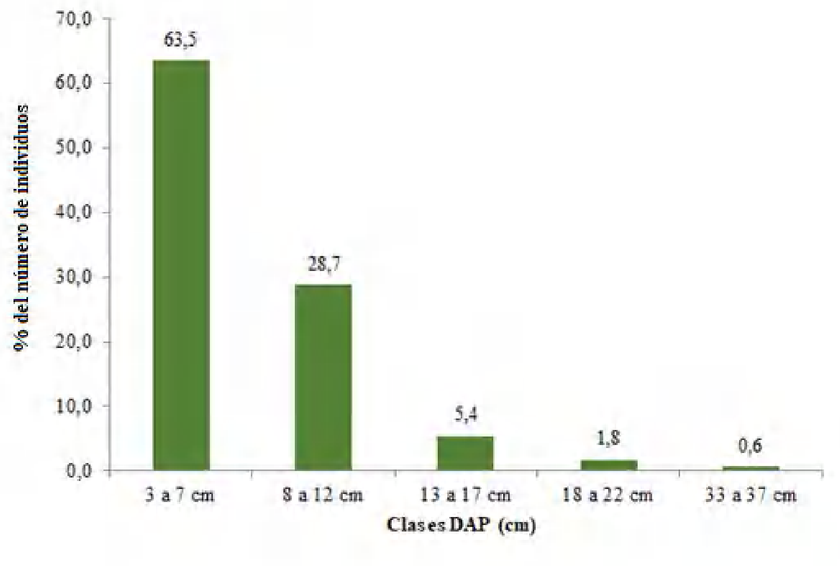


Figure 197 – Distribution of diameter classes (DAP) of individuals sampled in the ADA.

The average height was 4.28 m and the distribution of the total height indicates that 53.3% of the individuals have heights between 4.0 and 6.0 m.

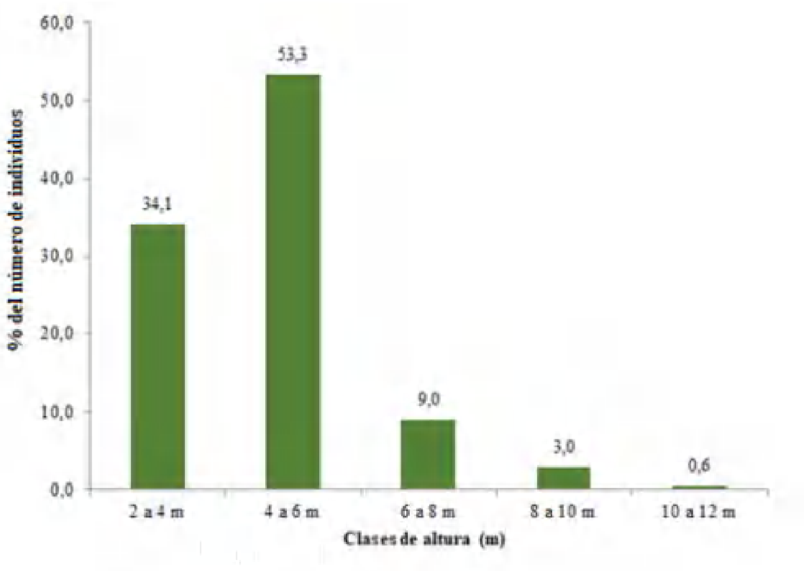


Figure 198 – Distribution of height classes of individuals sampled in the ADA.

The phytosociological parameters of the sampled tree species are presented in the table below.

Table 9 – Phytosociological parameters of the tree community. NInd – number of individuals; NAm – sample number; AbsDe – Absolute Density; RelDe – Relative Density; AbsFr – Absolute frequency; RelFr – Relative frequency; AbsDo – Absolute Dominance; RelDo – Relative Dominance; IVI – Importance value index; IVC – Coverage value index

Species	NInd	NAm	AbsDe	RelDe	AbsFr	RelFr	AbsDo	RelDo	IVI	IVC
Prosopis rubriflora Hassl.	63	8	393,80	37,72	100,00	18,60	2,54	36,25	92,58	73,97
Schinopsis balansae Engl.	50	5	312,50	29,94	62,50	11,63	2,84	40,60	82,16	70,54
Ziziphus mistol Griseb. [sin. *Ziziphus oblongifolius* S.Moore]	7	5	43,80	4,19	62,50	11,63	0,35	5,05	20,87	9,24
Plenckia populnea Reissek	5	3	31,30	2,99	37,50	6,98	0,29	4,15	14,12	7,15
Morta	6	3	37,50	3,59	37,50	6,98	0,11	1,60	12,17	5,19
Chloroleucon chacoense (Burkart) Barneby & J.W.Grimes	5	2	31,30	2,99	25,00	4,65	0,12	1,74	9,39	4,74
Sapium haematospermum Müll.Arg.	6	2	37,50	3,59	25,00	4,65	0,06	0,89	9,14	4,48
Samanea tubulosa (Benth.) Barneby & J.W.Grimes	2	2	12,50	1,20	25,00	4,65	0,15	2,09	7,94	3,29
Prosopis ruscifolia Griseb.	3	2	18,80	1,80	25,00	4,65	0,09	1,22	7,67	3,02
Anadenanthera colubrina (Vell.) Brenan	3	2	18,80	1,80	25,00	4,65	0,08	1,12	7,56	2,91
Ximenia americana L.	2	2	12,50	1,20	25,00	4,65	0,03	0,39	6,24	1,59
Schaefferia argentinensis Speg.	4	1	25,00	2,40	12,50	2,33	0,09	1,26	5,98	3,65
Myracrodruon urundeuva Allemão	2	1	12,50	1,20	12,50	2,33	0,07	0,96	4,48	2,16
Celtis iguanaea (Jacq.) Sarg. [sin. *Celtis pubescens* (Humboldt & Bonpl	3	1	18,80	1,80	12,50	2,33	0,02	0,35	4,47	2,15
Erythroxylum cuneifolium (Mart.) O.E.Schulz	2	1	12,50	1,20	12,50	2,33	0,06	0,84	4,36	2,03
Handroanthus heptaphyllus (Vell.) Mattos	2	1	12,50	1,20	12,50	2,33	0,06	0,79	4,32	1,99
Tabebuia aurea (Silva Manso) Benth. & Hook.f. ex S.Moore	1	1	6,30	0,60	12,50	2,33	0,04	0,61	3,54	1,21
Croton sp.	1	1	6,30	0,60	12,50	2,33	0,01	0,09	3,01	0,68

In terms of floristic similarity between the plots, of the 11 tree species found, only *Prosopis rubriflora* was common to all of them, followed by the species *Schinopsis balansae* y *Ziziphus mistol* sampled in five plots.

Cluster analysis is a method of numerical classification, with the objective of defining groups with different degrees of similarity, that is, it identifies objects that are sufficiently similar to be placed in the same group (Legendre, P; Legendre, L, 1998 apud Felfili, et al, 2011). The coefficient adopted was the Bray-Curtis, which is a similarity index for abundance data.

In accordance Mueller-Dombois & Ellenberg (1974) two or more areas are considered similar in terms of floristic composition when they have at least 25% of common species.

The similarity dendrogram between the study plots showed the tendency to form three groups, one formed by plots P15, P18, P19 and P20, one formed by plots P21, P22 and P23 and one formed only by P14. The highest similarity index obtained was 85% between plots P18 and P19.

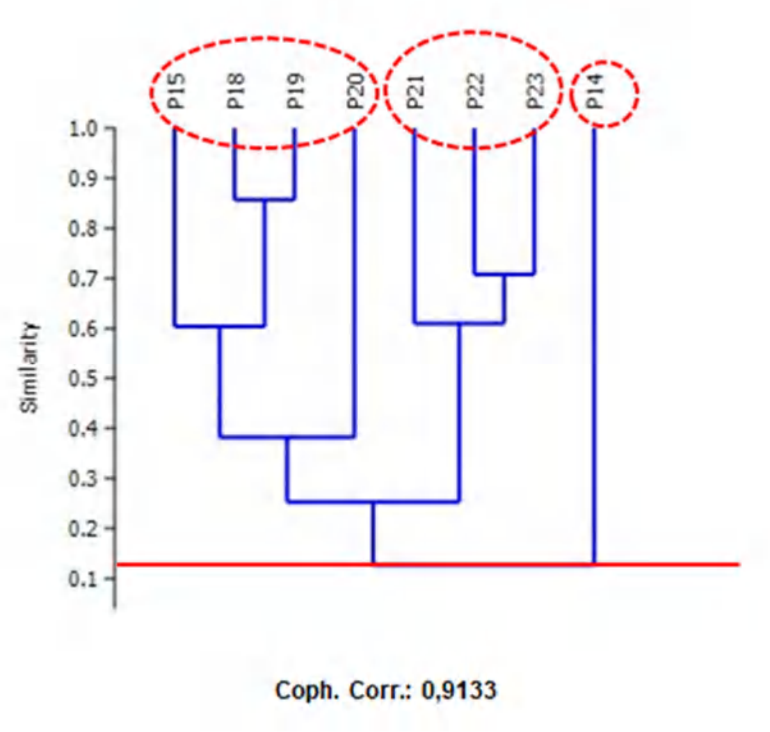


Figure 199 – Bray-Curtis similarity dendrogram in the sampled areas Legend: P: plot (20x10 m).

Equitability is derived from the Shannon diversity index, and makes it possible to represent the way in which the number of individuals is distributed among the different species (Pielou, 1966), that is, it indicates whether the different species have a similar or divergent abundance (number of individuals). Its value presents a range from 0 (minimum uniformity) to 1 (maximum uniformity).

The following figure presents the Pielou (J') equation diagram generated for the sampling carried out, where the index variation was from the lowest 0.56, found in plot P22, to 0.88, found in plot P14.

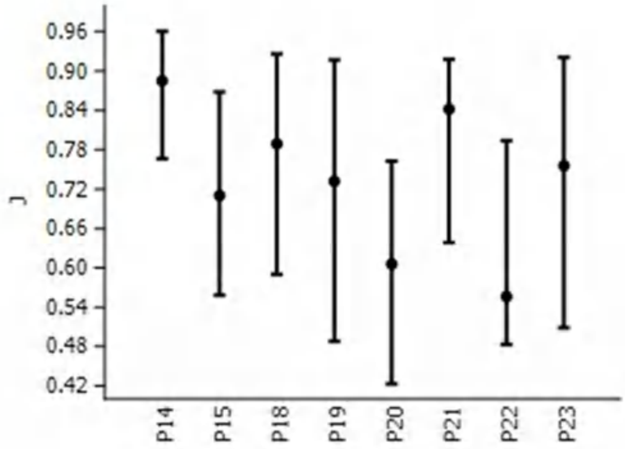


Figure 200 – Pielou Equitability Diagram (J'). Legend: P – plot (20 x10m).

Regarding the efficiency of the study, a random species accumulation curve was constructed, taking into account the cumulative number of species recorded by the graph method, in which a total of 17 species were added.

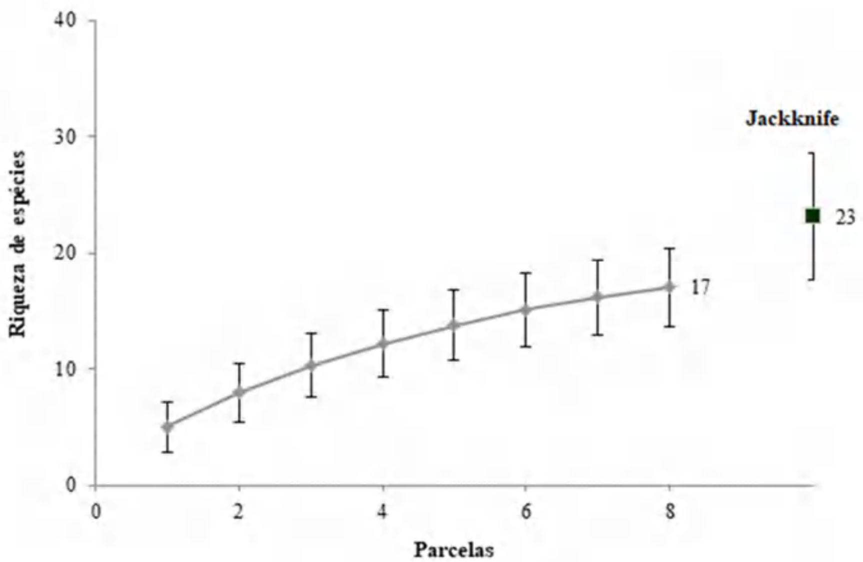


Figure 201 – Random accumulation curve of observed and expected species by the Jackknife estimator.

The Jackknife estimator assumes a total of 23 species for the areas sampled, with a deviation of 5.47 for major and minor. When considering the number of species recorded in the floristic study (144 spp) it is understood that increasing the sampling effort will always increase the richness value and approach the maximum number of species, so the greater the sampling effort performed, the more likely it is that a new species will be recorded. Therefore, the sampling effort is considered satisfactory for this study.

Direct Influence Area (DIA)

In the phytosociological study, samples were taken from 216 individuals belonging to 20 families and 31 species. Of the total number of individuals sampled, 13 were found dead, three species were identified only up to the genus and five species were not identified. The absolute values of density and basal area obtained for 3,000 m^2 of sampling were, respectively, 720.00 ind/ha and 5.07 m²/ha. The average diameter recorded was 13.13 cm, the average height corresponded to 4.87 m and the Shannon diversity index calculated for this study was 2.67.

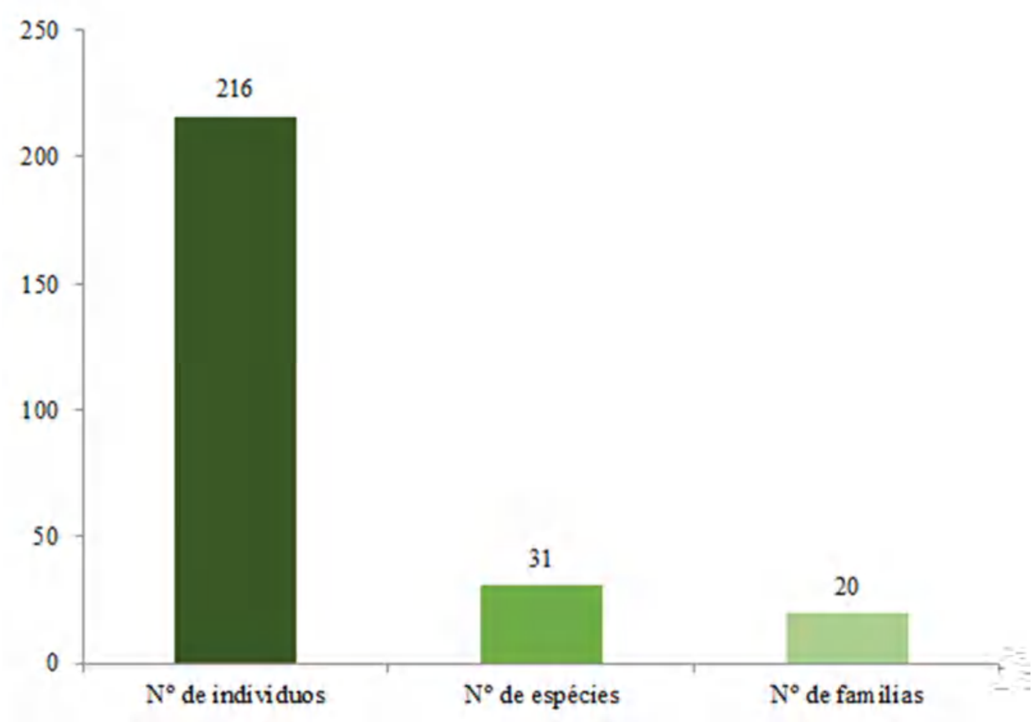


Figure 202 – Comparative table between the number of individuals, species and families found in the sample.

Table 10 – General characteristics of the stratum of trees and shrubs sampled in the plots

Parameters	
Number of individuals	216
Number of species	31
Number of families	20
Absolute density (ind/ha)	720,00
Total basal area (m2/ha)	5,07
Diameter - average	13,13
Height - medium	4,87
Shannon-Wiener (H')	2,67
Fairness (J')	0,74

The species with the highest Importance Value Index - IVI in decreasing order are: *Dalbergia frutescens* (74,02%), *Enterolobium contortisiliquum* (30,61%) and the *Priogymnanthus hasslerianus* (24,74%), however, the samples found dead represent 15.05% of the sampling.

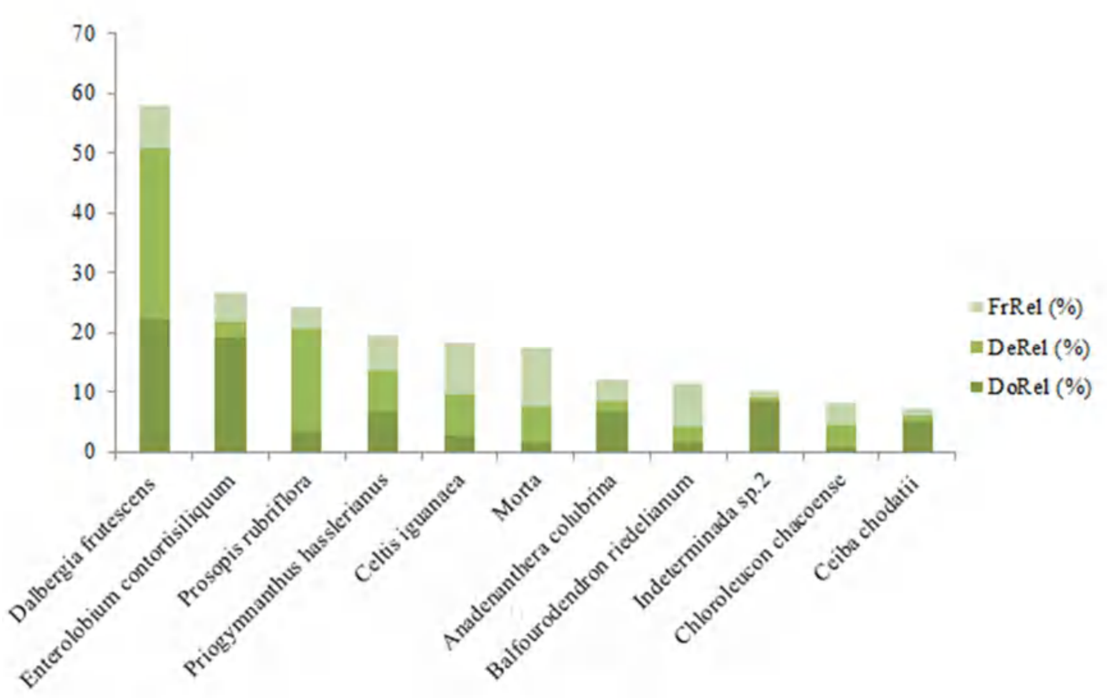


Figure 203 – Graph showing the distribution of the structural parameters of the 10 species with the highest IVI. Legend: FrRel: relative frequency; DeRel: Relative Density; DoRel: relative Dominance.

Of the species sampled in this study *Dalbergia frutescens* was the most abundant, represented by 62 individuals, and was present in six of the fifteen sample units, however, the *Ceiba chodatii* y *Croton* sp. both with 11.00 meters and the species *Enterolobium contortisiliquum* at 10.83 m presented the highest average height and a species here called *Indeterminado sp*.2 had the largest average diameter (73,53 cm).

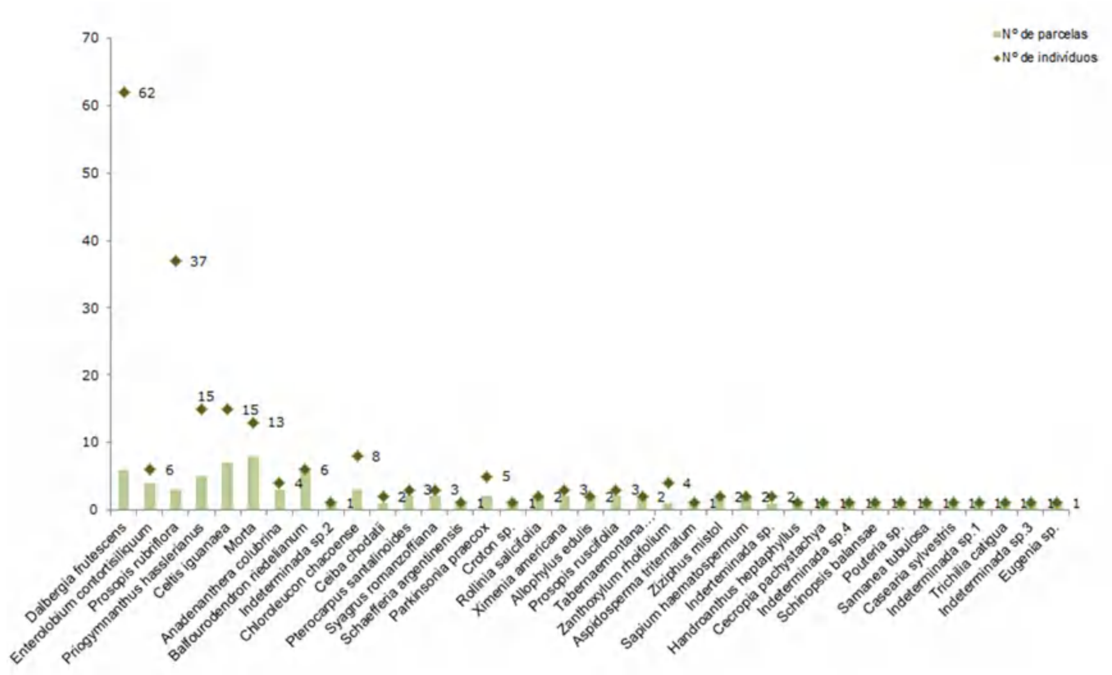


Figure 204 – A representative chart of the number of individuals per plot sampled.

Among the 31 species identified in this study *Balfourodendron riedelianum* takes place exclusively in the Bosque Húmedo de la Región Oriental (BHRO), according to the Manual of Families and Genders of Trees of Paraguay (2015), the others are in the other biogeographical regions, as presented in the table below.

Table 11 – Strata of native forest in Paraguay and the species found in the sampling

Species	BHRO	BSHC	BSHIRP	BSCH	BP
Dalbergia frutescens	x	x			
Enterolobium contortisiliquum	x		x		
Prosopis rubriflora			x	x	x
Priogymnanthus hasslerianus	x	x			
Celtis iguanaea	x		x	x	
Anadenanthera colubrina	x		x	x	
Balfourodendron riedelianum	x				

Species	BHRO	BSHC	BSHIRP	BSCH	BP
Chloroleucon chacoense			x	x	x
Ceiba chodatii	x	x	x	x	
Pterocarpus santalinoides	x		x		
Syagrus romanzoffiana	x		x		
Schaefferia argentinensis			x	x	
Parkinsonia praecox			x	x	
Croton sp.					
Rollinia salicifolia	x		x		
Ximenia americana			x	x	
Allophylus edulis	x		x		
Prosopis ruscifolia			x	x	x
Tabernaemontana catharinensis	x	x	x		
Zanthoxylum rhoifolium	x		x	x	
Aspidosperma triternatum	x	x	x	x	
Ziziphus mistol	x		x	x	
Sapium haematospermum	x		x	x	x
Handroanthus heptaphyllus	x		x	x	
Cecropia pachystachya	x		x		
Schinopsis balansae	x	x	x	x	
Pouteria sp.					
Samanea tubulosa	x	x	x		
Casearia sylvestris	x		x		
Trichilia catigua	x		x		
Eugenia sp.					

Source: Manual de Familias y Géneros de Árboles del Paraguay (2015) BHRO: Eastern Region Humid Forest; BSHC: Cerrado Subhumid Forest; BSHIRP: Paraguay River Flooded Subhumid Forest; BSCH: Chaco Dry Forest; BP: Palmar Forest.

Families with the highest values of IVC (index of coverage value) were Fabaceae (114.81) and Oleaceae (13.47). Of the 20 families in the sample, the Fabaceae with nine species (24,32%) represents the richest species, followed by Rutaceae, Euphorbiaceae, Apocynaceae, Annonaceae y Sapindaceae all with two species (5,41%), the other families were represented by one species each. Considering the dominance, density and relative frequency, the following figure presents the IVI (index of value of importance) of the most representative families in the sample.

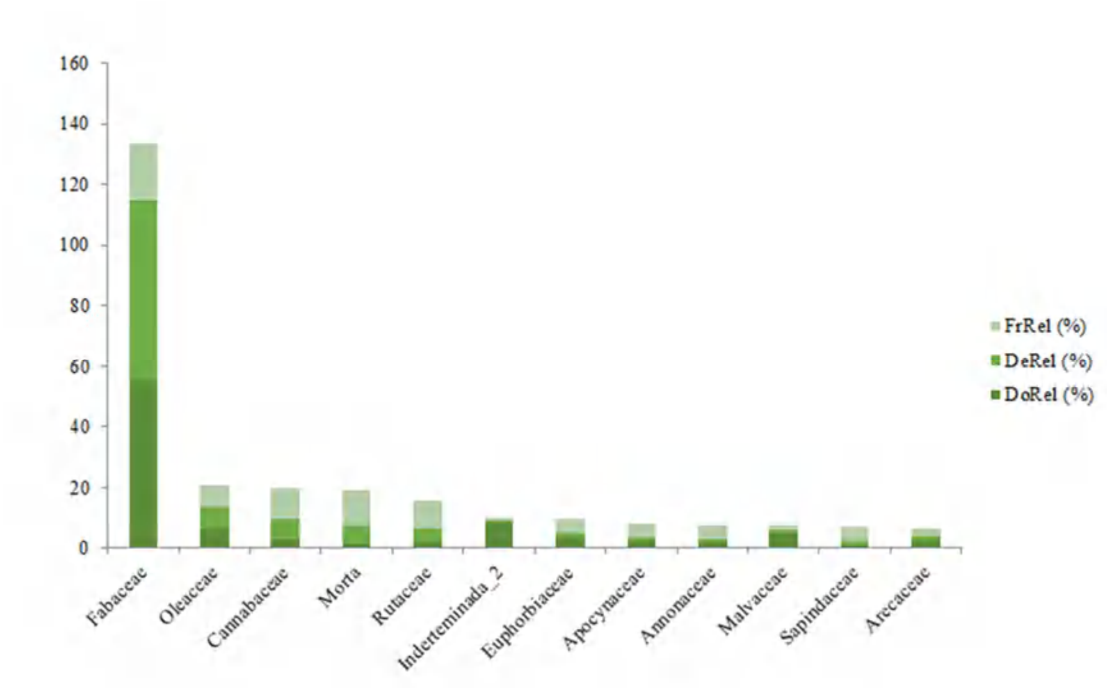


Figure 205 – Graph showing the distribution of the structural parameters related to the IVI of the points sampled. Legend: FrRel: Relative frequency; DeRel: Relative density; DoRel: Relative dominance.

In relation to the structure, this phytophysiology has an average diameter of 13.13 cm. The diametric distribution shows that this phytophysiology is composed of small trees with a high concentration of individuals between 4 and 13 cm of trunk circumference (49.5%).

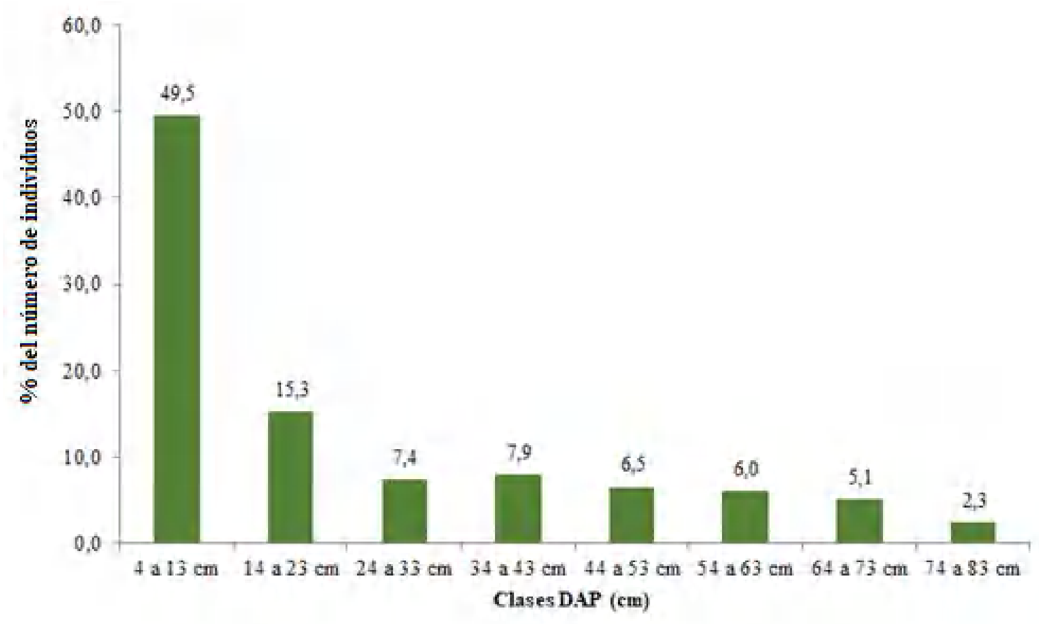


Figure 206 – Distribution of diameter classes (DBH) of individuals sampled in the ADA.

The average height was 4.87 m and the distribution of the total height indicates that 49.5% of the individuals have heights between 4.0 and 6.0 meters.

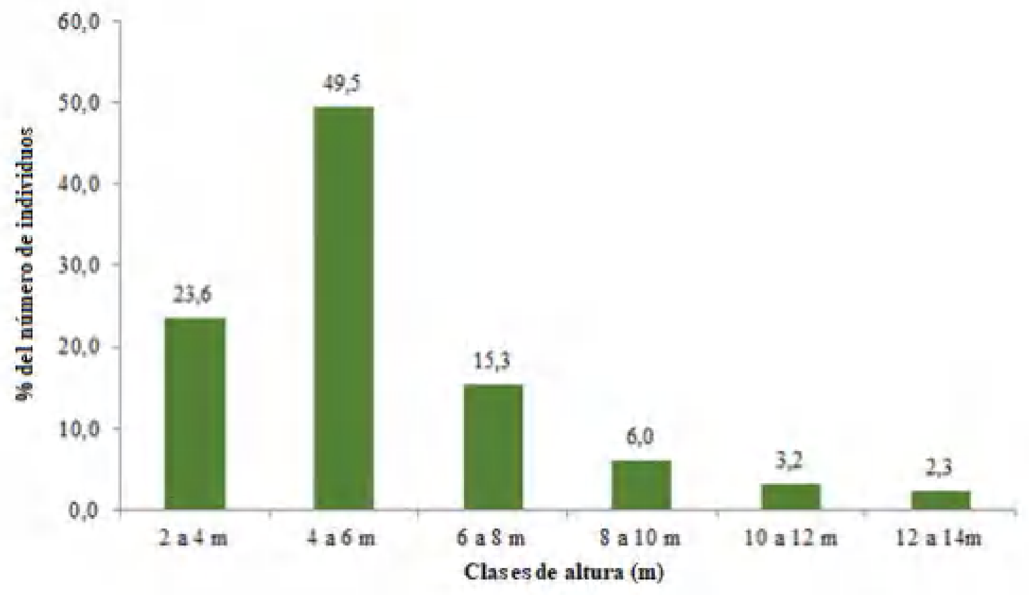


Figure 207 – Distribution of height classes of individuals sampled in the ADA.

The phytosociological parameters of the sampled tree species will be presented in the table below.

Table 12 – Phytosociological parameters of the tree community NInd - Number of individuals; NAm - Number of samples; AbsDe - Absolute density; RelDe - Relative density; AbsFr - Absolute frequency; RelFr - Relative frequency; AbsDo - Absolute dominance; RelDo - Relative dominance; IVI - Importance value index; IVC - Coverage value index

Species	NInd	NAm	AbsDe	RelDe	AbsFr	RelFr	AbsDo	RelDo	IVI	IVC
Dalbergia frutescens (Vell.) Britton	62	6	206,70	28,70	40,00	7,23	3,72	22,00	57,94	50,71
Enterolobium contortisiliquum (Vell.) Morong	6	4	20,00	2,78	26,67	4,82	3,21	19,02	26,62	21,80
Prosopis rubriflora Hassl.	37	3	123,30	17,13	20,00	3,61	0,59	3,51	24,25	20,63
Priogymnanthus hasslerianus (Chodat) P.S.Green	15	5	50,00	6,94	33,33	6,02	1,10	6,53	19,49	13,47
Celtis iguanaea (Jacq.) Sarg. [sin. *Celtis pubescens* (Humboldt & Bonpland) Sprengel]	15	7	50,00	6,94	46,67	8,43	0,46	2,75	18,13	9,69
Morta	13	8	43,30	6,02	53,33	9,64	0,26	1,56	17,22	7,58
Anadenanthera colubrina (Vell.) Brenan	4	3	13,30	1,85	20,00	3,61	1,12	6,65	12,12	8,50
Balfourodendron riedelianum Engl.	6	6	20,00	2,78	40,00	7,23	0,25	1,48	11,49	4,26
Indeterminate sp.2	1	1	3,30	0,46	6,67	1,20	1,42	8,38	10,05	8,84
Chloroleucon chacoense (Burkart) Barneby & J.W.Grimes	8	3	26,70	3,70	20,00	3,61	0,12	0,72	8,04	4,43
Ceiba chodatii (Hassl.) Ravenna	2	1	6,70	0,93	6,67	1,20	0,85	5,01	7,14	5,93
Pterocarpus santalinoides L'Hér. ex DC.	3	2	10,00	1,39	13,33	2,41	0,41	2,44	6,24	3,83
Syagrus romanzoffiana (Cham.) Glassman	3	2	10,00	1,39	13,33	2,41	0,41	2,41	6,21	3,80
Schaefferia argentinensis Speg.	1	1	3,30	0,46	6,67	1,20	0,61	3,62	5,28	4,08
Parkinsonia praecox (Ruiz & Pav.) Hawkins [sin. *Cercidium praecox* (Ruiz & Pav.) Harms]	5	2	16,70	2,31	13,33	2,41	0,08	0,49	5,21	2,80
Croton sp.	1	1	3,30	0,46	6,67	1,20	0,60	3,53	5,20	4,00
Rollinia salicifolia Schltdl.	2	2	6,70	0,93	13,33	2,41	0,29	1,74	5,08	2,67
Ximenia americana L.	3	2	10,00	1,39	13,33	2,41	0,16	0,92	4,72	2,31
Allophylus edulis (A.St.-Hil., A.Juss. & Cambess.) Radlk.	2	2	6,70	0,93	13,33	2,41	0,12	0,71	4,04	1,63
Prosopis ruscifolia Griseb.	3	2	10,00	1,39	13,33	2,41	0,02	0,14	3,94	1,53

Species	NInd	NAm	AbsDe	RelDe	AbsFr	RelFr	AbsDo	RelDo	IVI	IVC
Tabernaemontana catharinensis A.DC.	2	2	6,70	0,93	13,33	2,41	0,05	0,32	3,65	1,24
Zanthoxylum rhoifolium Lam.	4	1	13,30	1,85	6,67	1,20	0,09	0,55	3,61	2,40
Aspidosperma triternatum Rojas Acosta	1	1	3,30	0,46	6,67	1,20	0,32	1,90	3,57	2,36
Ziziphus mistol Griseb. [sin. *Ziziphus oblongifolius* S.Moore]	2	2	6,70	0,93	13,33	2,41	0,04	0,21	3,54	1,13
Sapium haematospermum Müll.Arg.	2	2	6,70	0,93	13,33	2,41	0,02	0,10	3,43	1,02
Inderteminada sp.	2	1	6,70	0,93	6,67	1,20	0,08	0,46	2,59	1,39
Handroanthus heptaphyllus (Vell.) Mattos	1	1	3,30	0,46	6,67	1,20	0,14	0,81	2,48	1,28
Cecropia pachystachya Trécul	1	1	3,30	0,46	6,67	1,20	0,10	0,60	2,27	1,07
Indeterminate sp.4	1	1	3,30	0,46	6,67	1,20	0,07	0,44	2,11	0,90
Schinopsis balansae Engl.	1	1	3,30	0,46	6,67	1,20	0,05	0,32	1,99	0,78
Pouteria sp.	1	1	3,30	0,46	6,67	1,20	0,05	0,28	1,94	0,74
Samanea tubulosa (Benth.) Barneby & J.W.Grimes	1	1	3,30	0,46	6,67	1,20	0,02	0,11	1,78	0,58
Casearia sylvestris Sw.	1	1	3,30	0,46	6,67	1,20	0,02	0,11	1,78	0,58
Indeterminate sp.1	1	1	3,30	0,46	6,67	1,20	0,01	0,06	1,72	0,52
Trichilia catigua A.Juss.	1	1	3,30	0,46	6,67	1,20	0,01	0,05	1,72	0,51
Indeterminate sp.3	1	1	3,30	0,46	6,67	1,20	0,01	0,04	1,70	0,50
Eugenia sp.	1	1	3,30	0,46	6,67	1,20	0,01	0,04	1,70	0,50

With regard to floristic similarity between the plots, of the 31 species identified, only *Celtis iguanaea* was found in 7 sampling units, followed by the species *Dalbergia frutescens*e e *Balfourodendron riedelianum* sampled in 6 plots, *Priogymnanthus hasslerianus* sampled in 5 plots, and finally the species *Enterolobium contortisiliquum* sampled in 4 plots.

Cluster analysis is a method of numerical classification, with the objective of defining groups with different degrees of similarity, that is, it identifies objects that are sufficiently similar to be placed in the same group (Legendre, P; Legendre, L, 1998 *apud* Felfili, *et al*, 2011). The coefficient adopted was Bray-Curtis which is a similarity index for abundance data.

In accordance with Mueller-Dombois & Ellenberg (1974) two or more areas are considered similar in terms of floristic composition when they have at least 25% of common species.

The similarity dendrogram between the study plots showed the tendency to form two groups, one composed of the plots P9, P11, P7, P8, P10 and P12 and another composed of the plots P2, P4, P3, P5, P1, P6, P13, P16 and P17. The highest similarity rate obtained was 84% between plots P10 and P12.

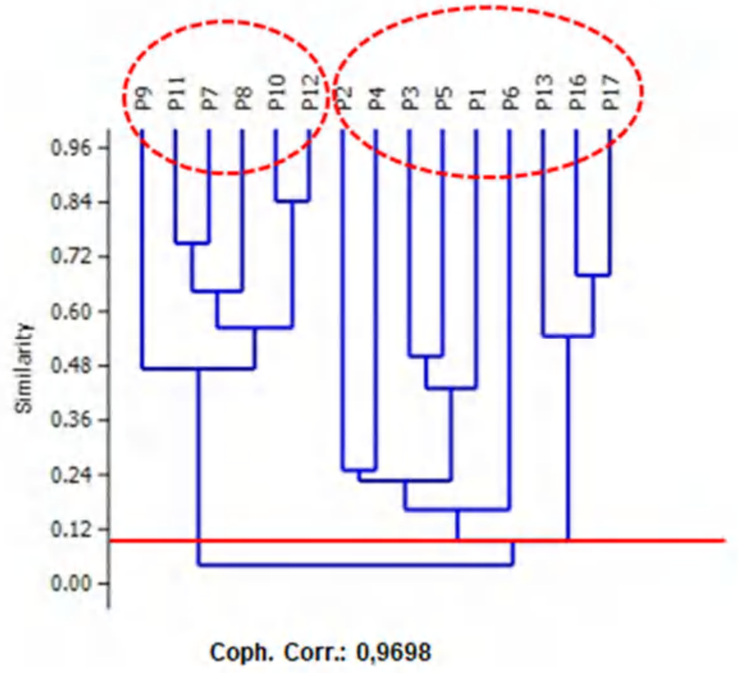


Figure 208 – Bray-Curtis similarity dendrogram between sampled areas. Legend: P: plot (20x10 m).

Equitability is derived from the Shannon diversity index, and makes it possible to represent the way in which the number of individuals is distributed among the different species (Pielou, 1966), which indicates whether the different species have a similar or divergent abundance (number of individuals). Its value presents a range from 0 (minimum uniformity) to 1 (maximum uniformity).

The following figure presents the Pielou (J') equation diagram generated for the sampling carried out, where the index variation was from the lowest 0.50, found in plot P16 to 0.98, found in plot P6.

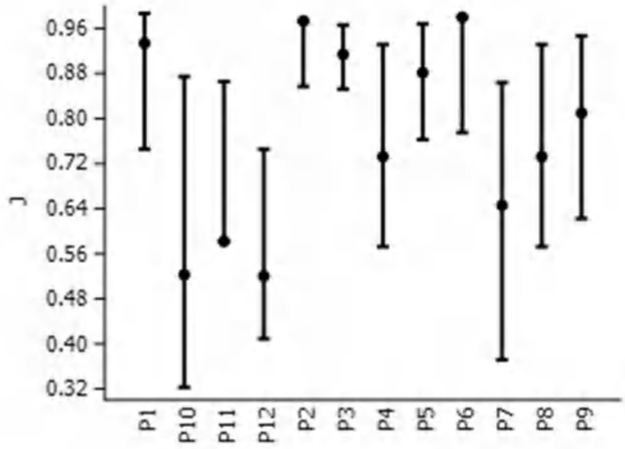


Figure 209 – Diagram Pielou (J'). Legend: P - parcela (20 x10m).

Regarding the efficiency of the study, a random species accumulation curve was constructed, considering the accumulated number of species recorded by the method of the diagram, in which a total of 31 species were added.

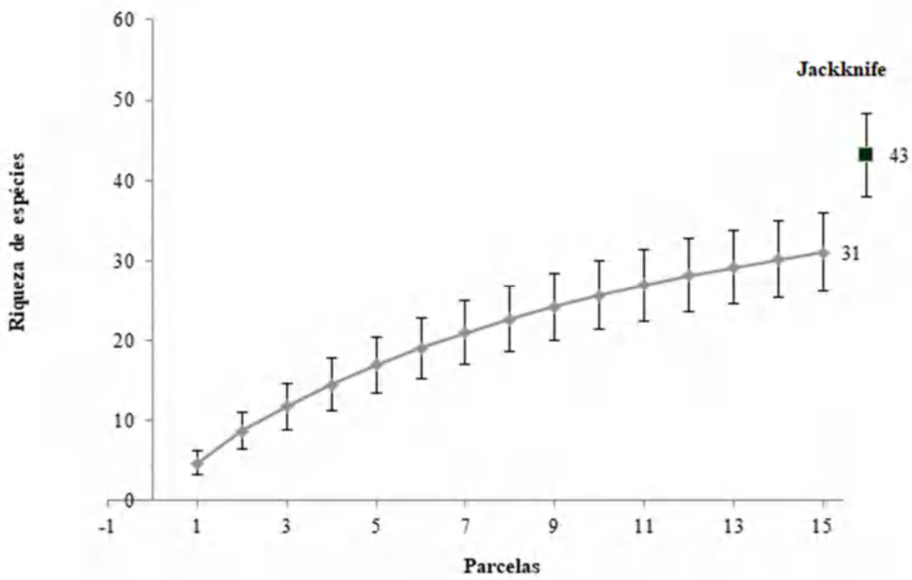


Figure 210 – Random accumulation curve of observed and expected species by the Jackknife estimator.

The Jackknife estimator assumes a total of 43 species for the areas sampled, with a deviation of about 5.27. However, it should be noted that in the present study five specimens were called indeterminate, because they did not present structures such as flowers and/or fruits that would help in their identification. When considering the number of species recorded in the floristic survey (144 spp) it is understood that increasing the sampling effort will always increase the value of richness and approach the maximum number of species, so the greater the sampling effort made, the greater the probability of increasing the record of a new species. Therefore, the sampling effort is considered satisfactory for this study.

Final considerations about Flora

The vegetation cover of a certain region is directly linked to the regulatory functions of the environment. Environmental factors such as temperature, altitude and the availability of nutrients in the soil are decisive for its physiognomy, its floristic composition and the grouping and distribution of species. Therefore, the identification of species occurring in a given geographical area represents an important step in the knowledge of an ecosystem by providing basic information for environmental studies.

From the species sampled in this study, five are listed in the lists of flora species in danger of extinction consulted (SEAM Resolution 524/2006 and SEAM Resolution 2,243/2006): the "jatai" *(Butia paraguayensis*),"grapia"*(Apuleia leiocarpa*), "algarrobo" (*Prosopis alba*), "preto carob" (*Prosopis nigra*) and the "guatambu" (*Balfourodendron riedelianum*) is endangered by IUCN 2021.

One of the greatest pressures on ecosystems is related to the reduction of natural environments due to deforestation. The areas of influence of the PARACEL pulp mill are highly anthropized and with low connectivity between the remaining vegetation, intensive use for livestock is another major pressure factor on these environments. Regarding vegetation cover, it is partly affected by anthropogenic occupations and economic activities already consolidated in the region.

The implementation of the pulp mill will require the suppression of approximately 3.99 ha of remaining vegetation of the Semideciduous Forest and 0.31 ha of remaining vegetation of the Savannah (african grasses) at riparian area for the implantation of the water intake system, the terrestrial emissary of treated effluents and the river port. Knowing that DAA has 150 ha, so the suppression will correspond only to 2,8% of the existing native forest. Paracel has committed to compensate the suppression by increasing the native area in relation to the current situation, specially enlarging the riparian areas, with approximately 250 ha, so that the net increase will represent approximately 400 ha. The implementation of the project will determine a native forest coverage in 30% of the mill site, compared to the 12% that it currently occupies. This compensation measure thus determines an increase in the native area of approximately 150% in relation to the current situation.

Vegetation suppression tends to cause loss of wildlife habitat, loss of critical areas for certain wildlife groups that use the area as breeding grounds, stopping of migratory animals and dispersion of corridors, which may impact on the genetic variability of some populations.

The adoption of ecological corridors between remaining fragments, especially those associated with waterways, which will not be affected by the project, can promote the movement of these species by ensuring their permanence and reproduction.

Considering the results obtained in this study, it is concluded that the implementation of the industrial plant and associated civil structures of the PARACEL Pulp Mill will have a local impact on the vegetation, however, there will be no impact on the connectivity of the remaining environment; the fragments and dispersed tree specimens affected are located within the site - Zapatero Cue Farm.

In conclusion, the project forecasts the suppression of and/or interference with the remaining fragments of the Savannah and Semideciduous forest located within the DAA and the intervention in the protective forest of the Paraguay River, where the ciliary vegetation fulfills an environmental function, which is to protect the margins of these and other bodies of water. It should be noted that, despite evidences of the effects of human activities on the remaining native vegetation, these continue to support the maintenance of native fauna and flora species. Therefore, any removal must be duly authorized in accordance with environmental law in force.

Paracel has committed to compensate the suppression by increasing the native area in relation to the current situation, specially enlarging the riparian areas, with approximately 250 ha, so that the total area will represent approximately 400 ha. The implementation of the project will determine a native forest coverage in 30% of the mill site, compared to the 12% that it currently occupies. This compensation measure thus determines an increase in the native area of approximately 150% in relation to the current situation.

Moreover that 30% will also regenerate the riparian forest, now highly fragmented, and also connect the native areas of the neighbouring properties to the NW and SE acting as a biological corridor, now non-existent. Therefore, **it can be said that the positive impact on biodiversity would be well over 150% in relation to the current situation**.

As summary of what will happen within Paracel pulp mill property is as follows:

Table 13 – Vegetation cover and PS 6 Type in pulp mill property

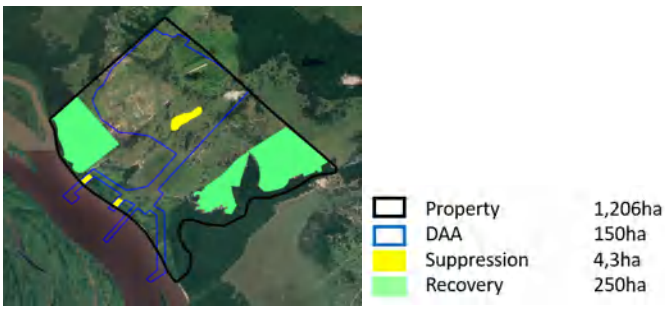
Class ID	Class type	Area (ha)	Percentage	Nat/ Mod	Area (ha)	Percentage
1	Native forest	192.96	16%	Natural	205.02	17%
2	Floodable/ Waterland	12.06	1%			
3	Grassland/Pasture/Roads	1,000.98	83%	Modified	1,000.98	83%
Total		**1,206**	**100%**		**1,206**	

It should be noted that most part of the area where the mill will be located is a Savanna area (African grass), however, currenty used for pasture.

But Paracel has committed to compensate the suppression of 3.99 ha + 0,31 ha by increasing the native area in relation to the current situation, specially enlarging the riparian areas, with approximately 250 ha, by converting Grassland/Pasture lands to native forest. So the vegetation cover in the future will be as follows:

Table 14 – Future Vegetation cover and PS 6 Type in pulp mill property

Class ID	Class type	Area (ha)	Percentage	Nat/ Mod	Area (ha)	Percentage
1	Native forest	438.66	36.4%	Natural	450.72	37.4%
2	Floodable/ Waterland	12.06	1%			
3	Grassland/Pasture/Roads	755.28	62,6%	Modified	755.28	62,6%
Total		**1,206**	**100%**		**1,206**	



9.2.2 Fauna

9.2.2.1 Mammal fauna

9.2.2.1.1 Regional Characterization (IIA)

The Republic of Paraguay is a country located in the center of South America, bordered by Bolivia to the north, Argentina to the south and west, and Brazil to the northeast (LEVI, 1873). Due to its geographical position in the center of South America, important biomes of the continent extend to Paraguay, so the country is home to a great diversity of environments. According to the work of Dinerstein et al. (1995), Paraguay is divided into five phytogeographical regions: the Humid Chaco, the Dry Chaco, the Pantanal, the Upper Paraná Atlantic Forest and the Cerrado, resulting in a more diverse fauna and flora than expected (SANCHA et al., 2019).

Mammals are an important group in terms of the biological control mechanisms of communities, since their species have great potential to influence human life, acting on the regeneration of forest areas through seed dispersal, pollination and the herbivore level (SANTOS & LIMA, 2016). Paraguay has played an important role in the history of mammal taxonomy in South America, being one of the first sites in the Americas to be explored (SAINZ OLLERO et al., 1989). The first publication on Paraguay's natural history had a considerable impact on the mammal-zoological community and was written by Féliz de Azara (1742-1821), who described the basis of numerous currently recognized taxon, many of which are widely distributed mammal species (SANCHA et al., 2017). Six currently recognized marsupial species (GARDNER, 2008), two armadillos (GARDNER, 2008), one cat, two canids (WOZENCRAFT, 2005), three primates (GROVES, 2005), two deer (GRUBB, 2005), seven bats (LÓPEZ-GONZÁLEZ, 2005; SIMMONS, 2005) and 17 species of rodents (PATTON et al, 2015) were described on the basis of Paraguayan specimens (SANCHA et al. , 2017). Despite the long history of mammal research, basic knowledge about mammals in the country remains limited (SANCHA et al., 2017).

For the study of regional mammal fauna, secondary data were collected through the literature (MORALES, 2007; SANCHA et al., 2017; RUMBO, 2010). Thus, 185 species of mammals were recorded in Paraguay, distributed among winged and land mammals (small, medium and large), 30 families and 11 orders. Of this total, 19 species are classified as "threatened with extinction" in accordance with Resolution n. 632/2017, which updates the mammal species protected by the Republic of Paraguay. Among these, the Anteater stands out (*Myrmecophaga tridactyla*), the leopard tiger (*Leopardus tigrinus*), the maned wolf (*Chrysocyon brachyurus*), the tapir (*Tapir terrestre*), el whitebearded peccary (*Tayassu pecari*), the Swamp Deer (*Blastocerus dichotomus*) and the minor roe deer (*Mazama nana*). According to the same list, there are also eight species of mammals classified as "endangered", including the armadillo carreta (*Priodontes maximus*), the Jaguar (*Panthera onca*), the vinegar fox (*Speothos venaticus*) and the Pampas Deer (*Ozotoceros bezoarticus*).

In the case of globally threatened mammals, 23 species were recorded on the IUCN Red List of Threatened Species (IUCN, 2020). Among them, the Chaco Armadillo (*Cabassous chacoensis*), the Little armadillo (*Tolypeutes matacus*), the Mountain Rabbit (*Sylvilagus brasiliensis*), Pampas Cat (*Leopardus colocolo*) and the river otter (*Lontra longicaudis*), as seen in the Table bellow.

Table 15 – List of mammal species likely to be found in the IIA of PARACEL pulp mill

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY (2017)	IUCN (2020)
Order Didelphimorphia Gill, 1872						
Family Didelphidae Gray, 1821						
Caluromys lanatus (Olfers, 1818)	Comadreja lanuda	X	X	X	AM	LC
Chironectes minimus (Zimmermann, 1780)	Lámpara de agua		X	X		LC
Cryptonanus chacoensis (Tate, 1931)	-		X			LC
Cryptonanus unduaviensis (Tate, 1931)	-		X			DD
Didelphis albiventris Lund, 1841	Comadreja común		X	X		LC
Didelphis aurita Wied-Neuwied, 1826	Comadreja orejuda	X	X	X		LC
Gracilinanus agilis (Burmeister, 1854)	Marmosa ágil		X	X		LC
Lutreolina crassicaudata (Desmarest, 1804)	Comadreja colorada		X	X		LC
Metachirus nudicaudatus (Desmarest, 1817)	Zorra morena	X	X	X	AM	LC
Marmosa constantiae (Thomas, 1904)	-		X			LC
Micoureus demerarae (Thomas, 1905)	Comadrejita grande gris	X				LC
Marmosa paraguayana (Tate, 1931)	Marmosa grande gris		X	X		LC
Monodelphis domestica (Wagner, 1842)	Colicorto gris		X	X		LC
Monodelphis kunsi Pine, 1975	Colicorto pigmeo		X			LC
Monodelphis sorex (Hensel, 1872)	Colicorto rojizo	X		X		LC
Philander frenatus (Olfers, 1818)	Comadreja		X	X		LC
Philander opossum (Linnaeus, 1758)	Comadreja		X			LC
Thylamys macrurus (Olfers, 1818)	Comadrejita cola corta	X	X	X		NT
Thylamys pusillus (Desmarest, 1804)	-		X	X		LC
Order Cingulata Illiger, 1811						
Family Dasypodidae Gray, 1821						
Dasypus hybridus (Desmarest, 1804)	Armadillo	X	X	X		NT
Dasypus novemcinctus Linnaeus, 1758	Mulita grande		X	X		LC
Euphractus sexcinctus (Linnaeus, 1758)	Tatú peludo		X	X		LC
Cabassous chacoensis Wetzel, 1980	Armadillo chaqueño de cola desnuda	X	X	X		NT
Cabassous tatouay (Desmarest, 1804)	Armadillo cola desnuda	X	X	X		LC
Calyptophractus retusus (Burmeister, 1863)	Pichiciego chaqueño	X	X	X		DD
Priodontes maximus (Kerr, 1792)	Tatú carreta	X	X	X	EP	VU
Tolypeutes matacus (Desmarest, 1804)	Tutú bolita	X	X	X		NT
Order Pilosa Flower, 1883						
Family Bradypodidae Gray, 1821						

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY (2017)	IUCN (2020)
Bradypus variegatus (Schinz, 1825)	Peresozo de tres dedos	X				LC
Order Xenarthra						
Family Myrmecophagidae Gray, 1825						
Myrmecophaga tridactyla (Linnaeus, 1758)	Oso hormiguero	X	X	X	AM	VU
Tamandua tetradactyla (Linnaeus, 1758)	Oso melero		X	X		LC
Order Primates Linnaeus, 1758						
Family Cebidae Gray, 1831						
Callithrix argentata (Linnaeus, 1771)	Ca’i eléctrico	X		X		LC
Callithrix melanura (É. Geoffroy, 1812)	tití de cola negra		X		AM	-
Sapajus apella Linnaeus, 1758	Mono capuchino	X		X		LC
Sapajus cay (Illiger, 1815)	Mono Ka´i		X			LC
Family Atelidae Gray, 1825						
Alouatta caraya (Humboldt, 1812)	Mono aullador negro	X	X	X		LC
Family Aotidae Elliot, 1913						
Aotus azarae (Humboldt, 1811)	Mono nocturno	X	X	X		LC
Family Pitheciidae Mivart, 1865						
Callicebus pallescens Thomas, 1907	Mono Titi		X	X		LC
Plecturocebus donacophilus (D'Orbigny, 1836)	Ca’i ygáu	X				LC
Order Rodentia Bowdich, 1821						
Family Sciuridae G. Fischer, 1817						
Guerlinguetus ignitus (Gray, 1867)	-		X			-
Guerlinguetus spadiceus Olfers, 1818	-		X			-
Family Cricetidae G. Fischer, 1817						
Akodon azarae (J. Fischer, 1829)	-		X	X		LC
Akodon montensis (Thomas, 1913)	-		X	X		LC
Akodon paranaensis Christoff, Fagundes, Sbalqueiro, Mattevi e Yonenaga-Yassuda, 2000	-		X	X		LC
Akodon toba Thomas, 1921	-		X	X		LC
Bibimys chacoensis (Shamel, 1931)	Rata acuática	X	X	X	AM	LC
Calomys callosus (Rengger, 1830)	Laucha grande		X	X		LC
Calomys laucha (G. Fischer, 1814)	Laucha chica		X	X		LC
Calomys tener (Winge, 1887)	-		X			LC
Calomys musculinus (Thomas, 1913)	Laucha bimaculada		X	X		LC
Holochilus brasiliensis (Desmarest, 1819)	-		X	X		LC
Holochilus chacarius Thomas, 1906	-		X	X		LC
Juliomys pictipes Osgood, 1933	Laucha de pies manchados		X	X	AM	LC
Necromys lasiurus (Lund, 1841)	-		X	X		LC
Necromys lenguarum (Thomas, 1898)	Ratón cavador		X			LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY (2017)	IUCN (2020)
Nectomys rattus Pelzeln, 1883	-		X			LC
Nectomys squamipes (Brants, 1827)	-			X		LC
Oecomys mamorae (Thomas, 1906)	-		X	X		LC
Oecomys franciscorum (Pardiñas et al. 2016)	-		X			-
Oligoryzomys chacoensis (Myers e Carleton, 1981)	-		X	X		LC
Oligoryzomys flavescens (Waterhouse, 1837)	-		X	X		LC
Oligoryzomys microtis (J. A. Allen, 1916)	-		X	X		LC
Oligoryzomys nigripes (Olfers, 1818)	-		X	X		LC
Oryzomys angouya Fischer, 1814	-		X	X		LC
Oryzomys maracajuensis Langguth e Bonvicino, 2002	-		X	X		LC
Oryzomys megacephalus Fischer, 1814	-		X	X		LC
Oryzomys russatus Wagner, 1848	-		X	X		LC
Oryzomys scotti Langguth e Bonvicino, 2002	-		X			LC
Graomys chacoensis (J. A. Allen, 1901)	Pericote común		X			DD
Graomys griseoflavus (Waterhouse, 1837)	-			X		LC
Oxymycterus delator Thomas, 1903	Ratón hocicudo negro	X	X	X		LC
Oxymycterus quaestor Thomas, 1903	-		X			LC
Oxymycterus misionalis Sanborn, 1931	-			X		-
Pseudoryzomys simplex (Winge, 1887)	-		X	X		LC
Rhipidomys macrurus Gervais, 1855	Cerrado Rhipidomys		X		AM	LC
Scapteromys tumidus (Waterhouse, 1837)	-		X			LC
Scapteromys aquaticus Thomas, 1920	-			X		LC
Thaptomys nigrita (Lichtenstein, 1829)	-		X			LC
Ctenomys dorsalis Thomas, 1900	Tuco-tuco		X	X	EP	DD
Ctenomys conoveri Osgood, 1946	Tuca-tuca		X	X		LC
Ctenomys paraguayensis	Tuco-tuco	X	X		EP	-
Ctenomys pilarensis Contreras, 1993	Tuco-tuco	X	X			EN
Ctenomys boliviensis Waterhouse, 1848	Tuco-tuco			X		LC
Family Echimyidae Gray, 1825						
Clyomys laticeps (Thomas, 1909)	Ratón espinoso	X	X	X		LC
Euryzygomatomys spinosus (G. Fischer, 1814)	Ratón espinoso	X	X	X		LC
Proechimys longicaudatus (Rengger, 1830)	-		X	X		LC
Thrichomys apereoides (Lund, 1839)	-		X	X		LC
Kannabateomys amblyonyx (Wagner, 1845)	Rata tacuarera	X	X	X		LC
Family Erethizontidae Bonaparte, 1845						

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY (2017)	IUCN (2020)
Coendou prehensilis (Linnaeus, 1758)	Puercoespín		X	X		LC
Sphiggurus spinosus (F. Cuvier, 1823)	Puerco espín	X	X	X		-
Family Caviidae G. Fischer, 1817						
Cavia aperea Erxelben, 1777	Cuis		X	X		LC
Galea leucoblephara (Burmeister, 1861)	-		X			LC
Dolichotis salinicola Burmeister, 1876	Conejo Del Palo		X	X		LC
Hydrochoerus hydrochaeris (Linnaeus, 1766)	Carpincho		X	X		LC
Family Dasyproctidae Bonaparte, 1838						
Dasyprocta azarae (Lichtenstein, 1823)	Agutí de Azara	X	X	X		DD
Family Cuniculidae Miller e Gidley, 1918						
Cuniculus paca (Linnaeus, 1766)	Paca	X	X	X		LC
Family Myocastoridae Ameghino, 1904						
Myocastor coypus (Molina, 1782)	Falsa nutria		X	X		LC
Order Lagomorpha Brandt, 1855						
Family Leporidae G. Fischer, 1817						
Sylvilagus brasiliensis (Linnaeus, 1758)	Conejito de monte		X	X		EN
Order Chiroptera Blumenbach, 1779						
Family Phyllostomidae Gray, 1825						
Chrotopterus auritus (Peters, 1856)	Falso vampiro orejón		X	X		LC
Lophostoma brasiliense (Peters, 1867)	Murciélago oreja redonda	X				LC
Lophostoma silvicolum d'Orbigny, 1836	Murciélago oreja redonda	X	X	X		LC
Macrophyllum (schinz, 1821)	Falso vampiro pata larga	X	X	X	AM	LC
Mimon crenulatum (É. Geoffroy, 1810)	-		X			LC
Phyllostomus discolor (Wagner, 1843)	-		X			LC
Phyllostomus hastatus (Pallas, 1767)	-		X			LC
Tonatia bidens (Spix, 1823)	Murciélago oreja redonda	X	X	X		DD
Artibeus fimbriatus (Gray, 1838)	Frutero grande oscuro		X	X		LC
Artibeus lituratus (Olfers, 1818)	Frutero grande de listas blancas		X	X		LC
Chiroderma doriae (Thomas, 1891)	Murciélago de ojos grandes	X	X		AM	LC
Platyrrhinus lineatus (É. Geoffroy, 1810)	Murciélago de listado de Geoffroy	X	X	X		LC
Pygoderma bilabiatum (Wagner, 1843)	Murciélago de hombros blancos		X	X		LC
Vampyressa pusilla (Wagner, 1843)	Murciélago frutero de oreja amarilla	X	X	X	AM	DD
Sturnira lilium (É. Geoffroy, 1810)	Frutero común		X	X		LC
Desmodus rotundus (É. Geoffroy, 1810)	Vampiro común		X	X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY (2017)	IUCN (2020)
Diaemus youngi (Jentink, 1893)	Vampiro de alas blancas		X	X		LC
Anoura caudifer (É. Geoffroy, 1818)	Falso vampiro hocicudo	X				LC
Glossophaga soricina (Pallas, 1766)	Murciélago nectarivoro		X	X		LC
Carollia perspicillata (Linnaeus, 1758)	Murcielago frutero		X	X		LC
Peropteryx macrotis (Wagner, 1843)	Muerciélago canino cola larga	X	X	X	AM	LC
Saccopteryx leptura (Schreber, 1774)	-		X			LC
Family Molossidae Gervais, 1856						
Cynomops abrasus (Temminck, 1827)	-		X	X		DD
Cynomops planirostris (Peters, 1866)	Moloso de pecho blanco		X	X		LC
Eumops auripendulus (Shaw, 1800)	Moloso oscuro		X	X		LC
Eumops bonariensis (Peters, 1874)	Moloso orejas anchas pardo		X	X		LC
Eumops glaucinus (Wagner, 1843)	Moloso acanelado		X	X		LC
Eumops patagonicus Thomas, 1924	Moloso gris de orejas anchas		X			LC
Eumops perotis (Schinz, 1821)	Moloso orejón grande		X	X		LC
Eumops dabbenei (Thomas, 1914)	Moloso grande		X	X		LC
Molossops temminckii (Burmeister, 1854)	Moloso pigmeo		X	X		LC
Molossus currentium Thomas, 1901	Molosso cola gruesa Correntino		X			LC
Molossus (Pallas, 1766)	Moloso cola gruesa chica		X	X		LC
Molossus rufus É. Geoffroy, 1805	Moloso cola gruesa grande		X	X		LC
Nyctinomops laticaudatus (É. Geoffroy, 1805)	Moloso labios arrugados chico		X	X		LC
Nyctinomops macrotis (Gray, 1840)	Moloso labios arrugados grande		X			LC
Promops centralis Thomas, 1915	Moloso cola larga grande		X	X		LC
Promops nasutus (Spix, 1823)	Moloso cola larga chica		X	X		LC
Tadarida brasiliensis (I. Geoffroy, 1824)	Moloso común		X	X		LC
Family Vespertilionidae Gray, 1821						
Eptesicus brasiliensis (Desmarest, 1819)	Murciélago pardo		X	X		LC
Eptesicus diminutus Osgood, 1915	Murciélago pardo chico		X	X		LC
Eptesicus furinalis (d'Orbigny, 1847)	Murciélago pardo común		X	X		LC
Lasiurus blossevillii (Lesson e Garnet, 1826)	-		X	X		LC
Lasiurus cinereus (Palisot de Beauvois, 1796)	Murciélago escarchado grande		X	X		LC
Lasiurus ega (Gervais, 1856)	-		X	X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY (2017)	IUCN (2020)
Histiotus macrotus (Poeppig, 1835)	Murciélago orejón grande	X	X			LC
Histiotus velatus (I. Geoffroy, 1824)	Murciélago orejón tropical	X	X	X		DD
Myotis albescens (É. Geoffroy, 1805)	Murciélaguito de vientre blanco		X	X		LC
Myotis levis (I. Geoffroy, 1824)	Murciélaguito amarillento		X	X		LC
Myotis midastactus Moratelli and Wilson, 2014	-		X			-
Myotis nigricans (Schinz, 1821)	Murciélaguito oscuro		X	X		LC
Myotis riparius Handley, 1960	Murciélaguito ochráceo		X	X		LC
Myotis ruber (É. Geoffroy, 1906)	Murciélago acanelado de Azara	X	X	X	AM	NT
Myotis simus Thomas, 1901	Murciélaguito afelpado		X	X		DD
Family Noctilionidae Gray, 1821						
Noctilio albiventris Desmarest, 1818	Murciélago pescador chico		X	X		LC
Noctilio leporinus (Linnaeus, 1758)	Murciélago pescador grande		X	X		LC
Family Natalidae Miller, 1899						
Natalus stramineus Gray, 1838	Murciélago oreja de embudo	X	X	X		LC
Order Carnivora Bowdich, 1821						
Family Felidae G. Fischer, 1817						
Leopardus colocolo (Molina, 1782)	Gato del pajonal	X	X	X		NT
Leopardus geoffroyi (Gervais e d'Orbigny, 1844)	Tirica	X	X	X		LC
Leopardus pardalis (Linnaeus, 1758)	Gato onza	X	X	X		LC
Leopardus tigrinus (Schreber, 1775)	Leopardo tigre	X	X	X	AM	VU
Leopardus wiedii (Schinz, 1821)	Gato tigrillo	X	X	X	AM	NT
Puma concolor (Linnaeus, 1771)	Puma	X	X	X		LC
Puma yagouaroundi (Lacépède, 1809)	Yaguarundí	X	X	X		LC
Panthera onca (Linnaeus, 1758)	Yaguareté	X	X	X	EP	NT
Family Canidae G. Fischer, 1817						
Cerdocyon thous (Linnaeus, 1766)	zorro de monte	X	X	X		LC
Chrysocyon brachyurus (Illiger, 1815)	lobo de crin	X	X	X	AM	NT
Lycalopex gymnocercus (G. Fischer, 1814)	Zorro de las pampas	X	X	X		LC
Lycalopex vetulus Lund, 1842	Yaguá yvyguy	X				LC
Speothos venaticus (Lund, 1842)	Zorro vinagre		X	X	EP	NT
Family Mustelidae G. Fischer						
Eira barbara (Linnaeus, 1758)	Hurón mayor	X	X	X		LC
Galictis cuja (Molina, 1782)	Grisón menor		X	X		LC
Galictis vittata (Schreber, 1776)	Grisón mayor		X			LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY (2017)	IUCN (2020)
Lontra longicaudis (Olfers, 1818)	Nutria de río	X	X	X		NT
Pteronura brasiliensis (Gmelin, 1788)	Nutria gigante	X	X	X	EP	EN
Family Mephitidae Bonaparte, 1845						
Conepatus humboldtii Gray, 1837	Huroncito	X				LC
Conepatus chinga (Molina, 1782)	Zorrino		X	X		LC
Family Procyonidae Gray, 1825						
Nasua (Linnaeus, 1766)	Coati	X	X	X		LC
Procyon cancrivorus (G. Cuvier, 1798)	Mapache comedor de cangrejos		X	X		LC
Order Perissodactyla Owen, 1848						
Family Tapiridae Gray, 1821						
Tapirus terrestris (Linnaeus, 1758)	Tapir	X	X	X	AM	VU
Order Artiodactyla Owen, 1848						
Family Tayassuidae Palmer, 1897						
Catagonus wagneri (Rusconi, 1930)	Taguá	X	X	X	EP	EN
Pecari tajacu (Linnaeus, 1758)	Pecarí de collar	X	X	X		LC
Tayassu pecari (Link, 1795)	Pecarí barbiblanco	X	X	X	AM	VU
Family Cervidae Goldfuss, 1820						
Blastocerus dichotomus (Illiger, 1815)	Ciervo de los pantanos	X	X	X	AM	VU
Mazama americana (Erxleben, 1777)	Corzuela roja	X		X		DD
Mazama gouazoubira (G. Fischer, 1814)	-		X	X		LC
Mazama nana (Hensel, 1872)	Corzuela menor	X	X	X	AM	VU
Ozotoceros bezoarticus (Linnaeus, 1758)	Ciervo de las pampas	X	X	X	EP	NT

References: (A) – MORALES, 2007; **(B)** – SANCHA *et al.*, 2017; **(C)** – RUMBO, 2010. **Categories of threats: PY 2017** – Resolution n 632/2017 of *Paraguay Environmental Secretariat*. **IUCN 2020** – *The IUCN Red List of Threatened Species*, versión 2020-11 **caption: EP** – endangered of extinction; **AM** – threatened of extinction; **EN** – endangerous; **VU** – vulnerable; **NT** – not threatened ; **LC** – Less concern; **DD** – deficient data.

9.2.2.2 Avifauna

9.2.2.2.1 Regional Characterization (IIA)

Birds are a notoriously important group in environmental analysis, as they are considered powerful bio-indicators due to their relative ease of study, the specific requirements of the territory and habitat, and the levels of sensitivity to changes in the environment (ALGER-DE-OLIVEIRA, 1993), and are widely used in environmental studies and the implementation of mitigation measures.

Paraguay's avifauna has been little explored scientifically for many years, and its first study of occurrence and distribution was published in 1995 (HAYES, 1995), with 645 species catalogued in the country. In 2004, this total was modified to 685 species (GUYRA PARAGUAY, 2004) and, in 2013, to 701 confirmed bird species (DEL CASTILLO, 2013). Currently, the biodiversity database of the Guyra Paraguay Association has 836 birds, among which are confirmed and not yet evaluated species. Although this figure is slightly lower than that of other Neotropical countries, it is considerably higher than that of areas of similar size in neighboring countries (CARTES & CLAY, 2009).

The convergence of five ecoregions in Paraguay gives rise to an abundant diversity of fauna and flora. These five phytogeographic regions (the Humid Chaco, Dry Chaco, Pantanal, Upper Paraná Atlantic Forest and Cerrado) are of great value for conservation (OLSON & DINERSTEIN, 2002; MITTERMEIER et al., 1999; DINERSTEIN, 1995) and have numerous globally threatened bird species (CARTES & CLAY, 2009). According to Birdlife International (2007), in Paraguay there are a total of 27 globally threatened bird species and 23 species classified as Near Threatened, of which five are probably extinct in the country: *Taoniscus nanus*, *Mergus octosetaceus*, *Leucopternis polionotus*, *Numenius boreali*s and *Anodorhynchus glaucus*.

Among the phytogeographic regions of the country, the Atlantic Forest and the Cerrado are considered biodiversity hot spots due to the high concentration of endemic species, added to the exceptional loss of habitat (MYERS et al., 2000). However, because Paraguay is an ecotone country with ecoregions shared with neighboring countries, only one species of dubious taxonomic validity is endemic to Paraguay: *Nothura chacoensis* (CARTES & CLAY, 2009). The Gran Chaco and the Pantanal are recognized as the last natural areas due to their relatively not altered status, their rich diversity and their low rate of human occupation (MITTERMEIER et al., 2002). The Chaco wetland in eastern Paraguay is an important resting place for migratory birds during their movements between the breeding grounds in northern Argentina and southern Paraguay and their largely unknown wintering grounds in central Brazil (CARTES & CLAY, 2009).

For the characterization of regional birdlife through literature, the surveys conducted by BENITES et al (2017) and STRAUBE et al (2006) were consulted. In addition, the global eBird database was consulted for the inclusion of birds in the region of Concepción, PY. In total, 477 bird species were studied, distributed among 71 families and 25 orders. Among these, 70 are included in Resolution MADES 254/19, which lists the bird species considered "endangered" and "threatened with extinction" of the national fauna. In addition, of the total number of birds studied, 27 appear in some category of global threat according to the IUCN Red List of Threatened Species (IUCN, 2020), as shown in Table bellow. It is worth mentioning the registration of 21 regional species that are threatened both at the national level (Resolution 254/19) and at the global level (IUCN, 2020), such as *Tinamus solitarius*, *Crax fasciolata*, *Urubitinga* *coronata*, *Morphnus guianensis*, *Harpia harpyja*, *Spizaetus ornatus*, *Laterallus xenopterus*, *Hydropsalis anomala*,), *Primolius maracana*, *Pyrrhura devillei*, *Alipiopsitta xanthops*, *Procnias nudicollis*, *Phylloscartes paulista*, *Culicivora caudacuta*, *Polystictus pectoralis*, *Alectrurus tricolor*, *Alectrurus risora*, *Neothraupis fasciata*, *Sporophila palustris* and *Sporophila cinnamomea*.

Table 16 – List of probable bird species for the IIA of PARACEL's pulp mill

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Order Rheiformes Forbes, 1884						
Family Rheidae Bonaparte, 1849						
Rhea americana (Linnaeus, 1758)	Ñandú Común	X	X	X		NT
Order Tinamiformes Huxley, 1872						
Family Tinamidae Gray, 1840						
Tinamus solitarius (Vieillot, 1819)	Tinamú Macuco			X	EP	NT
Crypturellus obsoletus (Temminck, 1815)	Tinamú Café			X	AM	LC
Crypturellus undulatus (Temminck, 1815)	Tinamú ondeado	X	X	X		LC
Crypturellus parvirostris (Wagler, 1827)	Tinamú piquicorto	X	X	X		LC
Crypturellus tataupa (Temminck, 1815)	Tinamú Tataupá	X	X	X		LC
Rhynchotus rufescens (Temminck, 1815)	Tinamú alirrojo	X		X		LC
Nothura boraquira (Spix, 1825)	Tinamú Ventriblanco	X	X			LC
Nothura maculosa (Temminck, 1815)	Tinamú chaqueño	X	X	X		LC
Order Anseriformes Linnaeus, 1758						
Family Anhimidae Stejneger, 1885						
Chauna torquata (Oken, 1816)	Chajá Común	X	X	X		LC
Family Anatidae Leach, 1820						
Dendrocygna viduata (Linnaeus, 1766)	Suirirí Cariblanco		X	X		LC
Dendrocygna autumnalis (Linnaeus, 1758)	Suirirí Piquirrojo	X	X	X		LC
Neochen jubata (Spix, 1825)	Pato de Crin		X			NT
Cairina moschata (Linnaeus, 1758)	Pato Criollo	X	X	X		LC
Callonetta leucophrys (Vieillot, 1816)	Pato Acollarado	X		X		LC
Amazonetta brasiliensis (Gmelin, 1789)	Pato Brasileño	X	X	X		LC
Nomonyx dominicus (Linnaeus, 1766)	Malvasía Enmascarada	X		X		LC
Order Galliformes Linnaeus, 1758						
Family Cracidae Rafinesque, 1815						
Penelope superciliaris Temminck, 1815	Pava Yacupemba	X		X		LC
Aburria cumanensis (Jacquin, 1784)	Pava Goliazul	X	X	X		LC
Ortalis canicollis (Wagler, 1830)	Chachalaca Charata	X	X	X		LC
Crax fasciolata Spix, 1825	Pavón Muitú	X		X	AM	VU
Family Odontophoridae Gould, 1844						
Odontophorus capueira (Spix, 1825)	Corcovado Urú			X	AM	LC
Order Podicipediformes Fürbringer, 1888						
Family Podicipedidae Bonaparte, 1831						

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Tachybaptus dominicus (Linnaeus, 1766)	Zampullín Macacito	X		X		LC
Podilymbus podiceps (Linnaeus, 1758)	Zampullín Picogrueso			X		LC
Order Ciconiiformes Bonaparte, 1854						
Family Ciconiidae Sundevall, 1836						
Ciconia maguari (Gmelin, 1789)	Cigüeña Maguari	X	X	X		LC
Jabiru mycteria (Lichtenstein, 1819)	Jabirú Americano	X	X	X		LC
Mycteria americana Linnaeus, 1758	Tántalo Americano	X	X	X		LC
Order Suliformes Sharpe, 1891						
Family Phalacrocoracidae Reichenbach, 1849						
Nannopterum brasilianus (Gmelin, 1789)	Cormorán Biguá	X	X	X		LC
Family Anhingidae Reichenbach, 1849						
Anhinga anhinga (Linnaeus, 1766)	Anhinga Americana	X	X	X		LC
Order Pelecaniformes Sharpe, 1891						
Family Ardeidae Leach, 1820						
Tigrisoma lineatum (Boddaert, 1783)	Avetigre Colorada	X	X	X		LC
Cochlearius cochlearius (Linnaeus, 1766)	Martinete Cucharón	X	X			LC
Nycticorax nycticorax (Linnaeus, 1758)	Martinete Común	X	X	X		LC
Butorides striata (Linnaeus, 1758)	Garcita Verdosa	X	X	X		LC
Bubulcus ibis (Linnaeus, 1758)	Garcilla Bueyera	X	X	X		LC
Ardea cocoi Linnaeus, 1766	Garza Cuca	X	X	X		LC
Ardea alba Linnaeus, 1758	Garceta Grande	X	X	X		LC
Syrigma sibilatrix (Temminck, 1824)	Garza Chiflona	X	X	X		LC
Pilherodius pileatus (Boddaert, 1783)	Garza Capirotada	X	X	X		LC
Egretta thula (Molina, 1782)	Garceta Nívea	X	X	X		LC
Family Threskiornithidae Poche, 1904						
Plegadis chihi (Vieillot, 1817)	Morito Cariblanco	X		X		LC
Mesembrinibis cayennensis (Gmelin, 1789)	Ibis Verde	X	X	X		LC
Phimosus infuscatus (Lichtenstein, 1823)	Ibis Afeitado	X	X	X		LC
Theristicus caerulescens (Vieillot, 1817)	Bandurria Mora	X	X	X		LC
Theristicus caudatus (Boddaert, 1783)	Bandurria Común	X	X	X		LC
Platalea ajaja Linnaeus, 1758	Espátula Rosada	X	X	X		LC
Order Cathartiformes Seebohm, 1890						
Family Cathartidae Lafresnaye, 1839						
Cathartes aura (Linnaeus, 1758)	Aura Gallipavo	X	X	X		LC
Cathartes burrovianus Cassin, 1845	Aura Sabanera	X	X	X		LC
Coragyps atratus (Bechstein, 1793)	Zopilote Negro	X	X	X		LC
Sarcoramphus papa (Linnaeus, 1758)	Zopilote Rey	X	X	X		LC
Order Accipitriformes Bonaparte, 1831						
Family Pandionidae Bonaparte, 1854						
Pandion haliaetus (Linnaeus, 1758)	Águila Pescadora	X	X	X		LC
Family Accipitridae Vigors, 1824						
Leptodon cayanensis (Latham, 1790)	Milano Cabecigrís	X	X	X		LC
Chondrohierax uncinatus (Temminck, 1822)	Milano Picogarfio	X		X		LC
Elanoides forficatus (Linnaeus, 1758)	Elanio Tijereta			X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Gampsonyx swainsonii Vigors, 1825	Elanio Enano	X		X		LC
Elanus leucurus (Vieillot, 1818)	Elanio Maromero	X	X	X		LC
Harpagus diodon (Temminck, 1823)	Milano Muslirrufo			X		LC
Circus buffoni (Gmelin, 1788)	Aguilucho de Azara		X			LC
Accipiter striatus Vieillot, 1808	Gavilán Americano	X		X		LC
Accipiter bicolor (Vieillot, 1817)	Gavilán Bicolor			X	AM	LC
Ictinia mississippiensis (Wilson, 1811)	Elanio del Misisipi			X		LC
Ictinia plumbea (Gmelin, 1788)	Elanio Plomizo	X	X	X		LC
Busarellus nigricollis (Latham, 1790)	Busardo Colorado	X	X	X		LC
Rostrhamus sociabilis (Vieillot, 1817)	Caracolero Común	X	X	X		LC
Geranospiza caerulescens (Vieillot, 1817)	Azor Zancón	X	X	X		LC
Heterospizias meridionalis (Latham, 1790)	Busardo Sabanero	X	X	X		LC
Urubitinga (Gmelin, 1788)	Busardo Urubitinga	X	X	X		LC
Urubitinga coronata (Vieillot, 1817)	Águila de Azara	X		X	AM	EN
Rupornis magnirostris (Gmelin, 1788)	Busardo Caminero	X	X	X		LC
Parabuteo unicinctus (Temminck, 1824)	Busardo Mixto		X	X		LC
Parabuteo leucorrhous (Quoy & Gaimard, 1824)	Busardo Culiblanco			X		LC
Geranoaetus albicaudatus (Vieillot, 1816)	Busardo Coliblanco	X	X	X		LC
Geranoaetus melanoleucus (Vieillot, 1819)	Águila Mora			X		LC
Buteo nitidus (Latham, 1790)	Busardo Gris Meridional		X			LC
Buteo brachyurus Vieillot, 1816	Busardo Colicorto			X		LC
Buteo swainsoni Bonaparte, 1838	Busardo Chapulinero			X		LC
Buteo albonotatus Kaup, 1847	Busardo Aura			X		LC
Morphnus guianensis (Daudin, 1800)	Arpía Menor			X	EP	NT
Harpia harpyja (Linnaeus, 1758)	Arpía Mayor			X	EP	NT
Spizaetus tyrannus (Wied, 1820)	Águila Negra		X		EP	LC
Spizaetus melanoleucus (Vieillot, 1816)	Águila Blanquinegra			X	AM	LC
Spizaetus ornatus (Daudin, 1800)	Águila Galana		X	X	EP	NT
Order Eurypygiformes Furbringer, 1888						
Family Aramidae Bonaparte, 1852						
Aramus guarauna (Linnaeus, 1766)	Carrao	X	X	X		LC
Family Rallidae Rafinesque, 1815						
Aramides ypecaha (Vieillot, 1819)	Cotara Ipacaá	X	X	X		LC
Aramides cajaneus (Statius Muller, 1776)	Cotara Chiricote	X	X	X		LC
Aramides saracura (Spix, 1825)	Cotara Saracura			X	AM	LC
Laterallus melanophaius (Vieillot, 1819)	Polluela Burrito	X		X		LC
Laterallus exilis (Temminck, 1831)	Polluela Pechigrís		X	X		LC
Laterallus xenopterus Conover, 1934	Polluela Guaraní			X	AM	VU
Mustelirallus albicollis (Vieillot, 1819)	Polluela Turura	X	X	X		LC
Pardirallus maculatus (Boddaert, 1783)	Rascón Overo	X				LC
Pardirallus nigricans (Vieillot, 1819)	Rascón Negruzco	X	X	X		LC
Pardirallus sanguinolentus (Swainson, 1837)	Rascón Gallineta			X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Gallinula galeata (Lichtenstein,1818)	Gallineta Americana	X		X		LC
Porphyrio martinicus (Linnaeus, 1766)	Calamoncillo Americano	X	X	X		LC
Family Heliornithidae Gray, 1840						
Heliornis fulica (Boddaert, 1783)	Avesol Americano	X		X		LC
Order Charadriiformes Furbringer, 1888						
Family Charadriidae Leach, 1820						
Vanellus cayanus (Latham, 1790)	Avefría de Cayena	X	X	X		LC
Vanellus chilensis (Molina, 1782)	Avefría Tero	X	X	X		LC
Pluvialis dominica (Statius Muller, 1776)	Chorlito Dorado Americano		X			LC
Charadrius collaris Vieillot, 1818	Chorlitejo de Azara	X	X	X		LC
Family Recurvirostridae Bonaparte, 1831						
Himantopus mexicanus (Statius Muller, 1776)	Cigüeñuela Cuellinegra			X		LC
Himantopus melanurus Vieillot, 1817	-	X	X			-
Family Scolopacidae Rafinesque, 1815						
Gallinago paraguaiae (Vieillot, 1816)	Agachadiza Paraguaya	X		X		LC
Gallinago undulata (Boddaert, 1783)	Agachadiza Gigante			X	AM	LC
Bartramia longicauda (Bechstein, 1812)	Correlimos Batitú	X	X	X		LC
Actitis macularius (Linnaeus, 1766)	Andarríos Maculado			X		LC
Tringa solitaria Wilson, 1813	Andarríos Solitario	X	X	X		LC
Tringa melanoleuca (Gmelin, 1789)	Archibebe Patigualdo Grande	X	X	X		LC
Tringa flavipes (Gmelin, 1789)	Archibebe Patigualdo Chico	X	X	X		LC
Calidris fuscicollis (Vieillot, 1819)	Correlimos Culiblanco	X		X		LC
Calidris melanotos (Vieillot, 1819)	Correlimos Pectoral	X	X	X		LC
Calidris himantopus (Bonaparte, 1826)	Correlimos Zancolín	X				LC
Phalaropus tricolor (Vieillot, 1819)	Falaropo Tricolor		X	X		LC
Family Jacanidae Chenu & Des Murs, 1854						
Jacana (Linnaeus, 1766)	Jacana Suramericana	X	X	X		LC
Family Rostratulidae Mathews, 1914						
Nycticryphes semicollaris (Vieillot, 1816)	Aguatero Americano			X		LC
Family Sternidae Vigors, 1825						
Sternula superciliaris (Vieillot, 1819)	Charrancito Amazónico	X	X	X		LC
Phaetusa simplex (Gmelin, 1789)	Charrán Picudo	X	X	X		LC
Family Rynchopidae Bonaparte, 1838						
Rynchops niger Linnaeus, 1758	Rayador Americano	X	X	X		LC
Order Columbiformes Latham, 1790						
Family Columbidae Leach, 1820						
Columbina minuta (Linnaeus, 1766)	Columbina Menuda	X		X		LC
Columbina talpacoti (Temminck, 1811)	Columbina Colorada	X	X	X		LC
Columbina squammata (Lesson, 1831)	Tortolita Escamosa	X	X	X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Columbina picui (Temminck, 1813)	Columbina Picuí	X	X	X		LC
Claravis pretiosa (Ferrari-Perez, 1886)	Tortolita Azulada	X		X		LC
Columba livia Gmelin, 1789	Paloma Bravía	X		X		LC
Patagioenas speciosa (Gmelin, 1789)	Paloma Escamosa			X	AM	LC
Patagioenas picazuro (Temminck, 1813)	Paloma Picazuró	X	X	X		LC
Patagioenas cayennensis (Bonnaterre, 1792)	Paloma Colorada	X	X	X		LC
Zenaida auriculata (Des Murs, 1847)	Zenaida Torcaza	X	X	X		LC
Leptotila verreauxi Bonaparte, 1855	Paloma Montaraz Común	X	X	X		LC
Leptotila rufaxilla (Richard & Bernard, 1792)	Paloma Montaraz Frentiblanca	X		X		LC
Geotrygon montana (Linnaeus, 1758)	Paloma Perdiz Común			X	AM	LC
Order Cuculiformes Wagler, 1830						
Family Cuculidae Leach, 1820						
Piaya cayana (Linnaeus, 1766)	Cuco-ardilla Común	X	X	X		LC
Coccyzus melacoryphus Vieillot, 1817	Cuclillo Canela	X		X		LC
Coccyzus americanus (Linnaeus, 1758)	Cuclillo Piquigualdo			X		LC
Crotophaga major Gmelin, 1788	Garrapatero Mayor	X	X	X		LC
Crotophaga ani Linnaeus, 1758	Garrapatero Aní	X	X	X		LC
Guira (Gmelin, 1788)	Pirincho	X	X	X		LC
Tapera naevia (Linnaeus, 1766)	Cuclillo Crespín	X	X	X		LC
Dromococcyx phasianellus (Spix, 1824)	Cuclillo Faisán			X		LC
Dromococcyx pavoninus Pelzeln, 1870	Cuclillo Pavonino			X		LC
Order Strigiformes Wagler, 1830						
Family Tytonidae Mathews, 1912						
Tyto furcata (Scopoli, 1769)	Lechúza Común	X	X	X		LC
Family Strigidae Leach, 1820						
Megascops choliba (Vieillot, 1817)	Autillo Chóliba	X	X	X		LC
Megascops atricapilla (Temminck, 1822)	Autillo Capirotado			X	AM	LC
Pulsatrix perspicillata (Latham, 1790)	Lechuzón de Anteojos	X		X		LC
Bubo virginianus (Gmelin, 1788)	Búho Americano	X	X	X		LC
Glaucidium brasilianum (Gmelin, 1788)	Mochuelo Caburé	X	X	X		LC
Athene cunicularia (Molina, 1782)	Mochuelo de Madriguera	X	X	X		LC
Asio clamator (Vieillot, 1808)	Búho Gritón		X			LC
Order Nyctibiiformes Yuri, Kimball, Harshman, Bowie, Braun, Chojnowski, Han, Hackett, Huddleston, Moore, Reddy, Sheldon, Steadman, Witt & Braun, 2013						
Family Nyctibiidae Chenu & Des Murs, 1851						
Nyctibius griseus (Gmelin, 1789)	Nictibio Urutaú	X	X	X		LC
Order Caprimulgiformes Ridgway, 1881						
Family Caprimulgidae Vigors, 1825						
Antrostomus rufus (Boddaert, 1783)	Chotacabras Colorado	X		X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Lurocalis semitorquatus (Gmelin, 1789)	Añapero Colicorto		X	X		LC
Nyctidromus albicollis (Gmelin, 1789)	Chotacabras Pauraque	X	X	X		LC
Hydropsalis parvula (Gould, 1837)	Chotacabras Chico	X	X	X		LC
Hydropsalis anomala (Gould, 1838)	Chotacabras Pantanero		X		EP	NT
Hydropsalis maculicaudus (Lawrence, 1862)	Chotacabras Colipinto	X			AM	LC
Hydropsalis torquata (Gmelin, 1789)	Chotacabras Tijereta	X	X	X		LC
Podager nacunda (Vieillot, 1817)	Añapero Ñacundá	X	X	X		LC
Chordeiles minor (Forster, 1771)	Añapero Yanqui			X		LC
Chordeiles acutipennis (Hermann, 1783)	Añapero Guarrapena			X		LC
Order Apodiformes Peters, 1940						
Family Apodidae Olphe-Galliard, 1887						
Cypseloides fumigatus (Streubel, 1848)	Vancejo Negruzco			X		LC
Chaetura cinereiventris Sclater, 1862	Vancejo Ceniciento			X		LC
Chaetura meridionalis Hellmayr, 1907	Vencejo de tormenta	X		X		LC
Family Trochilidae Vigors, 1825						
Phaethornis subochraceus Todd, 1915	Ermitaño Ocráceo	X				LC
Phaethornis pretrei (Lesson & Delattre, 1839)	Ermitaño del Planalto			X		LC
Eupetomena macroura (Gmelin, 1788)	Colibrí Golondrina	X	X	X		LC
Anthracothorax nigricollis (Vieillot, 1817)	Mango Gorjinegro			X		LC
Chlorostilbon lucidus (Shaw, 1812)	Esmeralda Ventridorada	X	X	X		LC
Thalurania furcata (Gmelin, 1788)	Zafiro Golondrina	X		X		LC
Thalurania glaucopis (Gmelin, 1788)	Zafiro Capirotado			X	AM	LC
Hylocharis sapphirina (Gmelin, 1788)	Amazilia Gorjirroja			X		LC
Hylocharis chrysura (Shaw, 1812)	Zafiro Bronceado	X	X	X		LC
Polytmus guainumbi (Pallas, 1764)	Colibrí Guainumbí			X		LC
Heliomaster longirostris (Audebert & Vieillot, 1801)	Colibrí Piquilargo			X		LC
Heliomaster furcifer (Shaw, 1812)	Colibrí de Barbijo	X	X	X		LC
Order Trogoniformes A. O. U., 1886						
Family Trogonidae Lesson, 1828						
Trogon surrucura Vieillot, 1817	Trogón Surucuá			X		LC
Trogon curucui Linnaeus, 1766	Trogón Curucuí	X	X	X		LC
Trogon rufus Gmelin, 1788	Trogón Amarillo			X	AM	LC
Order Coraciiformes Forbes, 1844						
Family Alcedinidae Rafinesque, 1815						
Megaceryle torquata (Linnaeus, 1766)	Martín Gigante Neotropical	X	X	X		LC
Chloroceryle amazona (Latham, 1790)	Martín Pescador Amazónico	X	X	X		LC
Chloroceryle aenea (Pallas, 1764)	Martín Pescador Enano	X				LC
Chloroceryle americana (Gmelin, 1788)	Martín Pescador Verde	X	X	X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Chloroceryle inda (Linnaeus, 1766)	Martín Pescador Verdirrufo	X		X		LC
Family Momotidae Gray, 1840						
Baryphthengus ruficapillus (Vieillot, 1818)	Momoto Yeruvá Oriental			X		LC
Momotus momota (Linnaeus, 1766)	Momoto Amazónico	X				LC
Order Galbuliformes Fürbringer, 1888						
Family Galbulidae Vigors, 1825						
Galbula ruficauda Cuvier, 1816	Jacamará Colirrufo	X				LC
Family Bucconidae Horsfield, 1821						
Notharchus swainsoni (Gray, 1846)	Buco de Swainson			X	AM	LC
Nystalus chacuru (Vieillot, 1816)	Buco Chacurú	X		X		LC
Nystalus maculatus (Gmelin, 1788)	Buco Durmilí			X		LC
Nystalus striatipectus (Sclater, 1854)	Buco Durmilí	X	X			-
Nonnula rubecula (Spix, 1824)	Monjilla Macurú		X	X	AM	LC
Order Piciformes Meyer & Wolf, 1810						
Family Ramphastidae Vigors, 1825						
Ramphastos toco Statius Muller, 1776	Tucán Toco	X	X	X		LC
Ramphastos dicolorus Linnaeus, 1766	Tucán Bicolor			X		LC
Selenidera maculirostris (Lichtenstein, 1823)	Tucanete Piquimaculado			X	AM	LC
Pteroglossus castanotis Gould, 1834	Arasarí Caripardo	X		X		LC
Family Picidae Leach, 1820						
Picumnus cirratus Temminck, 1825	Carpinterito Variable	X	X	X		LC
Picumnus temminckii Lafresnaye, 1845	Carpinterito Cuellicaneca			X	AM	LC
Picumnus albosquamatus d'Orbigny, 1840	Carpinterito Albiescamoso	X	X		EP	LC
Melanerpes candidus (Otto, 1796)	Carpintero Blanco	X	X	X		LC
Melanerpes flavifrons (Vieillot, 1818)	Carpintero Arcoiris			X		LC
Melanerpes cactorum (d'Orbigny, 1840)	Carpintero de Los Cardones	X	X			LC
Veniliornis passerinus (Linnaeus, 1766)	Carpintero Chico	X	X	X		LC
Veniliornis mixtus (Boddaert, 1783)	Pico Bataraz Chico	X	X	X		LC
Piculus chrysochloros (Vieillot, 1818)	Carpintero Verdiamarillo	X	X	X		LC
Colaptes melanochloros (Gmelin, 1788)	Carpintero real norteño	X	X	X		LC
Colaptes campestris (Vieillot, 1818)	Carpintero Campestre	X	X	X		LC
Celeus flavescens (Gmelin, 1788)	Carpintero Amarillento			X	AM	LC
Celeus lugubris (Malherbe, 1851)	Carpintero Lúgubre	X	X	X		LC
Dryocopus lineatus (Linnaeus, 1766)	Picamaderos Listado	X		X		LC
Campephilus robustus (Lichtenstein, 1818)	Picamaderos Robusto			X	AM	LC
Campephilus melanoleucos (Gmelin, 1788)	Picamaderos Barbinegro	X	X	X		LC
Campephilus leucopogon (Valenciennes, 1826)	Picamaderos Dorsiblanco	X	X			LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Order Cariamiformes Furbringer, 1888						
Family Cariamidae Bonaparte, 1850						
Cariama cristata (Linnaeus, 1766)	Chuña Patirroja	X	X	X		LC
Order Falconiformes Bonaparte, 1831						
Family Falconidae Leach, 1820						
Caracara plancus (Miller, 1777)	Carancho meridional	X	X	X		LC
Milvago chimachima (Vieillot, 1816)	Caracara Chimachima	X	X	X		LC
Milvago chimango (Vieillot, 1816)	Caracara Chimango			X		LC
Herpetotheres cachinnans (Linnaeus, 1758)	Halcón Reidor	X	X	X		LC
Micrastur ruficollis (Vieillot, 1817)	Halcón Montés Agavilanado		X	X		LC
Micrastur semitorquatus (Vieillot, 1817)	Halcón Montés Collarejo	X		X		LC
Falco sparverius Linnaeus, 1758	Cernícalo Americano	X	X	X		LC
Falco rufigularis Daudin, 1800	Halcón Murcielaguero	X	X	X		LC
Falco femoralis Temminck, 1822	Halcón Aleto	X	X	X		LC
Falco peregrinus Tunstall, 1771	Halcón Peregrino			X		LC
Order Psittaciformes Wagler, 1830						
Family Psittacidae Rafinesque, 1815						
Anodorhynchus hyacinthinus (Latham, 1790)	Guacamayo Jacinto	X	X	X	EP	VU
Ara ararauna (Linnaeus, 1758)	Guacamayo Azuliamarillo			X	EP	LC
Ara chloropterus Gray, 1859	Guacamayo Aliverde	X	X	X	EP	LC
Primolius maracana (Vieillot, 1816)	Guacamayo Maracaná		X	X	EP	NT
Primolius auricollis (Cassin, 1853)	Guacamayo Acollarado	X	X	X		LC
Thectocercus acuticaudatus (Vieillot, 1818)	Aratinga Cabeciazul	X	X	X		LC
Psittacara leucophthalmus (Statius Muller, 1776)	Aratinga Ojiblanca	X	X	X		LC
Aratinga nenday (Vieillot, 1823)	Aratinga Ñanday	X	X	X		LC
Eupsittula aurea (Gmelin, 1788)	Aratinga Frentidorada	X	X	X		LC
Pyrrhura devillei (Massena & Souancé, 1854)	Cotorra de Deville	X	X	X	AM	NT
Pyrrhura frontalis (Vieillot, 1817)	Cotorra Chiripepé		X	X		LC
Pyrrhura molinae (Massena & Souancé, 1854)	Cotorra de Molina			X		LC
Myiopsitta monachus (Boddaert, 1783)	Cotorra Argentina	X	X	X		LC
Forpus xanthopterygius (Spix, 1824)	Cotorrita Aliazul	X		X		LC
Brotogeris chiriri (Vieillot, 1818)	Catita Chirirí	X	X	X		LC
Pionopsitta pileata (Scopoli, 1769)	Lorito Pileado			X	AM	LC
Alipiopsitta xanthops (Spix, 1824)	Amazona del Cerrado			X	AM	NT
Pionus maximiliani (Kuhl, 1820)	Loro Choclero	X	X	X		LC
Amazona amazonica (Linnaeus, 1766)	Amazona Alinaranja			X	EP	LC
Amazona aestiva (Linnaeus, 1758)	Amazona Frentiazul	X	X	X		LC
Order Passeriformes Linnaeus, 1758						

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Family Thamnophilidae Swainson, 1824						
Formicivora rufa (Wied, 1831)	Hormiguerito Dorsirrufo	X	X			LC
Dysithamnus mentalis (Temminck, 1823)	Batarito Cabecigrís			X		LC
Herpsilochmus atricapillus Pelzeln, 1868	Tiluchí Plomizo			X		LC
Thamnophilus doliatus (Linnaeus, 1764)	Batará Barrado	X	X	X		LC
Thamnophilus sticturus Pelzeln, 1868	Batará Pizarroso Boliviano		X			LC
Thamnophilus caerulescens Vieillot, 1816	Batará Variable	X	X	X		LC
Taraba major (Vieillot, 1816)	Batará Mayor	X	X	X		LC
Hypoedaleus guttatus (Vieillot, 1816)	Batará Goteado			X	AM	LC
Pyriglena leucoptera (Vieillot, 1818)	Ojodefuego Aliblanco			X	AM	LC
Cercomacra melanaria (Ménétriès, 1835)	Hormiguero de Mato Grosso	X				LC
Family Formicariidae Gray, 1840						
Chamaeza campanisona (Lichtenstein, 1823)	Tovacá Colicorto			X	AM	LC
Family Dendrocolaptidae Gray, 1840						
Dendrocincla turdina (Lichtenstein, 1820)	Trepatroncos Turdino			X	AM	LC
Sittasomus griseicapillus (Vieillot, 1818)	Trepatroncos Oliváceo	X	X	X		LC
Xiphorhynchus fuscus (Vieillot, 1818)	Trepatroncos enano			X	AM	LC
Campylorhamphus trochilirostris (Lichtenstein, 1820)	Picoguadaña Piquirrojo	X	X	X		LC
Lepidocolaptes angustirostris (Vieillot, 1818)	Trepatroncos Chico	X	X	X		LC
Dendrocolaptes picumnus Lichtenstein, 1820	Trepatroncos Variable		X	X		LC
Dendrocolaptes platyrostris Spix, 1825	Trepatroncos Oscuros	X		X		LC
Xiphocolaptes albicollis (Vieillot, 1818)	Trepatroncos Gorgiblanco			X		LC
Xiphocolaptes major (Vieillot, 1818)	Trepatroncos Colorado	X	X	X		LC
Family Xenopidae Bonaparte, 1854						
Xenops rutilans Temminck, 1821	Picolezna Rojizo			X		LC
Family Furnariidae Gray, 1840						
Furnarius leucopus Swainson, 1838	Hornero Paticlaro	X	X			LC
Furnarius rufus (Gmelin, 1788)	Hornero Común	X	X	X		LC
Lochmias nematura (Lichtenstein, 1823)	Riachuelero			X	AM	LC
Clibanornis rectirostris (Wied, 1831)	Ticotico Cabecirrufo Oriental		X	X	AM	LC
Automolus leucophthalmus (Wied, 1821)	Ticotico Ojiblanco			X	AM	LC
Anabacerthia lichtensteini (Cabanis & Heine, 1859)	Ticotico Ocráceo Chico			X	AM	LC
Philydor rufum (Vieillot, 1818)	Ticotico Ocráceo Grande			X		LC
Syndactyla rufosuperciliata (Lafresnaye, 1832)	Ticotico Cejudo			X		LC
Syndactyla dimidiata (Pelzeln, 1859)	Ticotico del Planalto			X	EP	LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Pseudoseisura unirufa (d'Orbigny & Lafresnaye, 1838)	Cacholote Crestigrís	X	X			LC
Phacellodomus rufifrons (Wied, 1821)	Espinero Común	X	X	X		LC
Phacellodomus ruber (Vieillot, 1817)	Espinero Grande	X	X	X		LC
Anumbius annumbi (Vieillot, 1817)	Leñatero	X	X	X		LC
Schoeniophylax phryganophilus (Vieillot, 1817)	Pijuí Chotoy	X	X	X		LC
Certhiaxis cinnamomeus (Gmelin, 1788)	Curutié Colorado	X	X	X		LC
Synallaxis cinerascens Temminck, 1823	Pijuí Ceniciento			X	AM	LC
Synallaxis frontalis Pelzeln, 1859	Pijuí Frentigrís	X	X	X		LC
Synallaxis albescens Temminck, 1823	Pijuí Pechiblanco		X	X		LC
Synallaxis spixi Sclater, 1856	Pijuí Plomizo			X		LC
Synallaxis hypospodia Sclater, 1874	Pijuí Cenizo	X				LC
Synallaxis albilora Pelzeln, 1856	Pijuí Ocráceo	X	X	X		LC
Cranioleuca vulpina (Pelzeln, 1856)	Curutié Vulpino	X				LC
Family Pipridae Rafinesque, 1815						
Pipra fasciicauda Hellmayr, 1906	Saltarín Naranja	X	X	X		LC
Manacus manacus (Linnaeus, 1766)	Saltarín Barbiblanco			X	AM	LC
Chiroxiphia caudata (Shaw & Nodder, 1793)	Saltarín Azul			X	AM	LC
Family Oxyruncidae Ridgway, 1906 (1831)						
Oxyruncus cristatus Swainson, 1821	Picoagudo			X	AM	LC
Family Tityridae Gray, 1840						
Tityra inquisitor (Lichtenstein, 1823)	Titira Piquinegro	X		X		LC
Tityra cayana (Linnaeus, 1766)	Titira Colinegro	X	X	X		LC
Tityra semifasciata (Spix, 1825)	Titira Enmascarado			X	AM	LC
Pachyramphus viridis (Vieillot, 1816)	Anambé Verdoso	X	X	X		LC
Pachyramphus castaneus (Jardine & Selby, 1827)	Anambé Castaño			X	AM	LC
Pachyramphus polychopterus (Vieillot, 1818)	Anambé Aliblanco	X	X	X		LC
Pachyramphus validus (Lichtenstein, 1823)	Anambé grande	X	X	X		LC
Xenopsaris albinucha (Burmeister, 1869)	Amambé Chico	X		X		LC
Family Cotingidae Bonaparte, 1849						
Pyroderus scutatus (Shaw, 1792)	Yacutoro			X	EP	LC
Procnias nudicollis (Vieillot, 1817)	Campanero Meridional			X	EP	VU
Family Platyrinchidae Bonaparte, 1854						
Platyrinchus mystaceus Vieillot, 1818	Picoplano Bigotudo	X	X	X		LC
Family Rhynchocyclidae Berlepsch, 1907						
Mionectes rufiventris Cabanis, 1846	Mosquero Ladrillito			X	AM	LC
Leptopogon amaurocephalus Tschudi, 1846	Orejero Coronipardo	X	X	X		LC
Corythopis delalandi (Lesson, 1830)	Mosquero Terrestre Sureño			X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Phylloscartes paulista Ihering & Ihering, 1907	Orejerito de Sao Paulo			X	EP	NT
Tolmomyias sulphurescens (Spix, 1825)	Picoplano Sulfuroso	X	X	X		LC
Todirostrum cinereum (Linnaeus, 1766)	Titirijí Común	X	X	X		LC
Poecilotriccus latirostris (Pelzeln, 1868)	Titirijí Frentirrojo		X			LC
Myiornis auricularis (Vieillot, 1818)	Mosqueta Enana			X	AM	LC
Hemitriccus striaticollis (Lafresnaye, 1853)	Titirijí Gorgiestriado		X			LC
Hemitriccus margaritaceiventer (d'Orbigny & Lafresnaye, 1837)	Titirijí Perlado	X	X	X		LC
Family Tyrannidae Vigors, 1825						
Hirundinea ferruginea (Gmelin, 1788)	Birro Común		X	X		LC
Inezia inornata (Salvadori, 1897)	Piojito Picudo	X	X	X		LC
Euscarthmus meloryphus Wied, 1831	Tiranuelo Capetón	X	X	X		LC
Camptostoma obsoletum (Temminck, 1824)	Mosquerito Silbón	X	X	X		LC
Elaenia flavogaster (Thunberg, 1822)	Fiofío Ventriamarillo	X	X	X		LC
Elaenia spectabilis Pelzeln, 1868	Fiofío Grande	X		X		LC
Elaenia chilensis Hellmayr, 1927	Fiofío Crestiblanco	X		X		LC
Elaenia parvirostris Pelzeln, 1868	Fiofío Piquicorto	X		X		LC
Elaenia chiriquensis Lawrence, 1865	Fiofío Belicoso	X		X		LC
Suiriri suiriri (Vieillot, 1818)	Fiofío Suirirí	X	X	X		LC
Myiopagis gaimardii (d'Orbigny, 1839)	Fiofío Selvático	X				LC
Myiopagis caniceps (Swainson, 1835)	Fiofío Gris		X	X		LC
Myiopagis viridicata (Vieillot, 1817)	Fiofío Verdoso	X	X	X		LC
Capsiempis flaveola (Lichtenstein, 1823)	Mosquerito Amarillo			X		LC
Phaeomyias murina (Spix, 1825)	Piojito Pardo	X	X	X		LC
Phyllomyias reiseri Hellmayr, 1905	Mosquerito de Reiser			X	EP	LC
Culicivora caudacuta (Vieillot, 1818)	Tachurí Coludo			X	EP	VU
Polystictus pectoralis (Vieillot, 1817)	Tachurí Barbado	X		X	AM	NT
Serpophaga subcristata (Vieillot, 1817)	Piojito Tiquitiqui	X	X	X		LC
Serpophaga griseicapilla Straneck, 2007	Piojito de Straneck			X		LC
Serpophaga munda Berlepsch, 1893	Piojito Ventriblanco			X		LC
Legatus leucophaius (Vieillot, 1818)	Mosquero Pirata	X	X	X		LC
Myiarchus swainsoni Cabanis & Heine, 1859	Capetón de Swainsoni	X	X	X		LC
Myiarchus ferox (Gmelin, 1789)	Copetón Feroz	X	X	X		LC
Myiarchus tyrannulus (Statius Muller, 1776)	Copetón Tiranillo	X	X	X		LC
Sirystes sibilator (Vieillot, 1818)	Mosquero Silbador	X	X	X		LC
Casiornis rufus (Vieillot, 1816)	Burlisto Castaño	X	X	X		LC
Pitangus sulphuratus (Linnaeus, 1766)	Bienteveo Común	X	X	X		LC
Machetornis rixosa (Vieillot, 1819)	Picabuey	X	X	X		LC
Myiodynastes maculatus (Statius Muller, 1776)	Bienteveo Rayado	X	X	X		LC
Megarynchus pitangua (Linnaeus, 1766)	Bienteveo Pitanguá	X	X	X		LC
Myiozetetes cayanensis (Linnaeus, 1766)	Bienteveo de Alicastaño	X	X	X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Myiozetetes similis (Spix, 1825)	Bienteveo Sociable	X		X		LC
Tyrannus melancholicus Vieillot, 1819	Tirano Melancólico	X	X	X		LC
Tyrannus savana Vieillot, 1808	Tijereta Sabanera	X	X	X		LC
Griseotyrannus aurantioatrocristatus (d'Orbigny & Lafresnaye, 1837)	Tuquito Gris	X	X	X		LC
Empidonomus varius (Vieillot, 1818)	Tuquito Rayado	X	X	X		LC
Conopias trivirgatus (Wied, 1831)	Bienteveo Trilistado			X	AM	LC
Colonia colonus (Vieillot, 1818)	Mosquero Colilargo			X		LC
Myiophobus fasciatus (Statius Muller, 1776)	Mosquero Estriado	X		X		LC
Sublegatus modestus (Wied, 1831)	Mosquero Matorralero Sureño	X	X	X		LC
Pyrocephalus rubinus (Boddaert, 1783)	Mosquero Cardenal	X	X	X		LC
Fluvicola albiventer (Spix, 1825)	Viudita Dorsinegra	X	X	X		LC
Arundinicola leucocephala (Linnaeus, 1764)	Viudita Cabeciblanca	X	X	X		LC
Gubernetes yetapa (Vieillot, 1818)	Yetapá Grande	X	X	X		LC
Alectrurus tricolor (Vieillot, 1816)	Yetapá Chico			X	EP	VU
Alectrurus risora (Vieillot, 1824)	Yetapá Acollarado	X	X	X	EP	VU
Cnemotriccus fuscatus (Wied, 1831)	Mosquero Parduzco	X	X	X		LC
Lathrotriccus euleri (Cabanis, 1868)	Mosquero de Euler			X		LC
Contopus cinereus (Spix, 1825)	Pibí Tropical		X	X		LC
Hymenops perspicillatus (Gmelin, 1789)	Viudita Picoplata	X		X		LC
Satrapa icterophrys (Vieillot, 1818)	Mosquero Cejiamarillo	X	X	X		LC
Xolmis cinereus (Vieillot, 1816)	Monjita Gris	X	X	X		LC
Xolmis velatus (Lichtenstein, 1823)	Monjita Velada	X	X			LC
Xolmis irupero (Vieillot, 1823)	Monjita Blanca	X	X	X		LC
Family Vireonidae Swainson, 1837						
Cyclarhis gujanensis (Gmelin, 1789)	Vireón Cejirrufo	X	X	X		LC
Vireo olivaceus (Linnaeus, 1766)	Vireo Chiví		X			LC
Vireo chivi (Vieillot, 1817)	Vireo Chiví	X		X		LC
Family Corvidae Leach, 1820						
Cyanocorax cyanomelas (Vieillot, 1818)	Chara Morada	X	X	X		LC
*Cyanocorax cristatellus (Temminck, 1823)**	Chara Crestada	X		X	AM	LC
Cyanocorax chrysops (Vieillot, 1818)	Chara Moñuda	X	X	X		LC
Family Hirundinidae Rafinesque, 1815						
Alopochelidon fucata (Temminck, 1822)	Golondrina Cabecicastaña			X		LC
Stelgidopteryx ruficollis (Vieillot, 1817)	Golondrina Gorgirrufa	X	X	X		LC
Progne tapera (Vieillot, 1817)	Golondrina Parda	X	X	X		LC
Progne chalybea (Gmelin, 1789)	Golondrina Pechigrís	X	X	X		LC
Tachycineta albiventer (Boddaert, 1783)	Golondrina Aliblanca	X		X		LC
Tachycineta leucorrhoa (Vieillot, 1817)	Golondrina Cejiblanca	X	X	X		VU
Tachycineta leucopyga (Meyen ,1834)	Golondrina Chilena			X		LC
Riparia riparia (Linnaeus, 1758)	Avión Zaplador	X		X		LC
Hirundo rustica Linnaeus, 1758	Golondrina Común	X		X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Petrochelidon pyrrhonota (Vieillot, 1817)	Golondrina Risquera			X		LC
Family Troglodytidae Swainson, 1831						
Troglodytes musculus Naumann, 1823	Chochín Criollo	X	X	X		LC
Campylorhynchus turdinus (Wied, 1831)	Cucarachero Turdino	X	X	X		LC
Cantorchilus guarayanus (d'Orbigny & Lafresnaye, 1837)	Cucarachero del Guarayos	X		X		LC
Family Donacobiidae Aleixo & Pacheco, 2006						
Donacobius atricapilla (Linnaeus, 1766)	Angú	X	X	X		LC
Family Polioptilidae Baird, 1858						
Polioptila dumicola (Vieillot, 1817)	Perlita Azul	X	X	X		LC
Family Turdidae Rafinesque, 1815						
Catharus fuscescens (Stephens, 1817)	Zorzalito Rojizo			X		LC
Turdus leucomelas Vieillot, 1818	Zorzal Sabiá	X	X	X		LC
Turdus rufiventris Vieillot, 1818	Zorzal Colorado	X	X	X		LC
Turdus amaurochalinus Cabanis, 1850	Zorzal Chalchalero	X	X	X		LC
Turdus albicollis Vieillot, 1818	Zorzal Cuelliblanco			X		LC
Family Mimidae Bonaparte, 1853						
Mimus saturninus (Lichtenstein, 1823)	Sinsonte Calandria	X	X	X		LC
Mimus triurus (Vieillot, 1818)	Sinsonte Trescolas	X	X	X		LC
Family Motacillidae Horsfield, 1821						
Anthus lutescens Pucheran, 1855	Bisbita Amarillento	X	X	X		LC
Family Passerellidae Cabanis & Heine, 1850						
Zonotrichia capensis (Statius Muller, 1776)	Chingolo Común	X	X	X		LC
Ammodramus humeralis (Bosc, 1792)	Chingolo Pajonalero	X	X	X		LC
Arremon flavirostris Swainson, 1838	Cerquero Piquiamarillo	X	X	X		LC
Family Parulidae Wetmore, Friedmann, Lincoln, Miller, Peters, van Rossem, Van Tyne & Zimmer 1947						
Setophaga pitiayumi (Vieillot, 1817)	Parula Pitiayumí	X	X	X		LC
Geothlypis aequinoctialis (Gmelin, 1789)	Mascarita Equinoccial	X	X	X		LC
Basileuterus culicivorus (Deppe, 1830)	Reinita Coronidorada	X	X	X		LC
Myiothlypis flaveola Baird, 1865	Reinita Amarillenta	X	X	X		LC
Myiothlypis leucoblephara (Vieillot, 1817)	Reinita Silbona			X		LC
Family Icteridae Vigors, 1825						
Psarocolius decumanus (Pallas, 1769)	Cacique Crestado	X	X	X		LC
Procacicus solitarius (Vieillot, 1816)	Cacique Solitario	X	X	X		LC
Cacicus chrysopterus (Vigors, 1825)	Cacique Aliamarillo	X	X	X		LC
Cacicus haemorrhous (Linnaeus, 1766)	Cacique Lomirrojo	X		X		LC
Cacicus cela (Linnaeus, 1758)	Cacique Lomiamarillo		X			LC
Icterus cayanensis (Linnaeus, 1766)	Turpial Boyerito		X			LC
Icterus pyrrhopterus (Vieillot, 1819)	Turpial Variable	X		X		LC
Icterus croconotus (Wagler, 1829)	Turpial Amazónico	X		X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Gnorimopsar chopi (Vieillot, 1819)	Chopí	X	X	X		LC
Amblyramphus holosericeus (Scopoli, 1786)	Federal	X	X	X		LC
Agelasticus cyanopus (Vieillot, 1819)	Varillero Negro	X	X	X		LC
Chrysomus ruficapillus (Vieillot, 1819)	Varillero Congo	X		X		LC
Pseudoleistes guirahuro (Vieillot, 1819)	Tordo Güirahuró	X		X		LC
Agelaioides badius (Vieillot, 1819)	Tordo Músico	X	X	X		LC
Molothrus rufoaxillaris Cassin, 1866	Tordo Chillón	X	X	X		LC
Molothrus oryzivorus (Gmelin, 1788)	Tordo Gigante	X	X	X		LC
Molothrus bonariensis (Gmelin, 1789)	Tordo Renegrido	X	X	X		LC
Sturnella superciliaris (Bonaparte, 1850)	Charrancito Amazónico	X	X	X		LC
Dolichonyx oryzivorus (Linnaeus, 1758)	Tordo Charlatán			X		LC
Family Mitrospingidae Barker, Burns, Klicka, Lanyon & Lovette, 2013						
Lamprospiza melanoleuca (Vieillot, 1817)	Tangara Piquirroja		X			LC
Family Thraupidae Cabanis, 1847						
Pipraeidea melanonota (Vieillot, 1819)	Tangara de Antifaz			X		LC
Neothraupis fasciata (Lichtenstein, 1823)	Tangara Bandeada			X	AM	NT
Cissopis leverianus (Gmelin, 1788)	Tangara Urraca			X		LC
Paroaria coronata (Miller, 1776)	Cardenilla Crestada	X	X	X		LC
Paroaria capitata (d'Orbigny & Lafresnaye, 1837)	Cardenilla Piquigualda	X	X	X		LC
Tangara sayaca (Linnaeus, 1766)	Tangara Sayaca	X	X	X		LC
Tangara palmarum (Wied, 1823)	Tangara Palmera	X	X	X		LC
Tangara cayana (Linnaeus, 1766)	Tangara Isabel	X				LC
Nemosia pileata (Boddaert, 1783)	Tangara Encapuchada	X	X	X		LC
Conirostrum speciosum (Temminck, 1824)	Conirrostro Culirrufo	X	X	X		LC
Sicalis flaveola (Linnaeus, 1766)	Dorado	X	X	X		LC
Sicalis luteola (Sparrman, 1789)	Chirigüe Sabanero			X		LC
Hemithraupis guira (Linnaeus, 1766)	Tangara Guirá	X	X	X		LC
Volatinia jacarina (Linnaeus, 1766)	Semillero Volatinero	X	X	X		LC
Eucometis penicillata (Spix, 1825)	Tangara Cabecigrís	X		X		LC
Trichothraupis melanops (Vieillot, 1818)	Tangara de Anteojos			X		LC
Coryphospingus cucullatus (Statius Muller, 1776)	Soldadito Crestirrojo	X	X	X		LC
Tachyphonus rufus (Boddaert, 1783)	Tangara Negra	X	X	X		LC
Tachyphonus coronatus (Vieillot, 1822)	Tangara Coronada			X	AM	LC
Ramphocelus carbo (Pallas, 1764)	Tangara Picoplata	X	X			LC
Tersina viridis (Illiger, 1811)	Tangara Golondrina	X	X	X		LC
Dacnis cayana (Linnaeus, 1766)	Dacnis Azul			X		LC
Coereba flaveola (Linnaeus, 1758)	Platanero	X				LC
Sporophila lineola (Linnaeus, 1758)	Semillero Overo	X		X		LC
Sporophila plumbea (Wied, 1830)	Semillero Plomizo			X		LC
Sporophila collaris (Boddaert, 1783)	Semillero Acollarado	X	X	X		LC

Taxon	Popular Name in Paraguay	Reference			Categories of Threat	
		(A)	(B)	(C)	PY 2019	IUCN 2020
Sporophila nigricollis (Vieillot, 1823)	Semillero Ventriamarillo			X		LC
Sporophila caerulescens (Vieillot, 1823)	Semillero Corbatita	X	X	X		LC
Sporophila leucoptera (Vieillot, 1817)	Semillero Ventriblanco	X	X	X		LC
Sporophila bouvreuil (Statius Muller, 1776)	Semillero Camachuelo			X		LC
Sporophila hypoxantha Cabanis, 1851	Semillero Ventricanela	X		X		LC
Sporophila ruficollis Cabanis, 1851	Semillero Gorjioscuro	X				NT
Sporophila palustris (Barrows, 1883)	Semillero Palustre	X		X	EP	EN
Sporophila hypochroma Todd, 1915	Semillero Culirrufo			X		NT
Sporophila cinnamomea (Lafresnaye, 1839)	Semillero Castaño		X	X	AM	VU
Sporophila angolensis (Linnaeus, 1766)	Semillero Curió	X	X	X		LC
Embernagra platensis (Gmelin, 1789)	Coludo Verdón			X		LC
Emberizoides herbicola (Vieillot, 1817)	Coludo Colicuña	X		X		LC
Emberizoides ypiranganus Ihering & Ihering, 1907	Coludo Chico			X		LC
Saltatricula atricollis (Vieillot, 1817)	Pepitero Gorjinegro	X	X	X		LC
Saltatricula multicolor (Burmeister, 1860)	Pepitero Chico	X				LC
Saltator coerulescens Vieillot, 1817	Pepitero Grisáceo	X	X	X		LC
Saltator similis d'Orbigny & Lafresnaye, 1837	Pepitero Verdoso	X	X	X		LC
Saltator aurantiirostris Vieillot, 1817	Pepitero Piquigaldo			X		LC
Microspingus melanoleucus (d'Orbigny & Lafresnaye, 1837)	Monterita Cabecinegra	X	X	X		LC
Microspingus torquatus (d'Orbigny & Lafresnaye, 1837)	Monterita Acollarada			X		VU
Thlypopsis sordida (d'Orbigny & Lafresnaye, 1837)	Tangara Cabecinaranja			X		LC
Cypsnagra hirundinacea (Lesson, 1831)	Tangara Culiblanca			X	AM	LC
Family Cardinalidae Ridgway, 1901						
Piranga flava (Vieillot, 1822)	Piranga Bermeja	X	X	X		LC
Pheucticus aureoventris (d'Orbigny & Lafresnaye, 1837)	Picogrueso Dorsinegro			X		LC
Cyanoloxia brissonii (Lichtenstein, 1823)	Picogrueso Brisson	X				LC
Family Fringillidae Leach, 1820						
Spinus magellanicus (Vieillot, 1805)	Jilguero Encapuchado	X	X	X		LC
Euphonia chlorotica (Linnaeus, 1766)	Eufonia Golipúrpura	X	X	X		LC
Euphonia violacea (Linnaeus, 1758)	Eufonia Violácea		X	X		LC
Euphonia pectoralis (Latham, 1801)	Eufonia Ventricastaña			X	AM	LC
Family Passeridae Rafinesque, 1815						
Passer domesticus (Linnaeus, 1758)	Gorrión Común	X		X		LC

References: (A) – BENITES *et al.*, 2017; **(B)** – STRAUBE *et al.*, 2006; eBird list for the region of Concepción/PY (available at ebird.org/explore) **(C)** – eBird list for the region of Concepción/PY (available at ebird.org/explore). **Categories of threats: PY 2019** – Resolución nº 254/2019 *do Ministerio del Ambiente y Desarrollo Sostenible* de Paraguay. **IUCN 2020** – *The IUCN Red List of*

Threatened Species, versión 2020. **Caption: EP** – endangered of extinction; **AM** – threatened of extinction; **EN** – endangerous; **VU** – vulnerable; **NT** – not threatened ; **LC** – Less concern; **DD** – deficient data.

9.2.2.3 Herpetofauna

9.2.2.3.1 Regional Characterization (IAA)

Herpetology is the science dedicated to the study of amphibians and reptiles. This union is due to the belief in the past that these animals had many similarities, being sometimes even considered as a single natural group, as suggested by Linnaeus in the 18th century. However, today, evolutionary studies suggest that birds are reptiles (constituting the sister group to crocodiles), and that, in fact, reptiles are closer to mammals than to amphibians (Vitt & Caldwell, 2009). Despite these discoveries, the centuries-old tradition continues. Birds, with their peculiar characteristics and great diversity, continue to be the object of research in ornithology, while amphibians and "reptiles", even with their different evolutionary origins, remain the focus of herpetology. One of the reasons for this is that many aspects of the life and biology of these animals are complementary and allow zoologists and ecologists to study them using the same or similar techniques (Vitt & Caldwell, 2009).

Amphibians today constitute a group of 8,159 known living species, divided into three orders: Anura (frogs, toads; 7,203 species), Caudata (salamanders and newts; 742 species) and Gymnophiona (snakes or cecilia; 214 species) (AmphibiaWeb, 2020). The reptiles (from now on excluding birds) have so far about 10,800 known living species, distributed in four orders: Cocodylia (crocodiles, gulls and caimans; 24 species), Testudines/Chelonia (turtles and tortoises; about 351 species), Sphenodontia (tuatara; one species) and Squamata (amphibians = 196, lizards = 6,512 and snakes = 3,709) (Uetz et al, 2018).

Paraguay has a great diversity of environments, represented by five major eco-regions: Dry Chaco, Humid Chaco, Atlantic Forest, Cerrado and Pantanal (Dinerstein et al., 1995). Four of these ecoregions are biodiversity hotspots according to the Nature Conservancy (2005), which highlights the number of important areas for protection in the country (Brusquetti & Lavilla, 2006). The first list of amphibians and reptiles in Paraguay was made by Cope (1862). Since then, several updates have been prepared, such as: Schouten (1931; 1939), Gatti (1955), Canese (1970), Scott & Lovett (1975), Talbot (1979) and Cabral & Weiler (2014). In Cabral & Wieler (2014), a list of 137 specimens was observed in the Zoology Collection of the Facultad de Ciencias Exactas y Naturales de Asunción, indicating the presence of two species of turtles, four amphibians, 16 lizards and 40 snakes. In Núñez and others (2019), 31 species of amphibians and 22 species of reptiles were observed and sampled in the Ypoá region. The unique works, when added to other works, highlight the importance of regularly maintaining samples in the most diverse environments.

Among the ecoregions of Paraguay, it is inevitable to mention the importance of the Chaco. The Chaco is a vast plain occupied by forests and jungles, and covers more than 60% of Paraguay's surface area (Fauna Paraguay, 2006). It is one of the least inhabited regions in South America and therefore one of the least affected by human activities, although it is not completely free of them (Baumman et al., 2017). The Gran Chaco is divided into two sub-regions, the Dry Chaco and the Humid Chaco. The Dry Chaco is located in the northwestern region of Paraguay. The rivers of this region remain without water during the winter, but transport a large amount of sediment during the warm seasons of the year, directly from their sources in the Andes (Weiler et al., 2013). The amphibians that occupy the Chaco Seco present adaptations to the dry season. For example, the frog *Lepidobatrachus llanensis* (Ceratophryidae) is endemic to this ecoregion and has the ability to build a cocoon that reduces water loss from the skin by up to 70% during periods of drought (McLanahan et al., 1976). In turn, the Humid Chaco is a large area, with constant rainfall, which covers both banks of the Paraguay River. It has a varied topography, with high regions permeated by several swamps (Weiler et al., 2013). It is an environment analogous to the swamp, presenting several animals similar to those of the Brazilian biome such as: caiman (*Caiman yacare* and *Cayman latirostris*), Teiu lizard (*Salvator merianae*), turtle (*Acanthochelys pallidipectoris*) and snakes (*Eunectes notaeus* and *Bothrops alternatus*). Although there are several amphibians in the Humid Chaco (see Weiler et al., 2013), the only species known to be endemic to this region is *Melanophryniscus paraguayensis* (Bufonidae).

Among the endemic species in the Chaco, it is possible to mention the snake *Sybinomorphus lavillai* (Colubridae), the lizard *Stenocercus doellojuradoi* (Tropiduridae) (Leynaud & Bucher, 2005), the lizard species Homonota rupicola (Phyllodactylidae) (Cacciali et al, 2018), the yearling species of the genus Lepidobatrachus (Bufonidae): *L. asper*, *laevis*, and *llanensis* (Brusquetti et al., 2018), and also *Chacophrys pierottii* (Ceratophryidae) (Prohaska, 1959). Most of these species are found in high humidity refuges, frequently associated with decomposing organic matter, and in seasonal lagoons (Tailbot, 1978). Of the species mentioned above, the anurans *L. asper*, *L. llanensis*, *C. pierotti* are in danger of extinction in the Paraguayan Chaco, according to the IUCN Red List (Weiler et al., 2013). In addition, other species that occupy the Chaco as a whole have already been shown to be threatened with extinction, such as *Chelonoidis chilensis* (Testudinidae), *Boa constrictor occidentalis* (Boidae), or vulnerable, such as *Epicrates cenchria* (Boidae) and *Polychrus acutirostris* (Polychrotidae) (Kacoliris et al., 2006). Sampling efforts in the Chaco region, along with efficient taxonomic identification, will undoubtedly be important for future conservation measures for local species.

According to the collection of secondary data through literature (Brusquetti and Lavilla, 2006; Cabral and Weiler, 2014; Núñez and others, 2019; Weiler and others, 2013), 146 species were recorded in the Paraguay river region distributed in 36 families and 10 orders (as table bellow).

Table 17 – List of herpetofauna species likely to be found in IIA in PARACEL pulp mill

Taxon	(A)	(B)	(C)	(D)	Categories of Threat	
					List of Paraguay	IUCN 2020
Order Anura						
Family Alsodidae						
Limnomedusa macroglossa (Duméril & Bibron, 1841)	x			x	EN	LC
Family Bufonidae						
Melanophryniscus atroluteus (Miranda-Ribeiro, 1920)	x			x	EN	LC

Taxon	(A)	(B)	(C)	(D)	Categories of Threat	
					List of Paraguay	IUCN 2020
Melanophyniscus devincenzii (Klappenbach, 1968)				x	EN	-
Melanophryniscus fulvoguttatus (Mertens, 1937)	x			x		LC
Melanophryniscus klappenbachi (Prigioni & Langone, 2000)	x			x		-
Melanophryniscus krauczuki (Baldo y Basso, 2004)				x	EN	-
Melanophryniscus paraguayensis (Céspedez and Motte, 2007)			x	x	VU	-
Rhinella azarai (Gallardo, 1965)	x		x	x		-
Rhinella bergi (Céspedez, 2000 "1999")	x			x		LC
Rhinella fernandezae (Gallardo, 1957)	x		x	x		LC
Rhinella icterica (Spix, 1824)	x			x	EN	LC
Rhinella major (Muller & Helmich, 1936)	x			x		-
Rhinella ornata (Spix, 1824)	x			x	VU	LC
Rhinella diptycha (Cope, 1862)	x		x	x		LC
Rhinella scitula (Caramaschi & Niemeyer, 2003)	x			x	VU	DD
Family Ceratophryidae						
Ceratophrys cranwelli (Barrio, 1980)				x		LC
Chacophrys pierottii (Vellard, 1948)	x			x		LC
Lepidobatrachus asper (Budgett, 1899)	x			x	EN	NT
Lepidobatrachus laevis (Budgett, 1899)	x			x	VU	LC
Lepidobatrachus llanensis (Reig and Cei, 1963)	x			x		LC
Family Hylidae						
Argenteohyla siemersi pederseni (Mertens, 1937)	x			x	EN	-
Dendropsophus elianeae (Napoli & Caramaschi, 2000)	x			x	EN	LC
Dendropsophus jimi (Napoli & Caramaschi, 1999)	x			x	EN	LC
Dendropsophus melanargyreus (Cope, 1887)	x			x	EN	LC
Dendropsophus minutus (Peters, 1872)	x			x		LC
Dendropsophus nanus (Boulenger, 1889)	x		x	x		LC
Dendropsophus sanborni (Schmidt, 1944)	x			x		LC
Boana albopunctata (Spix, 1824)	x			x		LC
Boana caingua (Carrizo, 1991 "1990")	x			x		LC
Boana curupi (Garcia, Faivovichi & Haddad, 2007)				x	EN	LC
Boana faber (Wied-Neuwied, 1821)	x			x		LC
Boana pulchellus (Duméril & Bibron, 1841)	x			x	EN	LC
Boana punctata (Schneider, 1799)	x		x	x		LC
Boana raniceps (Cope, 1862)	x		x	x		LC
Boana aff. semiguttatus (A. Lutz, 1925)	x					LC
Itapotihyla langsdorffii (Duméril & Bibron, 1841)	x			x	EN	LC
Pithecopus azureus (Cope, 1862)	x		x	x		DD
Phyllomedusa sauvagii (Boulenger, 1882)	x			x		LC
Phyllomedusa tetraploidea (Pombal & Haddad, 1992)	x			x	EN	LC

Taxon	(A)	(B)	(C)	(D)	Categories of Threat	
					List of Paraguay	IUCN 2020
Lysapsus limellum (Cope, 1862)	x		x	x		LC
Pseudis paradoxa (Linnaeus, 1758)	x					LC
Pseudis platensis (Gallardo, 1961)	x		x	x		DD
Scinax acuminatus (Cope, 1862)	x		x	x		LC
Ololygon berthae (Barrio, 1962)	x		x	x		LC
Scinax fuscomarginatus (A. Lutz, 1925)	x		x	x		LC
Scinax fuscovarius (A. Lutz, 1925)	x		x	x		LC
Scinax nasicus (Cope, 1862)	x		x	x		LC
Scinax similis (Cochran, 1952)	x			x		LC
Scinax squalirostris (A. Lutz, 1925)	x		x	x		LC
Trachycephalus typhonius (Linnaeus, 1758)	x		x	x		-
Family Hylodidae						
Crossodactylus schmidti (Gallardo, 1961)	x			x	EN	NT
Family Leiuperidae						
Physalaemus nattereri (Steindachner, 1863)	x			x		LC
Physalaemus albonotatus (Steindachner, 1864)	x		x	x		LC
Physalaemus biligonigerus (Cope, 1861 "1860")	x		x	x		LC
Physalaemus centralis (Bokermann, 1962)	x			x	EN	LC
Physalaemus cuvieri (Fitzinger, 1826)	x		x	x		LC
Physalaemus marmoratus (Reinhardt & Lütken, 1862 "1861")	x			x	EN	LC
Physalaemus riograndensis (Milstead, 1960)	x			x		LC
Physalaemus santafecinus (Barrio, 1965)				x		LC
Pleurodema bibroni (Tschudi, 1838)				x		NT
Pseudopaludicola boliviana (Parker, 1927)	x		x	x		LC
Pseudopaludicola falcipes (Hensel, 1867)	x			x		LC
Pseudopaludicola mystacalis (Cope, 1887)	x			x		LC
Pseudopaludicola ternetzi (Miranda-Ribeiro, 1937)	x			x		LC
Family Leptodactylidae						
Adenomera diptyx (Boettger, 1885)			x	x		LC
Adenomera heyeri (Boistel, Massary & Angulo, 2006)	x					LC
Leptodactylus bufonius (Boulenger, 1894)	x			x		LC
Leptodactylus chaquensis (Cei, 1950)	x		x	x		LC
Leptodactylus elenae (Heyer, 1978)	x		x	x		LC
Leptodactylus furnarius (Sazima & Bokermann, 1978)	x			x		LC
Leptodactylus fuscus (Schneider, 1799)	x		x	x		LC
Leptodactylus gracilis (Duméril & Bibron, 1841)	x		x	x		LC
Leptodactylus labyrinthicus (Spix, 1824)	x			x		LC
Leptodactylus laticeps (Boulenger, 1918)	x			x		
Leptodactylus latinasus (Jiménez de la Espada, 1875)	x			x		LC

Taxon	(A)	(B)	(C)	(D)	Categories of Threat	
					List of Paraguay	IUCN 2020
Leptodactylus latrans (Steffen, 1815) Leptodactylus ocellatus	x		x	x		LC
Leptodactylus mystacinus (Burmeister, 1861)	x			x		LC
Leptodactylus podicipinus (Cope, 1862)	x		x	x		LC
Leptodactylus syphax (Bokermann, 1969)	x			x	VU	LC
Family Microhylidae						
Chiasmocleis albopunctata (Boettger, 1885)	x			x		LC
Dermatonotus muelleri (Boettger, 1885)	x		x	x		LC
Elachistocleis bicolor (Valenciennes in Guérin-Menéville, 1838)	x		x	x		LC
Family Odontophrynidae						
Odontophrynus americanus (Duméril & Bibron, 1841)	x		x	x		LC
Odontophrynus lavillai (Cei, 1985)	x			x		LC
Proceratophrys avelinoi (Mercadal del Barrio & Barrio, 1993)	x			x	EN	LC
Order Gymnophiona						
Family Siphonopidae						
Luetkenotyphlus brasiliensis (Lütken, 1852 "1851")	x					DD
Siphonops paulensis (Boettger, 1892)	x					LC
Family Typhlonectidae						
Chthonerpeton indistinctum (Reinhardt & Lütken, 1862″1861″)	x					LC
Order Testudines						
Family Chelidae						
Acanthochelys macrocephala (Rhodin, Mittermeier & McMorris, 1984)		x				NT
Acanthochelys pallidipectoris (Freiberg, 1945)		x			EN	EN
Order Crocodilya						
Family Alligatoridae						
Caiman yacare (Daudin, 1802)			x			LC
Order Squamata						
Family Iguanidae						
Iguana iguana (Linnaeus, 1758)		x			EN	LC
Family Polychrotidae Fitzinger, 1843						
Polychrus acutirostris (Spix, 1825)		x	x			LC
Family Tropiduridae						
Stenocercus caducus (Cope, 1862)		x				LC
Tropidurus etheridgei (Cei, 1982)		x				LC
Tropidurus guarani (Cope, 1862)		x				LC
Tropidurus torquatus (Wied, 1820)		x				LC
Family Gekkonidae						
Hemidactylus mabouia (Moreau de Jonnès, 1818)		x				LC
Family Phyllodactylidae						

Taxon	(A)	(B)	(C)	(D)	Categories of Threat	
					List of Paraguay	IUCN 2020
Homonota rupicola (Cacciali, Ávila y Bauer, 2007)		x				CR
Homonota aff. borellii		x				LC
Phyllopezus pollicaris (Spix, 1825)		x				LC
Family Teiidae						
Ameiva ameiva (Linnaeus, 1758)		x	x			LC
Ameivula abalosi (Cabrera, 2012)		x				LC
Dracaena paraguayensis (Amaral, 1950)		x				LC
Salvator merianae (Duméril & Bibron, 1839)			x			LC
Family Gymnophthalmidae						
Cercosaura schreibersii (Wiegmann, 1834)		x				LC
Family Mabuyidae (antiga Scincidae)						
Aspronema dorsivittatum (Cope, 1862)			x			-
Manciola guaporicola (Dunn, 1935)		x				-
Notomabuya frenata (Cope, 1862)		x				LC
Family Amphisbaenidae						
Amphisbaena albocingulata (Boettger, 1885)			x			LC
Amphisbaena bolivica (Mertens, 1929)		x				LC
Amphisbaena camura (Cope, 1862)		x				LC
Amphisbaena mertensii (Strauch, 1881)		x				LC
Leposternon microcephalum (Wagler, 1824)		x				LC
Family Leptotyphlopidae						
Epictia albipuncta (Burmeister, 1861)		x				LC
Family Typhlopidae						
Amerotyphlops brongersmianus (Vanzolini, 1976)		x	x			LC
Family Boidae						
Eunectes notaeus (Cope, 1862)		x	x			-
Family Colubridae						
Chironius maculoventris (Dixon, Wiest y Cei, 1993)		x				LC
Leptophis ahaetulla ahaetulla (Linnaeus, 1758)		x				LC
Palusophis bifossatus (Raddi, 1820)		x				LC
Family Elapidae						
Micrurus frontalis (Duméril, Bibron & Duméril, 1854)		x				LC
Micrurus pyrrhocryptus (Cope, 1862)		x				LC
Family Viperidae						
Bothrops alternatus (Duméril, Bibron & Duméril, 1854)		x	x			-
Bothrops diporus (Cope, 1862)		x	x			LC
Bothrops jararaca (Wied, 1824)		x				LC
Bothrops mattogrossensis (Amaral, 1925)		x			EN	-
Bothrops jararacussu (Lacerda, 1884)		x				LC
Family Dipsadidae						

Taxon	(A)	(B)	(C)	(D)	Categories of Threat	
					List of Paraguay	IUCN 2020
Atractus paraguayensis (Werner, 1924)		x				LC
Atractus reticulatus (Boulenger, 1885)			x			LC
Sibynomorphus turgidus (Cope, 1868)		x				
Sibynomorphus ventrimaculatus (Boulenger, 1885)		x				LC
Apostolepis dimidiata (Jan, 1862)		x				LC
Phalotris matogrossensis (Lema, D'Agostini & Cappellari, 2005)		x				LC
Phalotris tricolor (Duméril, Bibron & Duméril, 1854)		x				LC
Hydrodynastes gigas (Duméril, Bibron & Duméril, 1854)		x	x			LC
Helicops leopardinus (Schlegel, 1837)		x	x			LC
Pseudoeryx plicatilis (Linnaeus, 1758)		x				LC
Philodryas mattogrossensis (Koslowsky, 1898)		x				LC
Philodryas olfersii (Lichtenstein, 1823)		x	x			LC
Philodryas patagoniensis (Girard, 1858)		x				LC
Philodryas psammophidea (Günther, 1872)		x				LC
Mussurana bicolor (Peracca, 1904)		x	x			LC
Oxyrhopus guibei (Hoge & Romano, 1978)			x			LC
Phimophis vittatus (Boulenger, 1896)		x				LC
Phimophis guerini (Duméril, Bibron & Duméril, 1854			x			-
Thamnodynastes chaquensis (Bergna & Alvarez, 1993)		x	x			LC
Thamnodynastes hypoconia (Cope, 1860)			x			LC
Thamnodynastes strigatus (Günther, 1858)		x				LC
Erythrolamprus almadensis (Wagler, 1824)			x			LC
Erythrolamprus jaegeri coralliventris (Boulenger, 1894)		x				LC
Erythrolamprus poecilogyrus poecilogyrus (Wied, 1825)		x				-
Erythrolamprus semiaureus (Cope, 1862)		x				LC
Erythrolamprus sagittifer (Jan, 1863)		x				LC
Lygophis dilepis (Cope, 1862)		x				LC
Xenodon merremii (Wagler, 1824)			x			LC
Xenodon pulcher (Jan, 1863)		x				LC

Key: (A): Brusquetti & Lavilla, 2006; **(B):** Cabral & Weiler, 2014; **(C):** Núñez et al., 2019; **(D):** Weiler et al., 2013. **List of Paraguay:** Resolution 433/2019 (**EN**: endangered of extinction; **VU**: vulnerable). **IUCN 2020:** The IUCN Red List for Threatened Species, 2020-1 (**CR**: critical; **EN**: endangered; **NT**: threatened ; **LC**: less concern; **DD**: deficient data).

9.2.2.4 Ichthyofauna

9.2.2.4.1 Regional Characterization (IAA)

Neotropical ecosystems are known for their diversity and richness (Leal et al. 2018). Approximately 9,000 fish species are known for this system (Birindelli & Sidlauskas, 2018). The number of fish species increases by about 11% each decade, with approximately 390 new species known each year (Nelson et al. 2016; Fricke et al. 2018). In freshwater environments, 5,160 species have already been officially described (Reis et al. 2016), more than a third of which are found in South American aquatic habitats. Of this total, 307 species are found in Paraguayan waterways, representing almost 6% of the total and 2.3% of the fish in the continental area (Koerber, 2017). Estimates based on published articles have cited the abundance of Paraguayan fish in one hundred and twenty-nine species (Ramlow, 1989), one hundred and eighty-nine (Mandelburger et al., 1996) and two hundred and ninety-eight (Bertoni, 1939). According to the unpublished data bases present in the ichthyofaunal reference sites, these estimates range from 256 (www.fishbase.org), 395 (http://www.faunaparaguay.com/fishlist.html) (www.faunaparaguay.com/fishlist.html) and 451 (www.guyra.org.pf).

The main causes of fish population decline in Paraguay, as well as in several South American environments, include habitat loss due to changes in land use, urbanization, inappropriate agricultural practices, the construction and operation of hydroelectric dams, water pollution, excessive predatory fishing and the introduction of non-native species (Allan and others, 2005; Barletta and others, 2010; Reis, 2013; Reis and others, 2016).

Paraguay has hydrological systems belonging to the fifth largest basin in the world, the Rio de la Plata basin, which has a total area of about 3.1 million km2 . In this basin, which includes the Paraná, Paraguay and Uruguay rivers, there are about 1,250 species of fish (Buckup and others, 2007; Langeani and others, 2009). Four large freshwater ecoregions of Paraguay are part of this basin: Alto y Bajo Paraná, Paraguay and Chaco (Abell and others, 2008).

The Paraguay River Basin, which is approximately 2,500 km long, covers an area of more than 1 million km2 and is characterized by a wide plain ranging from 48 m from the border with the Paraná River to 125 m in the Pantanal region (Barros et al., 2004). On the right bank of the Paraguay River, the tributaries are mostly intermittent systems that drain the Paraguayan Chaco ecoregion (Iriondo et al., 2000). The eastern Chaco is characterized by swampy environments, located in the alluvial belts that flow into the Paraguay River, while the western Chaco has more transitory channels (Iriondo, 1993). The Paraguay river drains the rivers that make up the Pantanal basin, which has 276 described fish species (Bristiki et al., 2007). Between the municipality of Concepción and the Río Negro Toledo-Piza and others (2001) have identified 173 species of fish for the Paraguay river.

According to secondary data obtained through literature (Britski, 2007; Koerber, 2017; Toledo-Piza et al., 2001), a list of fish species likely to be found in the portion of Paraguay in the region of Concepción has been prepared. There are 310 species distributed in 37 families and 11 orders, arranged in Table bellow.

Table 18 – List of ichthyofauna species likely to be found in the IIA of the pulp mill

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
E L A S M O B R A N C H I I		
Order MYLIOBATIFORMES		
Family Potamotrygonidae		
Potamotrygon amandae (Loboda & Carvalho, 2013)		-
Potamotrygon brachyura (Guenther, 1880)	DD	DD
Potamotrygon falkneri (Castex & Maciel, 1963)	DD	DD
Potamotrygon histrix (Mueller & Henle, 1841)	DD	DD
Potamotrygon motoro (Mueller & Henle, 1841)	DD	DD
Potamotrygon pantanensis (Loboda & Carvalho, 2013)	-	-
Potamotrygon schuemacheri (Castex, 1964)	DD	DD
A C T I N O P T E R Y G I I		
Order CLUPEIFORMES		
Family Engraulidae		
Lycengraulis grossidens (Agassiz, 1829)	-	LC
Family Pristigasteridae		
Pellona flavipinnis (Valenciennes, 1837)	LC	LC
Order CHARACIFORMES		
Family Hemiodontidae		
Hemiodus orthonops (Eigenmann & Kennedy, 1903)	-	-
Hemiodus semitaeniatus (Kner, 1858)	-	-
Family Parodontidae		
Apareiodon piracicabae (Eigenmann, 1907)	-	-
Apareiodon affinis (Steindachner, 1879)	-	-
Family Curimatidae		
Curimatella dorsalis (Eigenmann & Eigenmann, 1889)	-	-
Curimatopsis myersi (Vari, 1982)	-	-
Cyphocharax gillii (Eigenmann & Kennedy, 1903)	-	-
Cyphocharax modestus (Fernández-Yépez, 1948)	-	-
Cyphocharax platanus (Guenther, 1880)	-	-
Cyphocharax saladensis (Meinken, 1933)	-	-
Cyphocharax pilotus (Vari, 1987)	-	-
Cyphocharax voga (Hensel, 1870)	LC	LC
Potamorhina squamoralevis (Braga & Azpelicueta, 1983)	-	-
Psectrogaster curviventris (Eigenmann & Kennedy, 1903)	-	-
Steindachnerina brevipinna (Eigenmann & Eigenmann, 1889)	-	-
Steindachnerina conspersa (Holmberg, 1891)	-	-
Family Prochilodontidae		
Prochilodus lineatus (Valenciennes, 1837)	-	-
Family Anostomidae		

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
Abramites hypselonotus (Guenther, 1868)	-	-
Leporellus pictus (Kner, 1858)	-	-
Leporinus acutidens (Valenciennes, 1837)	-	-
Leporinus lacustris (Amaral Campos, 1945)	-	-
Leporinus octofasciatus (Steindachner, 1915)	LC	LC
Leporinus striatus (Kner, 1858)	LC	LC
Megaleporinus obtusidens (Valenciennes, 1837)	-	-
Schizodon borellii (Boulenger, 1900)	-	-
Schizodon isognathus (Kner, 1858)	-	-
Schizodon nasutus (Kner, 1858)	-	-
Schizodon platae (Garman, 1890)	-	-
Family Erythrinidae		
Erythrinus erythrinus (Bloch & Schneider, 1801)		-
Hoplerythrinus unitaeniatus (Agassiz, 1829)		-
Hoplias malabaricus (Bloch, 1794)	LC	LC
Hoplias mbigua (Azpelicueta, Benítez, Aichino & Mendez, 2015)	-	-
Hoplias misionera (Rosso, Mabragaña, González-Castro, Delpiani, Avigliano, Schenone & Díaz de Astarloa, 2016)	-	-
Family Lebiasinidae		
SubFamily Pyrrhulininae		
Pyrrhulina australis (Eigenmann & Kennedy, 1903)	-	-
Family Gasteropelecidae		
Gasteropelecus sternicla (Linnaeus 1758)	-	-
Thoracocharax stellatus (Kner, 1858)	-	-
Family Serrasalmidae		
Metynnis mola (Eigenmann & Kennedy, 1903)	-	-
Metynnis otuquensis (Ahl, 1923)	-	-
Myloplus levis (Eigenmann & McAtee, 1907)	-	-
Myloplus tiete (Eigenmann & Norris, 1900)	-	-
Mylossoma duriventre (Cuvier, 1818)	-	-
Piaractus mesopotamicus (Holmberg, 1887)	-	-
Pygocentrus nattereri (Kner, 1858)	-	-
Serrasalmus maculatus (Kner, 1858)	-	-
Serrasalmus marginatus (Valenciennes, 1837)	-	-
Family Characidae		
SubFamily Acestrorhynchinae		
Acestrorhynchus pantaneiro (Menezes, 1992)	-	-
SubFamily Aphyocharacinae		
Aphyocharax anisitsi (Eigenmann & Kennedy, 1903)	-	-
Aphyocharax dentatus (Eigenmann & Kennedy, 1903)	-	-
Aphyocharax nattereri (Steindachner, 1882)	-	-

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
Aphyocharax rathbuni (Eigenmann, 1907)	-	-
Prionobrama paraguayensis (Eigenmann, 1914)	-	-
SubFamily Bryconinae		
Brycon hilarii (Valenciennes, 1850)	-	-
Brycon orbignyanus (Valenciennes, 1850)	-	-
Triportheus nematurus (Kner, 1858)	-	-
Triportheus pantanensis (Malabarba, 2004)	-	-
SubFamily Characinae		
*Charax leticiae (*Lucena, 1987)	-	-
Charax stenopterus (Cope, 1894)	-	-
Cynopotamus argenteus (Valenciennes, 1837)	-	-
Cynopotamus kincaidi (Schultz, 1950)	-	-
Galeocharax humeralis (Valenciennes, 1834)	-	-
Galeocharax gulo (Cope, 1870)	-	-
Phenacogaster tegatus (Eigenmann, 1911)	-	-
Roeboides affinis (Guenther, 1868)	LC	LC
Roeboides descalvadensis (Fowler, 1932)	-	-
Roeboides microlepis (Reinhardt, 1851)	-	-
SubFamily Cheirodontinae		
*Cheirodon stenodon (*Eigenmann, 1915)	-	-
Odontostilbe microcephala (Eigenmann, 1907)	LC	LC
Odontostilbe paraguayensis (Eigenmann & Kennedy, 1903)	-	-
Odontostilbe pequira (Steindachner, 1882)	-	-
Serrapinnus calliurus (Boulenger, 1900)	-	-
Serrapinnus kriegi (Schindler, 1937)	-	-
Serrapinnus microdon (Eigenmann, 1915)	-	-
Serrapinnus notomelas (Eigenmann, 1915)	-	-
SubFamily Clupeacharacinae		
Clupeacharax anchoveoides (Pearson, 1924)	-	-
SubFamily Cynodontinae		
Rhaphiodon vulpinus (Spix & Agassiz, 1829)	-	-
SubFamily Iguanodectinae		
Piabucus melanostoma (Holmberg, 1891)	-	-
SubFamily Salmininae		
Salminus brasiliensis (Cuvier, 1816)	-	-
SubFamily Stethaprioninae		
Brachychalcinus retrospina (Boulenger, 1892)	-	-
Gymnocorymbus ternetzi (Boulenger, 1895)	-	-
Poptella paraguayensis (Eigenmann, 1907)	-	-
SubFamily Stevardiinae		
Creagrutus meridionalis (Vari & Harold, 2001)	-	-

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
Creagrutus paraguayensis (Mahnert & Géry, 1988)	-	-
Bryconamericus exodon (Eigenmann, 1907)	-	-
Diapoma guarani (Mahnert & Géry, 1987)	-	-
Knodus moenkhausii (Eigenmann & Kennedy, 1903)	-	-
Piabarchus analis (Eigenmann, 1914)	-	-
Piabarchus stramineus (Eigenmann, 1908)	-	-
Piabarchus torrenticola (Mahnert & Géry, 1988)	-	-
Piabina argentea (Reinhardt, 1867)	-	-
Markiana nigripinnis (Perugia, 1891)	-	-
Mimagoniates barberi (Regan, 1907)	-	-
Xenurobrycon macropus (Myers & Miranda Ribeiro, 1945)	-	-
SubFamily Tetragonopterinae		
Tetragonopterus argenteus (Cuvier, 1816)	-	-
SubFamily Astyanax		
Astyanax abramis (Jenyns, 1842)	-	-
Astyanax alleni (Eigenmann & McAtee, 1907)	-	-
Astyanax eigenmanniorum (Cope, 1894)	-	-
Astyanax lacustris (Luetken, 1875)	-	-
Astyanax lineatus (Perugia, 1891)	-	-
Astyanax pellegrini (Eigenmann, 1907)	-	-
Astyanax rutilus (Jenyns, 1842)	-	-
Psellogrammus kennedyi (Eigenmann, 1903)	-	-
Oligosarcus oligolepis (Steindachner, 1867)	-	-
Oligosarcus paranensis (Menezes & Géry, 1983)	-	-
Oligosarcus pintoi (Campos, 1945)	-	-
SubFamily Bryconops		
Bryconops melanurus (Bloch, 1794)	-	-
SubFamily Hemigrammus		
Hemigrammus durbinae (Ota, Lima & Pavanelli, 2015)	-	-
Hemigrammus lunatus (Durbin, 1918)	-	-
Hemigrammus mahnerti (Uj & Géry, 1989)	-	-
Hemigrammus tridens (Eigenmann, 1907)	-	-
Hemigrammus ulreyi (Boulenger, 1895)	-	-
Hyphessobrycon anisitsi (Eigenmann, 1907)	-	-
Hyphessobrycon arianae (Uj & Géry, 1989)	-	-
Hyphessobrycon elachys (Weitzman, 1985)	-	-
Hyphessobrycon eques (Steindachner, 1882)	-	-
Hyphessobrycon luetkenii (Boulenger, 1887)	-	-
Hyphessobrycon procerus (Mahnert & Géry, 1987)	-	-
Hyphessobrycon pytai (Géry & Mahnert, 1993)	-	-
Moenkhausia dichroura (Kner, 1858)	-	-

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
Moenkhausia sanctaefilomenae (Steindachner, 1907)	-	-
Incertae Sedis		
Mixobrycon ribeiroi (Eigenmann, 1907)	-	-
Family Crenuchidae		
Characidium etzeli (Zarske & Géry, 2001)	-	-
Characidium laterale (Boulenger, 1895)	-	-
Order SILURIFORMES		
Family Doradidae		
Anadoras weddellii (Castelnau, 1855)	LC	LC
Ossancora eigenmanni (Boulenger, 1895)	-	-
Ossancora punctata (Kner, 1853)	-	-
Oxydoras kneri (Bleeker, 1862)	-	-
Platydoras armatulus (Valenciennes, 1840)	-	-
Pterodoras granulosus (Valenciennes, 1821)	-	-
Rhinodoras dorbignyi (Kner, 1855)	-	-
Trachydoras paraguayensis (Eigenmann & Ward, 1907)	-	-
Family Auchenipteridae		
SubFamily Auchenipterinae		
Ageneiosus inermis (Linnaeus, 1766)	-	-
Auchenipterus nigripinnis (Boulenger, 1895)	-	-
Auchenipterus osteomystax (Miranda Ribeiro, 1918)	-	-
Epapterus dispilurus (Cope, 1878)	-	-
Trachelyopterus galeatus (Linnaeus, 1766)	-	-
Trachelyopterus striatulus (Steindachner, 1877)	-	-
SubFamily Centromochlinae		
Tatia neivai (Ihering, 1930)	-	-
Family Pimelodidae		
Hemisorubim platyrhynchos (Valenciennes, 1840)	-	-
Hypophthalmus oremaculatus (Nani & Fuster, 1947)	-	-
Iheringichthys labrosus (Luetken, 1874)	-	-
Iheringichthys megalops (Eigenmann & Ward, 1907)	-	-
Megalonema argentinum (MacDonagh, 1938)	-	-
Megalonema pauciradiatum (Eigenmann, 1919)	-	-
Megalonema platanum (Guenther, 1880)	-	-
Parapimelodus valenciennis (Luetken, 1874)	-	LC
Pimelodus albicans (Valenciennes, 1840)	-	-
Pimelodus argenteus (Perugia, 1891)	-	LC
Pimelodus maculatus (Lacépède, 1803)	-	-
Pimelodus mysteriosus (Azpelicueta, 1998)	-	-
Pimelodus ornatus (Kner, 1858)	-	-
Pseudoplatystoma corruscans (Spix & Agassiz, 1829)	-	-

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
Pseudoplatystoma reticulatum (Eigenmann & Eigenmann, 1889)	-	-
Sorubim lima (Bloch & Schneider, 1801)	-	-
Family Pseudopimelodidae		
Microglanis carlae (Vera-Alcaraz, da Graça & Shibatta 2008)	-	-
Pseudopimelodus mangurus (Valenciennes, 1835)	-	-
Family Heptapteridae		
Heptapterus mustelinus (Valenciennes, 1835)	-	-
Pimelodella gracilis (Valenciennes, 1835)	-	-
Pimelodella griffini (Eigenmann, 1917)	-	-
Pimelodella laticeps (Eigenmann, 1917)	-	-
Pimelodella mucosa (Eigenmann & Ward, 1907)	-	-
Pimelodella parva (Guentert, 1942)	-	-
Rhamdia quelen (Quoy & Gaimard, 1824)	-	LC
Family Cetopsidae		
Cetopsis gobioides (Kner, 1858)	-	-
Family Aspredinidae		
Amaralia oviraptor (Friel & Carvalho, 2016)	-	-
Bunocephalus doriae (Boulenger, 1902)	LC	LC
Pseudobunocephalus iheringii (Boulenger, 1891)	LC	LC
Pseudobunocephalus rugosus (Eigenmann & Kennedy, 1903)	LC	LC
Pterobunocephalus depressus (Haseman, 1911)	LC	LC
Xyliphius barbatus (Alonso de Arámburu & Arámburu, 1962)	-	-
Family Trichomycteridae		
SubFamily Stegophilinae		
Homodiaetus anisitsi (Eigenmann & Ward, 1907)	-	-
Ochmacanthus batrachostoma (Miranda Ribeiro, 1912)	-	-
Pseudostegophilus maculatus (Steindachner, 1879)	-	-
SubFamily Trichomycterinae		
Ituglanis eichhorniarum (Miranda Ribeiro, 1912)	-	-
Trichomycterus boylei (Nichols, 1956)	-	-
SubFamily Vandelliinae		
Paravandellia oxyptera (Miranda Ribeiro, 1912)	-	-
Family Callichthyidae		
SubFamily Callichthyinae		
Callichthys callichthys (Linnaeus, 1758)	-	-
Hoplosternum littorale (Hancock, 1828)	-	-
Lepthoplosternum pectorale (Boulenger, 1895)	-	-
SubFamily Corydoradinae		
Corydoras aeneus (Gill, 1858)	-	-
Corydoras aurofrenatus (Eigenmann & Kennedy, 1903)	-	-
Corydoras britskii (Nijssen & Isbruecker, 1983)	-	-

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
Corydoras diphyes (Axenrot & Kullander, 2003)	-	-
Corydoras ellisae (Gosline, 1940)	-	-
Corydoras hastatus (Eigenmann & Eigenmann, 1888)	-	-
Corydoras polystictus (Regan, 1912)	-	-
Scleromystax macropterus (Regan, 1913)	-	EN
Family Loricariidae		
SubFamily Hypoptopomatinae		
Hisonotus maculipinnis (Regan, 1912)	-	-
Hypoptopoma inexspectatum (Holmberg, 1893)	-	-
Otocinclus arnoldi (Regan, 1909)	-	-
Otocinclus mimulus (Axenrot & Kullander, 2003)	-	-
Otocinclus vestitus (Cope, 1872)	-	-
Otocinclus vittatus (Regan, 1904)	-	-
Otothyropsis dialeukos (Calegari, Gill Morlis & Reis, 2017)	-	-
Otothyropsis piribebuy (Calegari, Lehmann & Reis, 2011)	-	-
SubFamily Hypostominae		
Ancistrus dubius (Eigenmann & Eigenmann, 1889)	-	-
Ancistrus hoplogenys (Guenther, 1864)	-	-
Ancistrus pirareta (Muller, 1989)	-	-
Ancistrus piriformis (Muller, 1989)	LC	LC
Hypostomus albopunctatus (Regan, 1906)	-	-
Hypostomus boulengeri (Eigenmann & Kennedy, 1903)	-	-
Hypostomus cochliodon (Kner, 1854)	-	-
Hypostomus commersonii (Valenciennes, 1836)	-	-
Hypostomus derbyi (Haseman, 1911)	-	-
Hypostomus dlouhyi (Weber, 1985)	-	-
Hypostomus formosae (Cardoso, Brancolini, Paracampo, Lizarralde, Covain & Montoya-Burgos, 2016)	-	-
Hypostomus latifrons (Weber, 1986)	-	-
Hypostomus meleagris (Marini, Nichols & La Monte, 1933)	DD	DD
Hypostomus microstomus (Weber, 1987)	-	-
Hypostomus paranensis (Weyenbergh, 1877)	-	-
Hypostomus paulinus (Ihering, 1905)	-	-
Hypostomus peckoltoides (Zawadzki, Weber & Pavanelli, 2010)	-	-
Hypostomus piratatu (Weber, 1986)	-	-
Hypostomus regani (Ihering, 1905)	-	-
Hypostomus ternetzi (Boulenger, 1895)	-	-
Pterygoplichthys ambrosettii (Holmberg, 1893)	-	-
Megalancistrus parananus (Peters, 1881)	-	-
SubFamily Loricariinae		
Farlowella hahni (Meinken, 1937)	-	-
Farlowella paraguayensis (Retzer & Page, 1997)	-	-

TAXON	Category of Threat	
	List of Paraguay	**IUCN (2021-1)**
Sturisoma robustum (Regan, 1904)	-	-
Sturisoma barbatum (Kner 1853)	-	-
Loricaria apeltogaster (Boulenger, 1895)	-	-
Loricaria luciae (Thomas, Rodriguez, Cavallaro, Froehlich & Castro, 2013)	-	-
*Loricaria simillima (*Regan, 1904)	-	-
Loricariichthys labialis (Boulenger, 1895)	-	-
*Loricariichthys platymetopon (*Isbruecker & Nijssen, 1979)	-	-
Loricariichthys rostratus (Reis & Pereira, 2000)	-	-
Paraloricaria agastor (Isbruecker, 1979)	-	-
Pseudohemiodon laticeps (Regan, 1904)	-	-
Pyxiloricaria menezesi (Isbrücker & Nijssen 1984)	-	-
Rineloricaria aurata (Knaack, 2002)	-	-
Rineloricaria lanceolata (Guenther, 1868)	-	-
Rineloricaria parva (Boulenger, 1895)	-	-
Spatuloricaria evansii (Boulenger 1892)	LC	LC
SubFamily Rhinelepinae		
Rhinelepis strigosa (Valenciennes, 1840)	-	-
Family Scoloplacidae		
Scoloplax distolothrix (Schaefer, Weitzman & Britski, 1989)	LC	LC
Order GYMNOTIFORMES		
Family Sternopygidae		
Eigenmannia trilineata (López & Castello, 1966)	-	-
Eigenmannia virescens (Valenciennes, 1842)	-	-
Sternopygus macrurus (Bloch & Schneider, 1801)	-	-
Family Apteronotidae		
Apteronotus albifrons (Linnaeus, 1766)	-	-
Apteronotus brasiliensis (Reinhardt, 1852)	-	-
Apteronotus ellisi (Arámburu, 1957)	-	-
Family Rhamphichthyidae		
Rhamphichthys hahni (Meinken, 1937)	-	-
*Gymnorhamphichthys britskii (*Carvalho, Ramos & Albert, 2011)	-	-
Family Hypopomidae		
Brachyhypopomus bombilla (Loureiro & Silva, 2006)	-	-
Brachyhypopomus draco (Giora, Malabarba & Crampton, 2008)	-	-
*Brachyhypopomus gauderio (*Giora & Malabarba, 2009)	-	-
Brachyhypopomus walteri (Sullivan, Zuanon & Cox-Fernández, 2013)	-	-
Family Gymnotidae		
Gymnotus inaequilabiatus (Valenciennes, 1839)	-	-
Gymnotus pantanal (Fernandes, Albert, Daniel-Silva, Lopes, Crampton & Almeida-Toledo, 2005)	-	-
Gymnotus paraguensis (Albert & Crampton, 2003)	-	-

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
Order CYPRINODONTIFORMES		
Family Rivulidae”		
SubFamily Cynolebiasinae		
Austrolebias monstrosus (Huber, 1995)	-	-
Austrolebias nigripinnis (Regan, 1912)	-	-
Austrolebias paranaensis (Costa, 2006)	-	-
Austrolebias patriciae (Huber, 1995)	-	-
Austrolebias vandenbergi (Huber, 1995)	-	-
Spectrolebias chacoensis (Amato, 1986)	-	-
SubFamily “Rivulinae”		
Neofundulus paraguayensis (Eigenmann & Kennedy, 1903)	-	-
Pterolebias longipinnis (Garman, 1895)	-	-
Trigonectes aplocheiloides (Huber, 1995)	-	-
Trigonectes balzanii (Perugia, 1891)	-	-
Papiliolebias bitteri (Costa, 1989)	-	-
Melanorivulus punctatus (Boulenger, 1895)	-	-
Family Poeciliidae		
SubFamily Poeciliinae		
Cnesterodon raddai (Meyer & Etzel, 2001)	-	-
Phalloceros harpagos (Lucinda, 2008)	-	-
Phallotorynus dispilos (Lucinda, Rosa & Reis, 2005)	-	-
*Phallotorynus psittakos (*Lucinda, Rosa & Reis, 2005)	-	-
Phallotorynus victoriae (Oliveros, 1983)	-	-
Poecilia reticulata (Peters, 1859)	LC	LC
Order BELONIFORMES		
Family Belonidae		
Potamorrhaphis eigenmanni (Miranda Ribeiro, 1915)	-	-
Pseudotylosurus angusticeps (Guenther, 1866)	-	-
Ordem SYNBRANCHIFORMES		
Family Synbranchidae		
Synbranchus marmoratus (Bloch, 1795)	LC	LC
INCERTAE SEDIS		
Pachyurus bonariensis (Steindachner, 1879)	LC	LC
*Plagioscion ternetzi (*Boulenger, 1895)	DD	DD
Plagioscion squamosissimus (Heckel, 1840)	LC	LC
Order CICHLIFORMES		
Family Cichlidae		
SubFamily Cichlinae		
Astronotus crassipinnis (Heckel, 1840)	-	-
Chaetobranchopsis australis (Eigenmann & Ward, 1907)	-	-
Bujurquina vittata (Heckel, 1840)	-	-

TAXON	Category of Threat	
	List of Paraguay	IUCN (2021-1)
Cichlasoma dimerus (Heckel, 1840)	-	-
Cichlasoma pusillum (Kullander, 1983)	-	-
Laetacara dorsigera (Heckel, 1840)	-	-
Cichla kelberi (Kullander & Ferreira, 2006)	-	-
Cichla piquiti (Kullander & Ferreira, 2006)	-	-
Apistogramma borellii (Regan, 1906)	-	-
Apistogramma commbrae (Regan, 1906)	-	-
Apistogramma trifasciata (Eigenmann & Kennedy, 1903)	-	-
Crenicichla gillmorlisi (Kullander & Lucena, 2013)	-	-
*Crenicichla lepidota (*Heckel, 1840)	LC	LC
Crenicichla mandelburgeri (Kullander, 2009)	-	-
Crenicichla ocellata (Perugia, 1897)	-	-
Crenicichla semifasciata (Heckel, 1840)	-	-
Crenicichla vittata (Heckel, 1840)	-	-
Gymnogeophagus balzanii (Perugia, 1891)	-	-
Gymnogeophagus caaguazuensis (Staeck, 2006)	-	-
Gymnogeophagus setequedas (Reis, Malabarba & Pavanelli, 1992)	-	-
Satanoperca pappaterra (Heckel, 1840)	-	-
Australoheros guarani (Říčan & Kullander, 2008)	-	-
Mesonauta festivus (Heckel, 1840)	-	-
SubFamily Pseudocrenilabrinae		
Coptodon rendalli (Boulenger, 1897)	-	LC
Order PLEURONECTIFORMES		
Family Achiridae		
Catathyridium jenynsii (Guenther, 1862)	LC	LC
Catathyridium lorentzii (Weyenbergh, 1877)	LC	LC
S A R C O P T E R Y G I I		
Order CERATODONTIFORMES		
Family Lepidosirenidae		
Lepidosiren paradoxa (Fitzinger, 1837)	-	-

9.2.2.5 Local Characterization (DIA and DAA)

9.2.2.5.1 Sampling, Working Method and Areas of Study

<u>Samples - Terrestrial Fauna</u>

The study was conducted in the areas of influence of the PARACEL pulp mill - the Direct Influence Area (DIA) and the Area Directly Affected (ADA), located in the site known as "Zapatero Cue" Concepción/PY. The municipality is located in the Chaco and Savannah area.

The campaigns were carried out in October 2019 and March 2020, 10 days of sampling, in the early morning hours between 5 and 10 am, and in the afternoon/evening between 4:30 and 10:30 pm. For this purpose, the methodology of non-linear transects was used, making stops in places with greater potential for recording species, transects were recorded with GARMIN 60cs GPS. Direct observations were made, with the help of binoculars, which were recorded in the field notebook and fact sheets for further assistance. To assist in the identification and recording of the species, the Nikon P900 and D800, Canon D80 and Sony hx400v cameras were also used, in addition to recording the vocalizations with the use of the Zoom H1n recorder. Traps were also used: 10 photographic traps, 02 for each transect.

In the areas of influence (AID and ADA) five transects of approximately 2.0 km were chosen, in forest fragments (Semideciduous Forest), savannah areas, protective forest of the Paraguay River and tributary, small portions of forest near the savannah and the pastureland (anthropogenic zone). These points were called T_01 for Transect 1, T_02 for Transect 2, T_03 for Transect 3, inserted in the DAI. For the DAA area you have defined T_04 for Transect 4 and T_05 for Transect 5.

The fragments of Lowland Dense Ombrophilous Forest are secondary forests in an advanced and medium state of regeneration. As in the entire Atlantic Forest Domain, the ecosystems covered by the ecoregion studied are predominantly forest. In addition to the dense lowland forest, transitional vegetation formations, such as coastal mangrove formations and restinga (sandbank) formations, occur in the ecoregion.

Thus, a study terrestrial fauna was carried out by evaluating the numerical richness and abundance of species according to environmental conditions (temperature, relative humidity, rainfall and seasonality) taking into account the five sampling transects.

For the analysis of the data the Shannon Diversity Index was used and from a matrix of species richness and abundance, the calculation of Diversity and Equitability by the Pielou index was done using the Past ver software. 3.24 (HAMMER et al.; 2012). (HAMMER et al.; 2012).

Expected patterns of species accumulation per sampling day were compared between studies and between methods. For this purpose, the richness projection (Jackknife 1 estimator), accumulated per sampling day, was computed analytically (Mao Tau) with 95% confidence intervals, with 100x random, by the EstimateS 9.10 Software (Colwell, 2005) and mapped in curves by means of the plotter.

Ecological analyses such as food guild, habitat, environmental sensitivity, bio-indicators, endemism and degree of threat were also analyzed, which corroborates the understanding of the degree of conservation of the sampled areas.

Sampling - Aquatic fauna

Ichthyofauna surveys were conducted at two sampling points on the Paraguay River near the pulp mill (Figure bellow). The sampling was done in March 2020.

In addition to ichthyofauna, two sampling campaigns of aquatic organisms (Phytoplankton, Zooplankton and Zoobenthos) were carried out, also in two points of the Paraguay River near the pulp mill. The first campaign was carried out on October 17, 2019, in spring, and the second on March 5th, 2020, in summer.

Figure bellow shows the design of the study and sampling areas.

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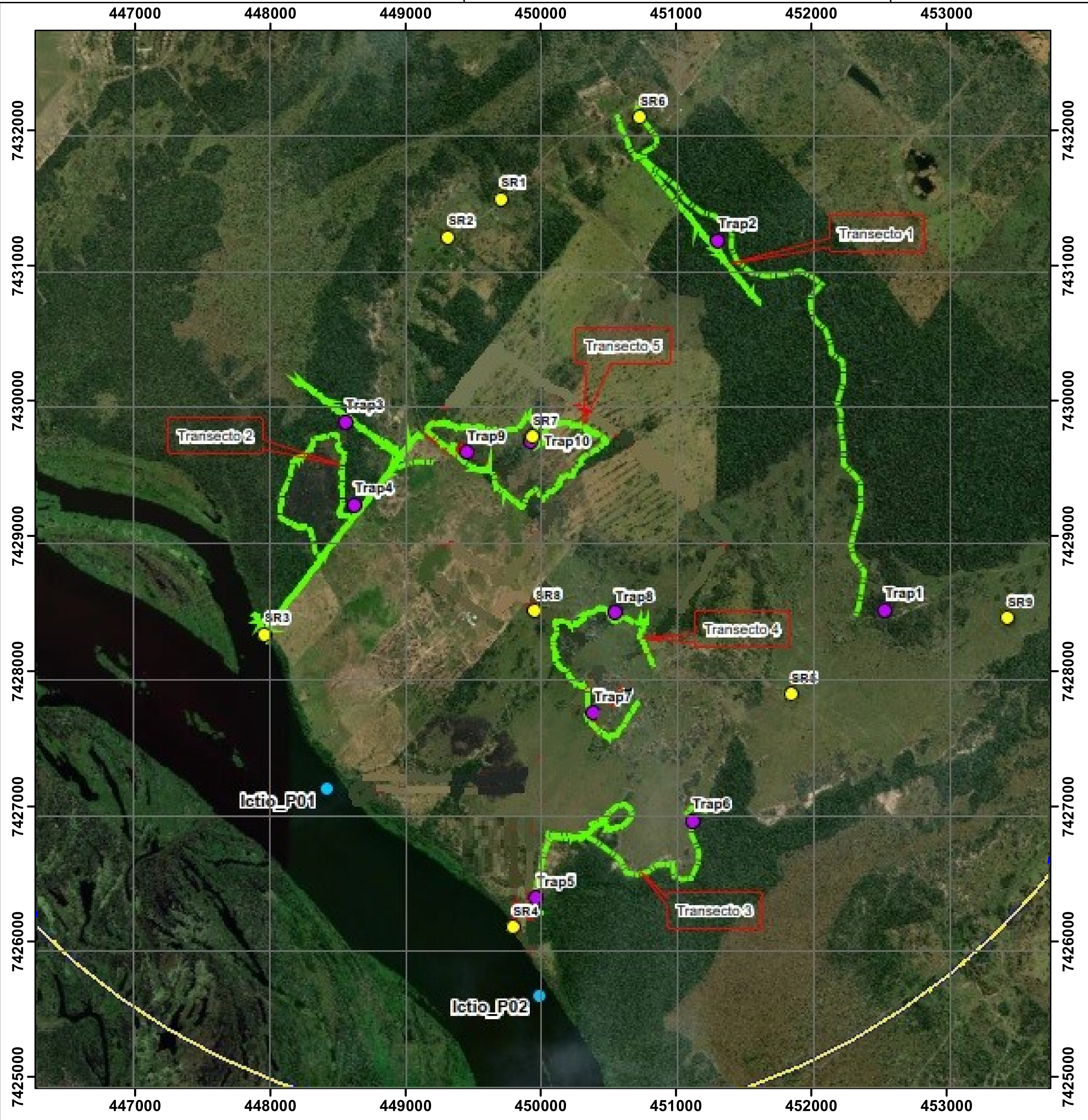
Figure 211 – Design of sampling for terrestrial and aquatic fauna in the areas of influence (DIA and DAA) of the pulp mill.



Sistema de Coordenadas: SIRGAS 2000 - UTM Zona 23S
Projección: UTM - Transversal de Mercator
Datum: SIRGAS 2000

- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos).

Subtitle

DIA

Transections

Camera Trap

Breeding Sites

Ichthyofauna

Monitoring Points

N

0 500 1,000 2,000 Metro

PARACEL PÖYRY

TÍTULO DEL MAPA:
Sampling areas for terrestrial and aquatic fauna

TÍTULO DEL PROYECTO:
BIOTIC ENVIRONMENT - DAA and DIA

PROCESO DE LICENCIA:
PRELIMINARY ENVIRONMENTAL IMPACT STUDY (EIAp-RIMA)

TIPO DE LICENCIA
ENVIRONMENT PROCESS PERMIT

UBICACIÓN	UGHRI
CONCEPCÍON-PAR	CIH8 Aquidaban y CIH18 Rio Pilcomayo

ESCALA:	REVISIÓN:	RESPONSABLE TÉCNICO:	CRBio
1:30.000	25/05/2020	EDUARDO MARTINS Biologo	Nº:26.063/01-D

Methods – Mammal fauna

For the sampling of terrestrial mammal species, medium and large mammal groups were evaluated using non-invasive methods. Five sample transects were carried out, as described above, to obtain direct and indirect records of the mammal fauna. To complement the direct and indirect recording method, 10 photographic traps were installed along the areas of influence of the PARACEL pulp mill.

Direct and indirect observation

The method of direct observation consists of visual (including the carcass) and auditory recording of mammal specimens, while the methods of indirect observation include the recording of tracks, caves and nests, signs, marks, and feces.

Since the majority of wild mammal species have extremely discrete habits, which makes it difficult to see them through direct observation (BECKER & DALPONTE, 1991), an alternative for the diagnosis of wild mammals is the observation of signs of their daily activities, such as food remains, burrows/caves and nests, feces, and tracks (Figure 204 and Figure 205) on the trails (BECKER & DALPONTE, 1991; WEMMER et al., 1996). Since some species of the mammal move along the edges of the drains (where "sand or clay banks" are formed), these areas are considered excellent places for the visualization of footprints and tracks left by medium and large mammals. Therefore, the technique proposed by BECKER and DALPONTE (1991) and WEMMER et al. (1996) focused on these areas.

For data collection, a sampling effort of 8 hours per day has been made for each sampled transect, divided between morning (4h), twilight (2h) and night (2h). With this division of the sampling effort into different periods, we sought to record species with different activity hours and foraging period. The species diagnosed were classified according to the proposals of Wilson and Reeder, 2005

Figure 212 – Indirect recording of the mammal (tracks).

Figure 213 – Indirect recording method (tracks)

Camera Trap

Camera traps are connected to external infrared or mechanical sensors that detect movement and/or thermal variations (CHEIDA & RODRIGUES, 2010). Camera traps are a widely used and effective technique for recording hard-to-see species, especially rare and nocturnal ones, as they allow specimens to be pictured without human interference in a natural environment. This device allows the researcher to have constant access to the presence of animals at the point where it was installed, recording the day and time when it was done, and even at night, when most mammal species are active (CHEIDA & RODRIGUES, 2010).

Six photographic traps were installed in the DIA and four camera traps in the DAA of the PARACEL pulp mill (Figure 206 and Figure 207), in points where the mammal fauna is likely to occur, such as near humid environments and in the interior of forests. The camera traps remained active for 5 consecutive days in the first and second sampling campaigns.

Figure 214 – Installing the Camera Trap.

Figure 215 – Camera trap in the study area.

The UTM (Zone 21K) coordinates of the photographic trap site are in Table below

Table 19 – UTM coordinates of the camera traps for the sampling of mammals in the DIA and DAA of PARACEL pulp mill

TRAP	UTM SIRGAS 2000 Coordinates (Zone 21K)	
	Longitude	Latitude
Trap 1 AID	452521.000	7428507.000
Trap 2 AID	451297.000	7431225.000
Trap 3 AID	448560.000	7429890.000
Trap 4 AID	448626.000	7429278.000
Trap 6 AID	449962.000	7426391.000

TRAP	UTM SIRGAS 2000 Coordinates (Zone 21K)	
	Longitude	**Latitude**
Trap 7 ADA	451108.000	7426955.000
Trap 8 ADA	450383.000	7427752.000
Trap 9 ADA	450541.000	7428491.000
Trap 10 ADA	449454.000	7429665.000

Study Area - Mammals

From Figure 208 to Figure 223 a visual representation of the five sampling transects carried out in the DIA and DAA of the PARACEL pulp mill and the installation points of the camera traps for the sampling of medium and large mammals is shown.

Figure 216 – Aerial image indicating transect 01.

Figure 217 – Transect overview 01.

Figure 218 - Aerial image indicating transect 02.

Figure 219 – Transect overview 02.

Figure 220 – Aerial image indicating transect 02.

Figure 221 – Transect overview 02.

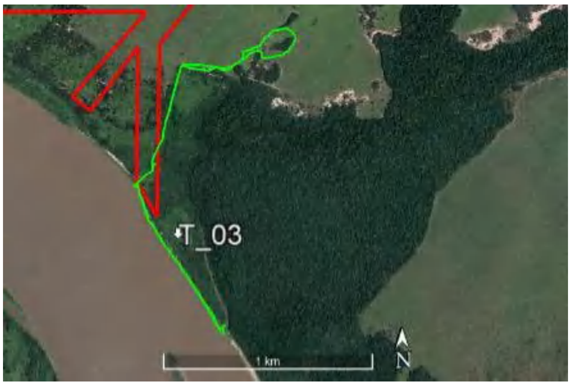


Figure 222 – Aerial image indicating transect 03.

Figure 223 – Transect overview 03.

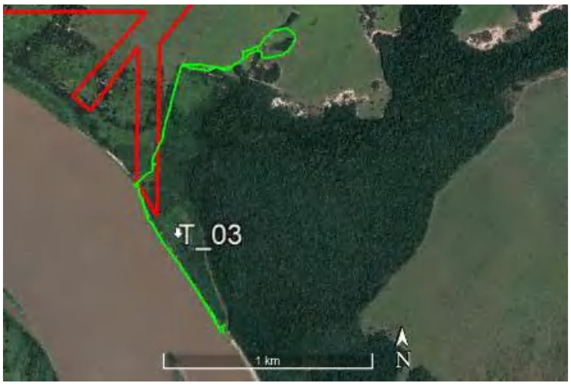


Figure 224 – Aerial image indicating transect 03.

Figure 225 – Transect overview 03.

Figure 226 Aerial image indicating transect 04.

Figure 227 – Transect overview 04.

Figure 228 – Aerial image indicating transect 04.

Figure 229 – Transect overview 04.

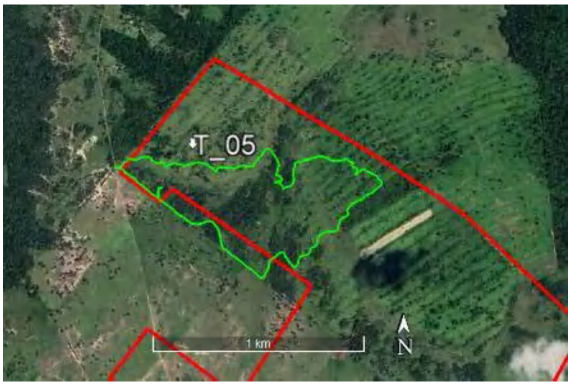


Figure 230 – Aerial image indicating transect 05.

Figure 231 – Transect overview 05.

Data presentation and analysis - Mammals

Richness

Species richness (n) was calculated by the total number of species found in each sampling area (DIA and ADA).

Relative abundance

Relative abundance (RA) represents the number of individuals of a given species at the sampling points, and is represented by N. The calculation of relative abundance was made using the following equation:

A.R. = (n/N).100

where:

n = number of individuals of each species;

N = total number of individuals of all species, represented by N %.

Shannon-Wiener Diversity Index (H')

Measures of diversity consider two factors: species richness and uniformity in the proportional distribution of each species (SEMENSATTO JR., 2003). The Shannon-Wiener (H') diversity index measures the degree of uncertainty in predicting to which species a randomly selected individual will belong from a sample with species n and individuals N. It is calculated with the following formula:

$$H' = -\sum pi.\, log_2 pi \text{ y } pi = \frac{n}{N}$$

where:

H'= Shannon-Wiener diversity index, in bit.ind.^{-1};

pi= Relative Abundance (AR);

n= number of individuals sampled from the species;

N= total number of individuals sampled at the spot or during sampling.

The Shannon-Wiener (H') diversity index was carried out through the *Software Past 3.0.*

Pielou Equitability Index (J')

In ecology, the Equitability Index (J') makes it possible to represent the uniformity of the distribution of individuals among the species existing in a community or sample (PIELOU, 1966). Its value has a range of 0 to 1, and the closer to one, the greater the homogeneity among the species. The Pielou Equitability Index (J') is calculated using the following formula:

$$J' = \frac{H'}{Hmax}$$

where:

Hmax= ln (S);

S= total number of species sampled;

J'= Pielou's Equitability;

H'= Shannon-Wiener Diversity Index.

The Pielou Equitability Index (J') was carried out through the *Software Past 3.0.*

<u>Rarefaction curve</u>

To analyze the efficiency of the sampling campaign it is necessary to estimate the number of species present in the community, and one way to do this is to present a species scarcity curve, which represents the statistical expectation of a species accumulation curve (GOTELLI & COLWELL, 2001). The rarefaction curve (scarcity) is produced by repeated random sampling of the total data set in order to obtain an average of the number of species found in the samples (CHAO, 2004).

Sufficiency of sampling and estimator calculations were performed with the EstimateS Win 8.20 program when three or more species were recorded.

Ecological analysis

For the ecological analysis of the community in this diagnosis, the habitat preference of the studied species, the food levels (guild) present in the community, the relationship with the environment and the degree of synanthropic, the habitat and the period of activity were evaluated.

The species threatened with extinction at the national level have been classified in accordance with MADES Resolution 623/2017. In the case of globally threatened species, the IUCN Red List of Threatened Species was also consulted (IUCN, 2020).

Methods - Birdlife

Transcect Census

For the execution of transect (course) surveys, the observer travels along a path of limited size in controlled time (constant speed) while visually and audibly recording the bird species (Figure 224 and Figure 225). This method also gives priority to recording the greatest number of species, since it samples an area larger than that delimited by the fixed-point method. By covering a greater variety of environments, it is possible to establish a more complete list of bird species in a given study area (ANJOS et al., 2010).

For the study of birdlife, five sample transects (courses) were defined along the DIA and DAA of PARACEL pulp mill, named T_01, T_02, T_03, T_04 and T_05. Each transect is composed of three sections of approximately 500 meters each, totaling 15 sampling sections per campaign. The transect census was conducted at a speed of approximately 1 km/h in each sample section, with a final effort of four hours in the morning, two hours in the afternoon and two hours in the twilight period, making a total of 8 hours of transect census/campaign. Acoustic and visual records were considered at a distance of 20m for each side of the path.

Figure 232 Bird sampling by transect census.

Figure 233 – Notes on bird observations in notebook.

Area of Study - Bird Life

From Figure 226 to Figure 235 is presented the visual representation of the five sampling transects carried out in the AID (T_01, T_02 and T_03) and the DAA (T_03 and T_04) of the pulp mill for the sampling of birds through the census by means of roads.

The sampling grid tried to contemplate all the environmental variation in the area that will suffer the impact, so that most of the local richness was sampled. The areas were selected according to the characteristics of the PARACEL pulp mill, the landscape, the specialist's prior knowledge of the natural history characteristics of the group to be studied and the potential of each environment.

Figure 234 – Aerial image indicating the transect 01.

Figure 235 – Overview of the transect 01.

Figure 236 – Aerial image indicating the transect 02.

Figure 237 – Overview of the transect 02.

Figure 238 – Aerial image indicating the transect 03.

Figure 239 – Overview of the transect 03.

Figure 240 – Aerial image indicating the transect 04.

Figure 241 – Overview of the transect 04.

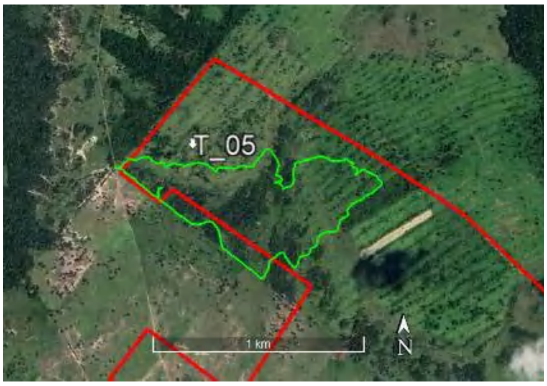


Figure 242 – Aerial image indicating the transect 05.

Figure 243 – Overview of the transect 05.

Data Analysis Presentation – Avifauna

Richness

Species richness (n) was calculated by the total number of species found in each sample.

Frequency of Occurrence

The frequency of occurrence (FO) of each species was determined by the equation FO=Nx100/NT (LINSDALE, 1928), where "N" is the number of sections in which the species was recorded and "NT" is the total number of sections sampled. With the calculation of FO, in percentage, the species were categorized according to Table below.

Table 20 – Abundance class distribution by frequency of occurrence as proposed by Linsdale (1928)

Class of Abundance	Frequency of Occurrence (%)
Very abundant	81 to 100
Abundant	61 to 80
Frequent	41 to 60
Occasional	21 to 40
Rare	1 to 20
Very rare	< 1

Shannon-Wiener Diversity Index (H')

Measures of diversity consider two factors: species richness and uniformity in the proportional distribution of each species (SEMENSATTO JR., 2003). The Shannon-Wiener (H') diversity index measures the degree of uncertainty in predicting to which species a randomly selected individual will belong from a sample with species n and individuals N. It is calculated with the following formula:

$$H' = -\sum pi.\,log_2 pi \text{ y } pi = \frac{n}{N}$$

Where:

H'= Shannon-Wiener diversity index, in bit.ind.$^{-1}$;
pi= relative abundance (AR);
n= number of individuals sampled from the species;
N= total number of individuals sampled at the point or at the sampling.

The Shannon-Wiener (H') diversity index was carried out using the *Software Past 3.0.*

In ecology, the Equitability Index (J') makes it possible to represent the uniformity of the distribution of individuals among the species existing in a community or sample (PIELOU, 1966). Its value has a range of 0 to 1, and the closer to one, the greater the homogeneity among the species. The Pielou Equitability Index (J') is calculated using the following formula:

$$J' = \frac{H'}{Hmax}$$

Where:

Hmax= ln (S);
J' = Pielou's Equitability;
S = total number of species sampled;
H' = Shannon-Wiener diversity index.

The Pielou Equitability Index (J') was carried out through the *Software Past 3.0.*

Scarcity curve

To analyze the adequacy of sampling effort it is necessary to estimate the number of species present in the community, and one way to do this is by presenting a scarcity curve, which represents the statistical expectation of a species accumulation curve (GOTELLI & COLWELL, 2001). The curve is produced by repeated random sampling of the total data set in order to obtain an average of the number of species found in the samples (CHAO, 2004).

Sufficiency of sampling and estimator calculations were performed with the EstimateS Win 8.20 program when three or more species were recorded.

Ecological analysis

For the ecological analysis of the community in this diagnosis, we evaluated the habitat preference of the species studied, the food levels (guild) present in the community, the relationship with the environment and the degree of synanthropic, the habitat and the period of activity.

The species threatened with extinction at the national level have been classified in accordance with MADES Resolution 623/2017. In the case of globally threatened species, the IUCN Red List of Threatened Species was consulted (IUCN, 2020).

Methods - Herpetofauna

The diagnosis has been carried out by a team of specialized biologists in two campaigns of 5 days each. The first campaign took place during the dry period, from 23 to 27 October 2019, and the second during the rainy period, from 4 to 8 March 2019. To comply with the mandate of this study, sampling was carried out in the periods between 8:00 and 11:00 a.m. and resumed at 4:00 p.m., lasting until 11:30 p.m., which represents approximately 52 hours of sampling per campaign and 104 hours in the added campaigns, at the times and periods most conducive to the observation of herpetofauna in the various phytophysiognomies.

Active research and point sampling consisted of visual and audio searches conducted near previously defined sites for inspection of visually accessible microhabitats such as logs, rocks, foliage, bromeliads, hollow trees, and termites (Verdade et al., 2010). The visual and auditory search allows the recording of species with different habits (e.g., tree, aquatic, terrestrial and fossil). It is a very versatile and generalist process of detecting and capturing vertebrates in the field (Crump & Scott-Jr, 1994) and can be carried out in the daytime, twilight and nighttime periods. However, this method depends on the availability of resources (water bodies), as well as on the vocalization activity of the anurans.

Sampling of anurans species was mainly carried out during twilight and night periods (the period of most activity for these animals), in the aquatic environments used as breeding sites and also along trails. The active search was conducted randomly in the environment and the effort employed by the method was measured by the number of hours of search/research. The active search was carried out in the same areas and in different areas during the two campaigns. Interviews were also conducted with residents and nearby neighbors or residents of the sampled areas. They were conducted informally, pointing out the species spontaneously cited by the interviewees and the possible places of occurrence. These species were not included in the analyses, as it is not possible to confirm the identification of the species, since some popular names can be used for several species, so it was not possible to obtain the specific epithet, but rather to get an idea of the animals observed by the residents.

Figure 244 – Twilight search active

Figure 245 – Twilight search active

Figure 246 – Biologist doing the registration of the daytime fauna.

Figure 247 – Biologist making the recording of the nocturnal fauna.

Figure 248 – Biologist doing the registration of the daytime fauna.

Figure 249 – Biologist conducting an active search during the day.

Area of Study - Herpetofauna

The areas sampled were identified: Direct Influence Area (DIA) and Indirect Influence Area (IIA), for the quantitative analysis and to cover a larger area, 9 areas, reproductive sites (called H 01 to H 09) were investigated and 5 transects called T 01 to T 05 (Table bellow) were covered, being these, primary data collected through field searches in the area of the pulp mill and its surroundings. Three methods were used for the study of the herpetofauna: active search, point sampling and interview (Verdade et al., 2010) (the method has no collection or capture).

Table 21 – Description and location of the herpetofauna survey sampling points

Sampling points	Environment description	Sampling Area	Coordinates of sampling points (UTM, 21K - SIRGAS 2000)	
			E	S
H 01	Artificial lake with an environment formed by gramineae and other tree and bush species, with great influence of the cattle farming.	DIA	449701	7431530
H 02	Artificial lake with an environment formed by grasses and other tree and shrub species, with great influence of cattle.	DIA	449314	7431248
H 03	Breeding place located in the Paraguay river with some points that suffer great influence of the aquatic vegetation, and connected to a wide fragment of native vegetation.	DAA	447962	7428329
H 04	Breeding site located on the Paraguay River with some points that are heavily influenced by aquatic vegetation, and connected to a large fragment of native vegetation.	DAA	449790	7426177
H 05	Lake with great presence of native aquatic vegetation, with an environment formed by grasses and other tree and shrub species.	DAA	451835	7427888
H 06	Small temporary natural pool, with an environment formed by grasses and other tree and shrub species.	DIA	450723	7432129
H 07	An artificial lake with an environment formed by grasses and other native tree and shrub species, one of the shores is connected to the native vegetation fragment.	DAA	449935	7429778
H 08	Lake and extensive flooded area, with a large presence of native aquatic vegetation, with an environment formed	DAA	449954	7428504

Sampling points	Environment description	Sampling Area	Coordinates of sampling points (UTM, 21K - SIRGAS 2000)	
			E	S
	by grasses and other native tree and shrub species.			
H 09	Lake and extensive flooded area, with a large presence of native aquatic vegetation, with an environment formed by grasses and other tree and shrub species.	DIA	453423	7428453
T 01	Fragment of forest with presence of native trees, great amount of lianas, abundant burlap and with body of running water in some parts of its interior.	DIA	452387	7429196
T 02	Open area, with abundant grasses, trees and bushes spaced with the presence of some temporary water bodies.	DAA	450018	7430052
T 03	Fragment of forest with the presence of native trees, a large amount of lianas, abundant burlap and with a body of running water in some parts of its interior.	DIA	448311	7429819
T 04	Open area, with abundant grasses, trees and bushes spaced with the presence of some temporary water bodies.	DAA	450372	7427320
T 05	Fragment of forest with the presence of native trees, a large number of lianas, abundant sackcloth	DIA	451343	7430934

The images below are examples of the areas of study.

Figure 250 – Aerial image with visual representation of the point H_01.

Figure 251 – Overview of the Point H_01.

Figure 252 – Aerial image with visual representation of the point H_02.

Figure 253 – Overview of the Point H_02.

Figure 254 Aerial image with visual representation of the point H_03.

Figure 255 – Overview of the Point H_03.

Figure 256 – Aerial image with visual representation of the point H_04.

Figure 257 – Overview of the Point H_04.

Figure 258 – Aerial image with visual representation of the point H_05.

Figure 259 – Overview of the Point H_05.

Figure 260 – Aerial image with visual representation of the point H_06.

Figure 261 – Overview of the Point H_06.

Figure 262 – Aerial image with visual representation of the point H_07.

Figure 263 – Overview of the Point H_07

Figure 264 – Aerial image with visual representation of the point H_08.

Figure 265 – Overview of the Point H_08

Figure 266 – Aerial image with visual representation of the point H_09.

Figure 267 – Overview of the Point H_09

Figure 268 – Aerial image with visual representation of the transect T_01.

Figure 269 – Transect Overview T_01

Figure 270 – Aerial image with visual representation of the transect T_02.

Figure 271 – Transect Overview T_02

Figure 272 – Aerial image with visual representation of the transect T_03.

Figure 273 – Transect Overview T_03

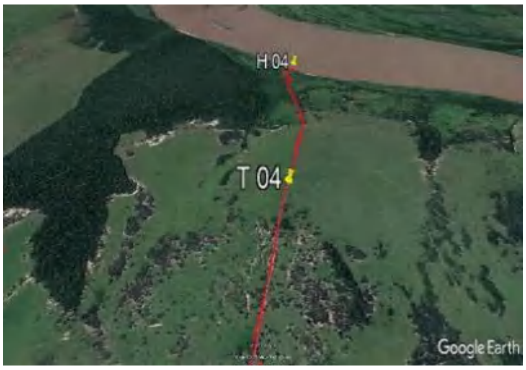


Figure 274 – Aerial image with visual representation of the transect T_04.

Figure 275 – Transect Overview T_04

Figure 276 – Aerial image with visual representation of the transect T_05.

Figure 277 – Transect Overview T_05

Data Presentation and Analysis - Herpetofauna

The registered species of the herpetofauna will be analyzed for their presence in the following lists: Endangered Species of the International Union for the Conservation of Nature (IUCN, 2020), Paraguay List: Resolution n. 433 of 14 August 2019).

The following will be used to describe amphibian and reptile diversity: a) number of individuals, b) observed and estimated species richness, c) Shannon-Wiener diversity index, equitability and dominance.

The taxonomic classification of amphibians will follow Segalla et al. (2016) and that of reptiles will follow Bérnils e Costa (2016).

- Shannon-Wiener diversity index

$$\boxed{H' = -\sum pi.\log_2 pi} \quad \text{y} \quad \boxed{pi = \frac{n}{N}}$$

where:

H' = Shannon-Wiener diversity index, in bit.ind.-1
pi = relative abundance
n = number of individuals sampled from the species
N = total number of individuals sampled at the point

- Equitability Index

This index refers to the distribution of individuals among species, being proportional to diversity and inversely proportional to dominance. The results of equitability vary from 0 to 1, with values above 0.5 indicating that individuals are well distributed among the different species. This index is obtained by the equation:

$$J=H'/H'max$$

Where:

H’ = Shannon index
J = equitability,
H'max = neper logarithm of S.

The Equitability and Shannon indices will be calculated using the *Sotware PAST*.

- Similarity index

- Scarcity Curve and Estimated Richness (Jackknife 1)

The Jackknife1 richness extrapolation index will be used, Shannon will be calculated using a sample with 1,000 randomizations in the *Software EstimateS 9.10* (Colwell, 2013).

An accumulation curve of amphibian and reptile species will be constructed for all areas together.

Methods - Ichthyofauna

Two points were sampled in the mill's area of influence, distributed along the banks of the Paraguay River. The collection methods used were 8 mm trawls along the margin and underneath the macrophytes, 5 bait-armed plastic cages and 20 to 70 mm mesh waiting nets (two nets of each mesh, each 25 meters in total length) were placed in the deepest locations, above 1.5 meters.

Waiting nets and cages were mounted and baited twice a day for 4 days, and were monitored at different times, trawling was carried out during the daytime period at the margins and under the islands of aquatic macrophytes. The effort in sampling hours totaled approximately 32 hours, at each of the 3 collection points adding up the different types of fishing gear. The collected individuals were identified on site, measured, counted, recorded by photograph and returned to the river. The identification was based on the keys and descriptions in the Pantanal fish literature (Britski et al., 2007). The images below are examples of some methods of capturing and processing the captured individuals.

Figure 278 – Withdrawal from the waiting trap.

Figure 279 – Cage trap is being installed near the macrophytes on the river bank.

Figure 280 – Individual processing (metric analysis and photographic recording).

Figure 281 – Cage trap being removed.

Area of Study - Ichthyofauna

The ichthyofauna campaign was carried out at 2 points on the Paraguay River, one point upstream the effluent disposal point and one point downstream the water intake.

Table 22 – UTM coordinates of the ichthyofauna collection points in the first sampling campaign.

Points	UTM Coordinates (SIRGAS 2000) 21K	
P01 – Upstream	448425.00 m E	7427193.00 m S
P02 – Downstream	449983.00 m E	7425672.00 m S

The location of the Ichthyofauna sampling points can be seen in Figure 274 and Figure 275 below.

Figure 282 – Aerial image with visual representation of the point P_01.

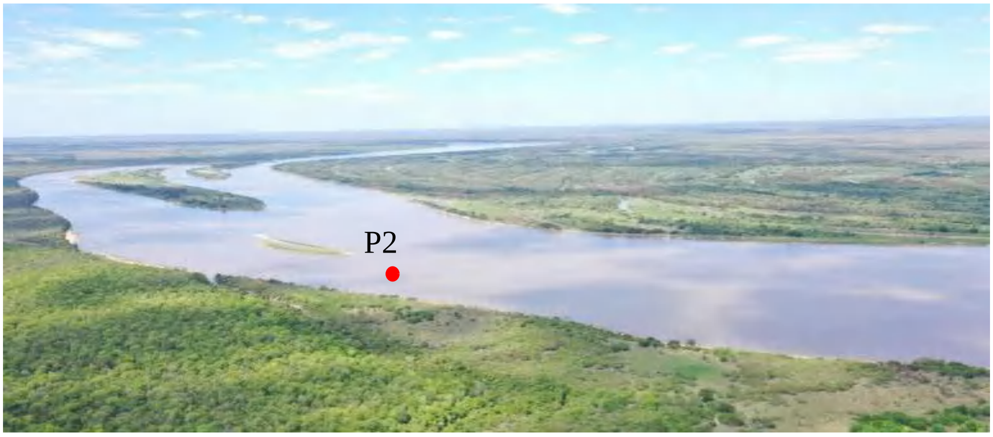


Figure 283 – Aerial image with visual representation of the point P_02

Data Analysis Presentation - Ichthyofauna

The area's ichthyofauna was analyzed with evaluations of rarity, richness, dominance, diversity, and uniformity. The species accumulation curve was developed according to the Mao Tau sampling method (Colwell et al., 2004).

The diversity of the set is addressed by two main components, species richness and equitability, represented by the absolute number of species found, and the relative abundance of these (HSIEH; LI,1998).

Species diversity was estimated using the Shannon index and the "Chao1" estimator used to estimate expected species richness for the site (CHAO et al., 2005). The analyses were carried out in the Software of the previous version 3.1

The classification of species according to their vulnerability to extinction was made considering the Official List of Threatened Fishery Species of the Ministry of Environment of Paraguay and the IUCN (2018). In the same way, species with possible economic interest were identified.

9.2.2.5.2 Results

9.2.2.5.2.1 Mammal fauna

<u>**Richness**</u>

Twenty-two species of mammals were diagnosed, distributed in 16 families in the orders Didelphimorphia, Cingulata, Rodentia, Carnivora and Artiodactyla. With regard to temporality, 19 species of land mammals were recorded during the first season (dry season) in the AID and 8 species in the ADA. For the second campaign (beginning of the rainy season), 15 species were recorded in the AID and 12 in the ADA.

In addition, it should be noted that the second campaign (rainy season) had the registration of three exclusive species, namely *Cavia aperea*, *Myocastor coypus* and *Eira barbara*.

The results obtained in the field represent 12% of the total species recorded by collecting secondary data for the region of the pulp mill, without any exclusive species not included in the regional list being recorded.

It should be noted that the data obtained through the secondary records do not include small mammals and bats. It should also be considered that the works consulted include differentiated sampling efforts, as well as habitats and hydrophilicities not sampled during the present diagnosis.

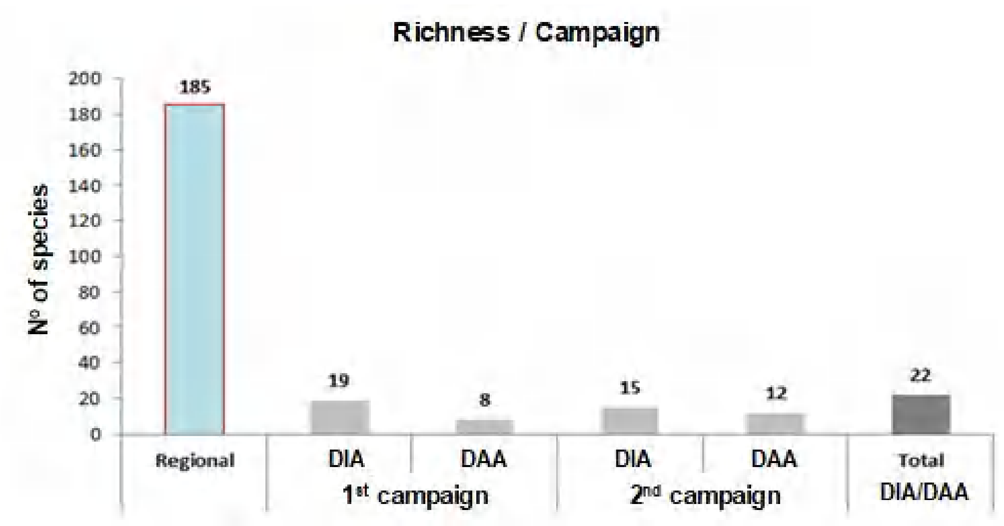


Figure 284 – Species richness of the mammal fauna recorded during the first and second sampling campaigns. SD - secondary data.

The sampling method by indirect observation is responsible for records of n= 15. Of the total 22 sp, 7 species were obtained in records through direct observation, which is expected, although the mammal has discrete habits.

Sampling through the photographic trap generated results of n= 6. An important record through the camera trap was achieved by three species: *M. tridactyla*, *E. barbara* and ‘ in the second season (rainy season).

Abundance

Before presenting data on relative abundance, it is necessary to examine what is meant by the proportion of records of a given method in relation to the actual abundance of the species associated with them. In this regard, Jorge (1986) and Walker et al. (2000) state that the frequency of records does not necessarily represent the actual abundance of the species. Although this statement seems contradictory in relation to the objectives of the present study, it points out one of the main conclusions: the need to apply several methods to access population data. It is therefore necessary to take into account the variation between the rates of obtaining the records analyzed and the actual abundance of the species (Walker et al., 2000).

During the present study, a total of 98 individuals were recorded, 50 in the first campaign and 48 in the second sampling campaign. In general, the most abundant species were: L. gymnocercus, C. thous and D. aurita, also common to all sampling areas. The other species obtained a lower occurrence, but with at least 1 record in one of the transects (**Figure 277**).

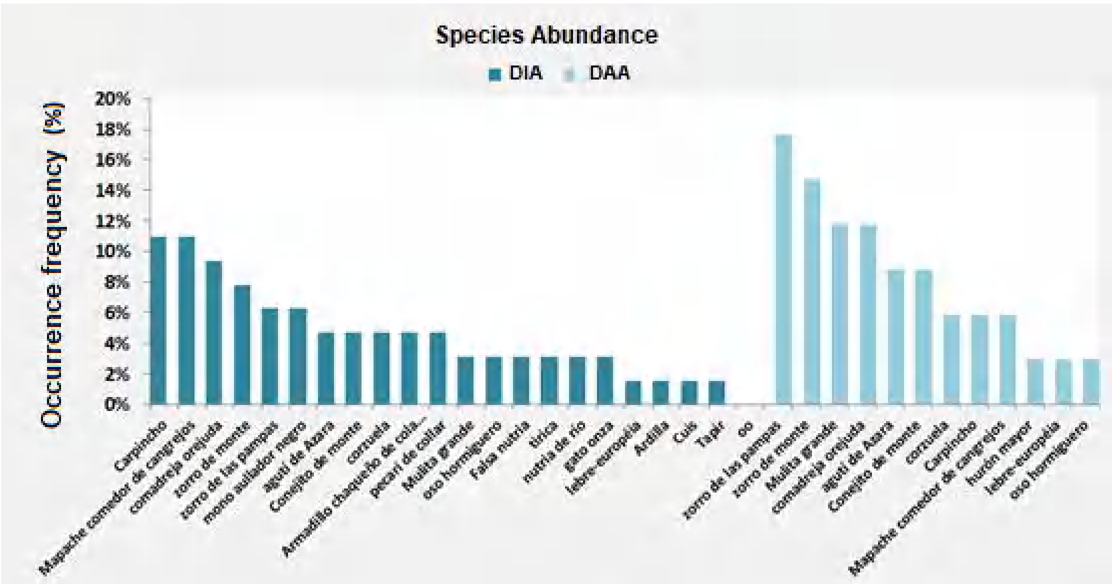


Figure 285 – Absolute abundance of mammals recorded during the first and second sampling campaigns.

Sample efficiency curve

For the analysis of the sampling effort, the rarefaction (scarcity) curve of the observed species (richness) was generated in relation to the sampling effort carried out, using the statistical program EstimateSWin version 9.1.0. The sampling units considered were composed of morning, afternoon and night periods in each transect sampled during two campaigns, making a total of 15 sampling periods. For this study we used the Jackknife 1 richness estimator, which has the function of estimating the accuracy of the statistical sample using subsets of the available data (jackknifing).

Considering the **Figure 278** is then possible to observe that, for the first sampling campaign, the rarefaction curve tends to be asymptotic, which indicates that the sampling effort carried out was satisfactory for the present study. Although the curve shows that the richness obtained was satisfactory, it should be noted that increasing the sampling effort can always result in the recording and a greater number of species. This is evidenced by the advent of the second campaign, which resulted in the registration of 03 exclusive species that had not been previously registered. It is observed that the rarefaction curve obtained for the second campaign has approached the Jackknife 1.

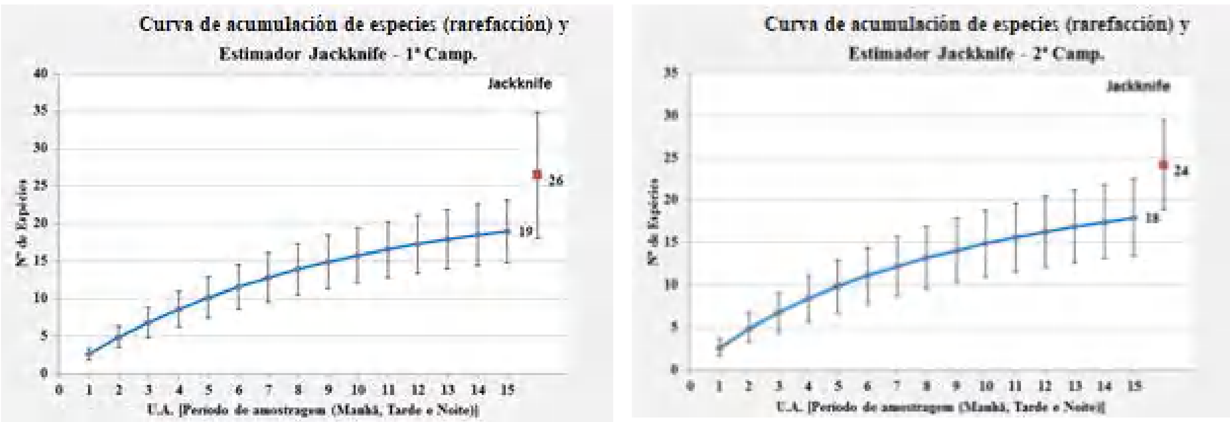


Figure 286 – Rarefaction curve and Jackknife estimator for the first and second sampling campaign.

Analyzing the curve of the two campaigns Figure 279, it can be seen that the mast cell rarefaction curve has not reached its asymptote, however, it shows a slight tendency to stabilize. Thus, a total of 22 species were diagnosed during the present study, with Jackknife 1 estimating the occurrence of 28 species. These results suggest that, with increased sampling effort, more species are expected to be recorded in the areas of interest. Observing the standard deviation of the Jacknife estimator (SD ±4), the effort carried out can be considered satisfactory.

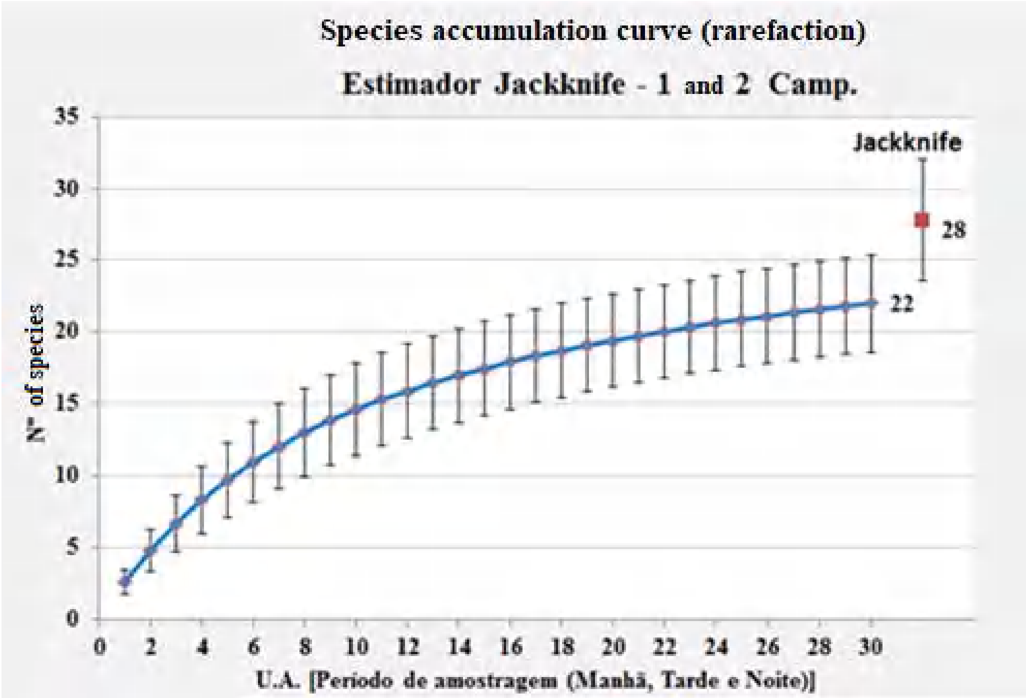


Figure 287 – Sample efficiency curve for the mammal group.

Diversity index

The diversity calculations were performed with the software of the previous version 3.1, using the natural logarithm (base e) and the results are arranged in Table below.

The total diversity of the study area was low, with Shannon H'= 1,931, and showed low equitability, demonstrating the existence of few abundant species in the sample (J'= 0,753).

Table 23 – Species diversity indices of the species diagnosed by transect during the first and second sampling season

Sampling area	Station	Richness observed	Abundance	Shannon Diversity (H')	Pielou (J') Equitability
DIA	1st Campaign	19	40	0.9263	0.9381
ADA		8	10	0.86	0.974
DIA	2nd Campaign	15	24	0.9201	0.9655
ADA		12	24	0.8889	0.936
DIA	**TOTAL**	22	98	2.837	0.9178

Analyzing the areas separately, the first and second campaigns (Figure 280), it can be seen that the DIA in the first campaign obtained the greatest diversity among the others, with the total of H'= 2.71. The lowest diversity was DAA in the first campaign with H'= 2.03. As for the difference by sampling campaign, in the second campaign the richness obtained, comparing the first and second campaigns, increased when exclusive species were recorded. However, if the objective is to verify diversity according to seasonality, the results, in this case, cannot be compared, because in the second campaign, despite the rainy season, the climatic conditions were the same as in the first campaign, because the amount of rain for the period in the region was not satisfactory.

Regarding the Equitability (J'), it can be observed that, in general, the community structure is basically composed of three dominant species. Analyzing the campaigns separately, the equitability shows that there is a certain homogeneity in the distribution of abundance among the species.

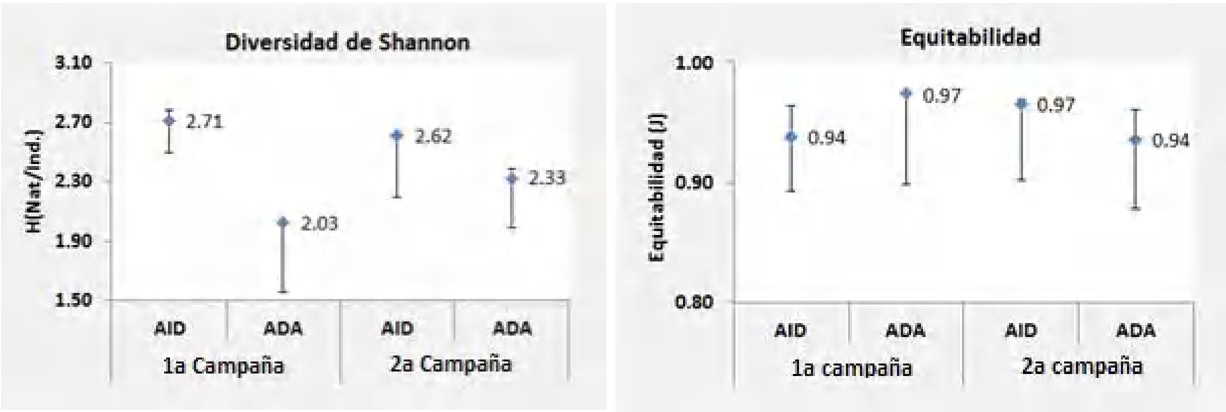


Figure 288 – Shannon Diversity Index (A) and Equivalence (B) for the mammal group during the first and second sampling campaigns.

The table below lists the species of mammal fauna recorded during the first and second sampling campaigns, as well as the categories of threat, habit, guild, period of activity, life area, relationship with the environment, degree of synanthropism and some observations.

Table 24 – List of species of mammal fauna recorded during the first and second sampling period, in October/2019 and March/2020, respectively.

Specie	Popular Name in Paraguay	1st campaign		2nd campaign		General	Record Type		Category of Threat		Habit	Eating Habit	Activity period	Life area	Environment relation	Degree of Sinanthropism	Observation
		AID	ADA	AID	ADA	1st and 2nd campaign	AID	ADA	PY Res. 632 (2017)	IUCN (2021-1)							
Order Didelphimorphia Gill, 1872																	
Family Didelphidae Gray, 1821																	
Didelphis aurita (Wied-Neuwied, 1826)	comadreja orejuda	3	1	3	3	10	OD/ CT	OD/ CT		LC	Arb	Oni	N	1,23 km^2	Eu	Sin	sp abundant
Order Cingulata Illiger, 1811																	
Family Dasypodidae Gray, 1821																	
Dasypus novemcinctus (Linnaeus, 1758)	Mulita grande	1	1	1	3	6	PE	PE		LC	Ter	Oni	C/N	0,03 a 0,15 km^2	Eu	Per	Interest cinegenic
Cabassous chacoensis (Wetzel, 1980)	Armadillo chaqueño de cola desnuda	2		1		3	PE			NT	Fos	Ins	N	3,7 km^2	Es	Per	
Order Xenarthra																	
Family Myrmecophagidae Gray, 1825																	
Myrmecophaga tridactyla (Linnaeus, 1758)	oso hormiguero	1		1	1	3	PE, CT	CT	AM	VU	Ter	Ins	D	9 a 25 km^2	Es	Alo	
Order Primates Linnaeus, 1758																	
Family Atelidae Gray, 1825																	
Alouatta guariba (Humboldt, 1812)	mono aullador negro	3		1		4	OD			VU	Arb	Fru	D	0,45 km^2	Es	Per	
Order Rodentia Bowdich, 1821																	
Family Sciuridae G. Fischer, 1817																	
Guerlinguetus ignitus (Gray, 1867)	Ardilla	1				1	OD			-	Arb	Fru	D	0,014 km^2	Eu	Per	
Family Caviidae G. Fischer, 1817																	
Cavia aperea (Erxleben, 1777)	Cuis			1		1	OD			LC	Ter	Her	D	1,7 km^2	Eu	Per	

Specie	Popular Name in Paraguay	1st campaign		2nd campaign		General	Record Type		Category of Threat		Habit	Eating Habit	Activity period	Life area	Environment relation	Degree of Sinanthropism	Observation
		AID	ADA	AID	ADA	1st and 2nd campaign	AID	ADA	PY Res. 632 (2017)	IUCN (2021-1)							
Hydrochoerus hydrochaeris (Linnaeus, 1766)	Carpincho	4	1	3	1	9	PE, FE	PE, FE		LC	Saq	Her	D	1,74 km^2	Eu	Sin	Interest cinegenic
Family Dasyproctidae Bonaparte, 1838																	
Dasyprocta azarae (Lichtenstein, 1823)	agutí de Azara	1	1	2	2	6	PE	PE		DD	Ter	Her	D	0,085 km^2	Eu	Per	Interest cinegenic
Family Myocastoridae Ameghino, 1904																	
Myocastor coypus (Molina, 1782)	Falsa nutria			2		2	PE			LC	Saq	Her	C/N	2,3 km^2	Es	Per	
Order Lagomorpha Brandt, 1855																	
Family Leporidae G. Fischer, 1817																	
Lepus europaeus (Pallas, 1778)		1			1	2		OD		LC	Ter	Her	D/N	0,2 km^2	Eu	Sin	exotic species
Sylvilagus brasiliensis (Linnaeus, 1758)	Conejito de monte	1	2	2	1	6	OD	CT		EN	Ter	Her	D/N	0,004 km^2	Es	Per	
Order Carnivora Bowdich, 1821																	
Family Felidae G. Fischer, 1817																	
Leopardus pardalis (Linnaeus, 1758)	gato onza	1		1		1	PE	PE		LC	Ter	Car	N	3,5 to 17,7 km^2	Es	Alo	
Leopardus tigrinus (Schreber, 1775)	tirica	2				2			AM	VU	Ter	Car	N	3,5 to 17,7 km^2	Es	Alo	Skin trade
Family Canidae G. Fischer, 1817																	
Cerdocyon thous (Linnaeus, 1766)	zorro de monte	5	1		4	10	OD, PE, CT	OD, PE,CT		LC	Ter	Oni	C/N	10 km^2	Eu	Sin	Skin trade
Lycalopex gymnocercus (G. Fischer, 1814)	zorro de las pampas	2	2	2	4	10	CT	CT		LC	Ter	Car	D/N	10 km^2	Eu	Sin	
Family Mustelidae G. Fischer																	
Eira barbara (Linnaeus, 1758)	hurón mayor				1	1		CT		LC	Ter	Oni	D	2 to 24 km^2	Es	Per	

Specie	Popular Name in Paraguay	1st campaign		2nd campaign		General	Record Type		Category of Threat		Habit	Eating Habit	Activity period	Life area	Environment relation	Degree of Sinanthropism	Observation
		AID	ADA	AID	ADA	1st and 2nd campaign	AID	ADA	PY Res. 632 (2017)	IUCN (2021-1)							
Lontra longicaudis (Olfers, 1818)	nutria de río	1		1		2	OD	PE/OD		NT	Saq	Psic	D	7 to 80 km²	Es	Alo	
Family Procyonidae Gray, 1825																	
Procyon cancrivorus (G. Cuvier, 1798)	Mapache comedor de cangrejos	5		2	2	9	PE	PE		LC	Ter	Oni	N	8 to 50 km²	Es	Per	
Order Perissodactyla Owen, 1848																	
Family Tapiridae Gray, 1821																	
Tapirus terrestris (Linnaeus, 1758)	Tapir	1				1	PE		AM	VU	Ter	Her	C/N	0,04 km²	Es	Alo	
Order Artiodactyla Owen, 1848																	
Family Tayassuidae Palmer, 1897																	
Pecari tajacu (Linnaeus, 1758)	pecarí de collar	3				3	PE			LC	Ter	Fru	D/N	0,24 to 8 km²	Es	Alo	Interest cinegetic
Family Cervidae Goldfuss, 1820																	
Mazama gouazoubira (G. Fischer, 1814)	corzuela	2	1	1	1	5	PE, CT	PE, CT		LC	Ter	Her	D	1,5 km²	Es	Alo	Interest cinegenic

Legend: Threat Categories: Py: Paraguay 2017; IUCN - The IUCN Red List for Threatened Species, version 2020.1. Record Form: E - interview; PE - footprint; TO - covo; OD - direct observation; CT - camera trap. Habitat: ARB - arboreal; ESC - scanned; FOS - semi-fossorial; SAQ - semi-aquatic; TER - terrestrial. Guilda: FRU - frugivore; HER - herbivore; ONI - omnivore; PISC - piscivore. Relationship with the environment: EU - eurieca; EN - stenocetic. Synanthropic Grade: SIN - synanthropic; PER - perianthropic; ALO - allotropic. Activity period: D - daytime; N - nighttime; C/N - twilight and nighttime. Observations (Obs.) - IC - hunting interest; IE - economic interest; CP - skin trade.

Ecological Categories

A. Habitat preference and period of activity

The species have been classified by habitat preference and period of activity according to Sigrist (2012) and Reis et al. Data obtained in the field show that most of the recorded mammals have terrestrial habits (15 sp), 03 tree and semi-aquatic species and only one fossil species, as shown in the figure below.

As for the land representatives, they are found in the area: *D. novemcinctus, M. tridactyla, C. aperea, D. azarae, L. europaeus, S. brasiliensis, L. pardalis, L. tigrinus, C. thous, L. gymnocercus, E. barbara, P. cancrivorus, T. terrestres, P. tajacu y M. gouazoubira.*

Of these, *C. thous* and *D. novemcinctus* have peaks of activity in the twilight and night period, moving in search of food and reproductive activity, while P. cancrivorus moves mainly at night, preferably near aquatic environments. Mammals of preferential daytime activity are represented by *M. tridactyla, A. guariba, G. ignitus, C. aperea, H. hydrochaeris, D. azarae E. barbara, L. longicaudis* and *M. gouazoubira*, which can be considered of great hunting interest since they are commonly hunted for their meat.

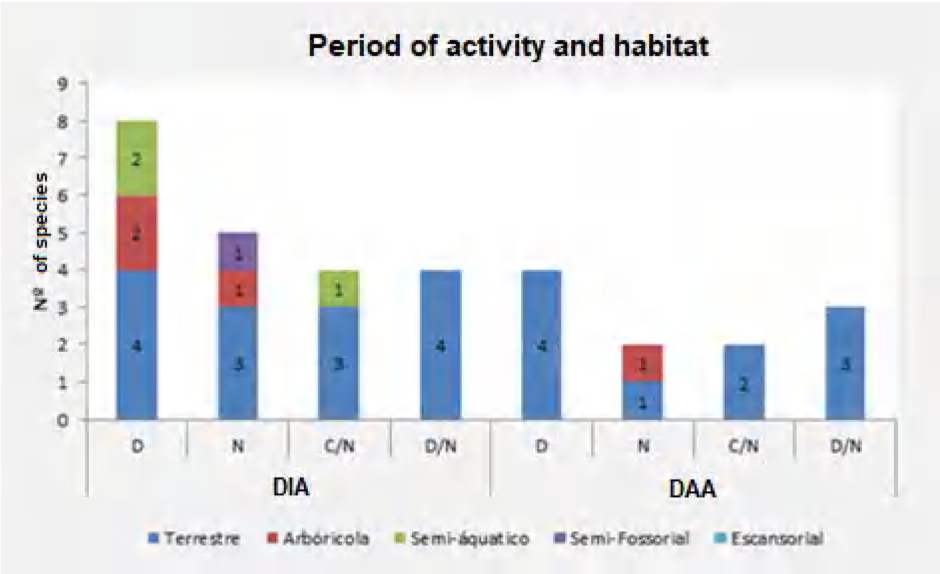


Figure 289 – Distribution of species by period of activity and habitat preference: D - daytime; N - nighttime; C/N - twilight/night; D/N - day/night.

B. Guilds

The study of trophic relationships in communities has been considered an important tool for the implementation of biodiversity conservation measures in tropical environments (Soulé & Simberloff, 1986). However, it is necessary to measure biodiversity not only through censuses of animal and plant species, but also through the study of their population and food interactions, the lack of which may prevent an integrated understanding of ecosystem functioning (Walker, 1992).

Food is an important factor because it influences fertility, development, longevity and mortality. Analysis of the framing of certain species in their respective food guilds can indicate the food supply available in the study environment and reveal whether their trophic structure is balanced.

For the present study, species representing 6 trophic guilds were recorded. Most of the identified mammals belong to the guild of herbivores with 36%, omnivores with 23% of the records, followed by frugivores and carnivores with 14%, insectivores with 9% and piscivores with 5%, as shown in the figure below.

Figure 290 – Eating habits of mammal species.

Omnivorous species are known to exploit more than one trophic category, consuming both plant and animal foods. For this category some of the representatives: *D. albiventris*, o *D. novemcinctus*, *C. thous* and the *P. cancrivorus*.

The herbivorous species represented by, *D. azarae*; *M. gouazoubira* e a *H. hydrochaeris*. According to Sigrist (2012), the cutia (*D. azarae*) is a forest species and is associated with watercourses, feeding on fruits, sprouts and seeds, its habitable area is approximately 2 to 3 hectares. The capybara (*H. hydrochaeris*) is considered the largest rodent in the world and the only species represented by the family Hydrochoerinae. It has semi-aquatic habits and inhabits the most varied environments, preferably consuming grasses and aquatic vegetation, fruits and shoots. The red deer (*M. gouazoubira*) is a generalist, it eats, leaves, shoots and twigs, fruits, and can vary according to the environment and seasonality. Its living area is 1.5 km².

Among those that feed on fruits (frugivores), only coatipuru was observed (*G. ingrami*), which feeds mainly on palm coconut. Carnivorous ocelots (*L. pardalis*) have a diet ranging from small rodents, cycads, lizards, birds and insects. *L. longicaudis* feeds on fishes.

C. Environmental Quality Bioindicator Species

In the neotropics, frugivores constitute a significant portion of the vertebrate biomass (Willis, 1980. Terborg, 1986). This group is particularly vulnerable to seasonal variations in the supply and availability of food (Foster, 1977; Foster, 1982), to structural changes in their habitats, such as the fragmentation or selective elimination of plants that serve as food (Willis, 1979; Howe, 1984).

Many species of neotropical fruit-eating mammals are currently considered to be in danger of extinction (Collar et al., 1992). On the other hand, it is precisely this vulnerability that gives vertebrate frugivores the status of good ecological indicators in the detection of environmental changes (Strahl & Grajal, 1991), or in the planning of conservation measures (Powell & Bjork, 1995). Higher species are also good indicators, since they are structuring species of the food guild.

A. guariba is a forest species considered to be an important seed disperser. It mainly inhabits forests, which are found in different formations of wooded savannahs, semi-deciduous forests and riparian forests (Sigrist, 2012). Given its dependence on forest environments and its important role in maintaining ecosystems, *A. guariba* can be considered a good bioindicator of the quality of the environment.

Among the species diagnosed in the study area are 05 bioindicators of environmental quality.

Table 25 – List of mammal species bioindicators of environmental quality.

Specie	Popular Name in Paraguay	DIA	ADA
Myrmecophaga tridactyla (Linnaeus, 1758)	oso hormiguero	x	x
Leopardus pardalis (Linnaeus, 1758)	gato onza	x	x
Leopardus tigrinus (Schreber, 1775)	tirica		
Lontra longicaudis (Olfers, 1818)	nutria de río	x	x
Tapirus terrestris (Linnaeus, 1758)	Tapir	x	
Pecari tajacu (Linnaeus, 1758)	pecarí de collar	x	
Mazama gouazoubira (G. Fischer, 1814)	corzuela	x	x

D. Endangered species

Threatened species are classified according to the global list (IUCN, 2020-1) and also the classification of Paraguay - Resolution 632/2017.

During the present study 06 species were found to be listed by IUCN (2020-1) in the category of "Near Threatened" (NT), "Endangered" (EN), "Vulnerable" (VU) and "Threatened" (AM) and 03 in the list of Paraguay (Resolution 632/2017) according to the following table.

Table 26 – List of mammal species threatened with extinction.

Specie	Popular Name in Paraguay	Resolution 632/2017	IUCN (2021-1)
Cabassous chacoensis (Wetzel, 1980)	Armadillo chaqueño de cola desnuda		NT
Cabassous chacoensis (Linnaeus, 1758)	oso hormiguero	AM	NT
Sylvilagus brasiliensis (Linnaeus, 1758)	tirica		EN
Leopardus tigrinus (Schreber, 1775)	tirica	AM	VU
Lontra longicaudis (Olfers, 1818)	nutria de río		NT
Tapirus terrestris (Linnaeus, 1758)	Tapir	AM	VU

E. Species of Economic or Hunting Importance

Seven species of hunting interest can be included in this category. *D. novemcinctus* is considered, together with the limpet, the most tasty and appreciated wild animal meat by hunters (Sigrist, 2012). Similarly, *Dasyprocta sp.; H. hydrochaeris and M. gouazoubira* are usually hunted for sport or as a source of food.

C. thous; L. pardalis and L. tigrinus are under hunting pressure to obtain and market their skins.

F. Ecological Valency

In Odum (1977), the term ecological valence is the name given to a species that has the capacity to populate different environments characterized by great variations in ecological factors. According to ecological valence (Margarido, 1994), species are divided into:

Euriecio: species of great ecological value. They can inhabit several environments.

Estenecio: species of little ecological value. It supports a small variation of ecological factors and is restricted to certain environments.

Thus, some species, depending on the level of organization studied, can survive with or without the presence of vegetation, while others only survive with the presence of vegetation, so it is a good tool for the evaluation and classification of the quality of these ecosystems.

The framework of the species is given by the animal's own biology, as well as by the places and natural environmental conditions in which the establishment of populations of these organisms is feasible. Although the habitat is an element of nature, there are also artificial habitats, built by man, or which have suffered from human intervention, and therefore are subject to the increase of the population of a species or community.

For the degree of synanthropism, the following types of species can be distinguished (Margarido, 1994):

Alloanthropic: species that do not tolerate human presence.

Perianthropic: live close to humans with restrictions.

Synanthropic: They live with the humans by adaptation.

Therefore, some species can be considered as bio-indicators of environmental quality. Thus, when species information is crossed, for example, Estenaecium and Aloanthropico, the result is species that are demanding in relation to the environment, resources and not very tolerant to human presence. On the other hand, species such as Euriecio and Synanthropic and even some that are Perianthropic can benefit from changes in the environment due to the implementation of projects considered to have a relevant environmental impact.

The mammal fauna diagnosed in the study area is predominantly composed of species of estenecio considered perianthropic and alloanthropic, with 13 representatives, among these 07 alloanthropic species. Of this total, 9 species are considered euriecio. Therefore, most of the large and medium mammals in the study area can be considered sensitive to environmental changes and with little or no tolerance to human presence.

Table 27 – Relationship with the environmental quality of the species of the registered mammal fauna Legend: red - high; orange - medium; green - low.

Specie	Popular Name in Paraguay	Relationship with environmental quality and the environment
Didelphis aurita Wied-Neuwied, 1826	comadreja orejuda	Euriecio/ Synanthropic
Dasypus novemcinctus Linnaeus, 1758	Mulita grande	Euriecio/ Perianthropic
Cabassous chacoensis Wetzel, 1980	Armadillo chaqueño de cola desnuda	Estenecio/ Perianthropic
Myrmecophaga tridactyla (Linnaeus, 1758)	oso hormiguero	Estenecio / Alloanthropic
Alouatta guariba (Humboldt, 1812)	mono aullador negro	Estenecio / Perianthropic
Guerlinguetus ignitus (Gray, 1867)	Ardilla	Euriecio/ Perianthropic
Cavia aperea (Erxleben, 1777)	Cuis	Euriecio/ Perianthropic
Hydrochoerus hydrochaeris (Linnaeus, 1766)	Carpincho	Euriecio / Synanthropic
Dasyprocta azarae (Lichtenstein, 1823)	agutí de Azara	Euriecio / Perianthropic
Myocastor coypus (Molina, 1782)	Falsa nutria	Estenecio / Perianthropic
Lepus europaeus Pallas, 1778	Liebre	Euriecio / Synanthropic
Sylvilagus brasiliensis (Linnaeus, 1758)	Conejito de monte	Estenecio / Perianthropic
Leopardus pardalis (Linnaeus, 1758)	gato onza	Estenecio / Alloanthropic
Leopardus tigrinus (Schreber, 1775)	tirica	Estenecio / Alloanthropic
Cerdocyon thous (Linnaeus, 1766)	zorro de monte	Euriecio / Synanthropic
Lycalopex gymnocercus (G. Fischer, 1814)	zorro de las pampas	Euriecio / Synanthropic
Eira barbara (Linnaeus, 1758)	hurón mayor	Estenecio / Perianthropic
Lontra longicaudis (Olfers, 1818)	nutria de río	Estenecio / Alloanthropic
Procyon cancrivorus (G. Cuvier, 1798)	Mapache comedor de cangrejos	Estenecio / Perianthropic
Tapirus terrestris (Linnaeus, 1758)	Tapir	Estenecio / Alloanthropic

Specie	Popular Name in Paraguay	Relationship with environmental quality and the environment
Pecari tajacu (Linnaeus, 1758)	pecarí de collar	Estenecio / Alloanthropic
Mazama gouazoubira (G. Fischer, 1814)	corzuela	Estenecio / Alloanthropic

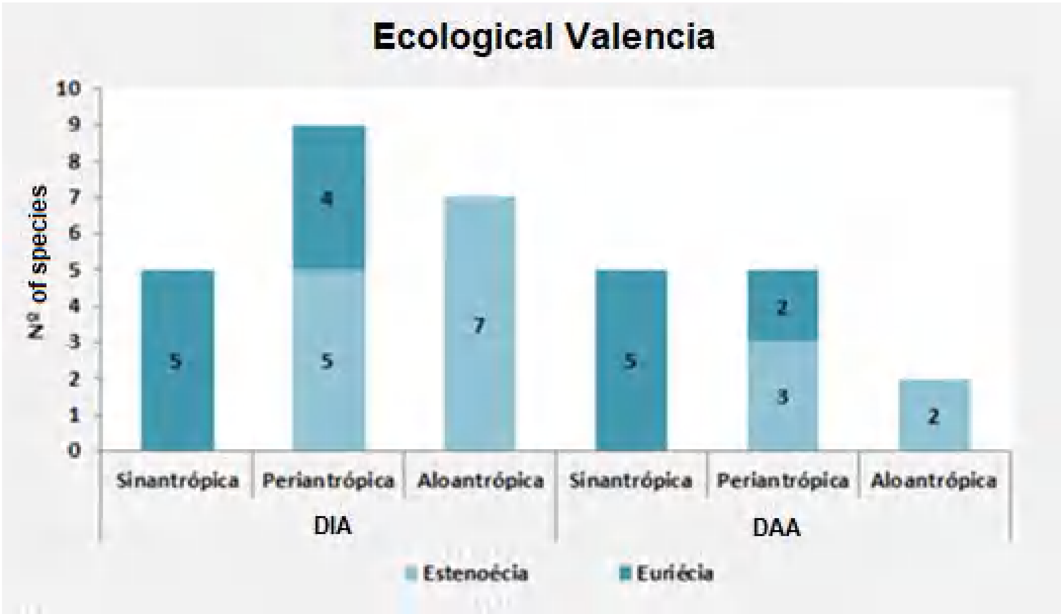


Figure 291 – Ecological value of mammal species diagnosed in the study area.

The following figures present the photographic record of some species of mammals sampled in the study area.

Figure 292 – tracks of *Cerdocyon thous*.

Figure 293 – *Didelphis aurita*.

Figure 294 – tracks of *Didelphis aurita*.

Figure 295 –*Guerlinguetus ignitus*.

Figure 296 – *Didelphis aurita*.

Figure 297 – *Leopardus pardalis*.

Figure 298 – *Lycalopex gymnocercus*

Figure 299 – *Mazama gouazoubira*

Figure 300 – *Dasypus novemcinctus*

Figure 301 – tracks of *Procyon cancrivorus*.

Figure 302 – *Dasypus novemcinctus*.

Figure 303 – *Hydrochoerus hydrochaeris*.

Figure 304 – *Mazama gouazoubira*.

Figure 305 – *Lontra longicaudis*.

Figure 306 – track of *Leopardus pardalis*

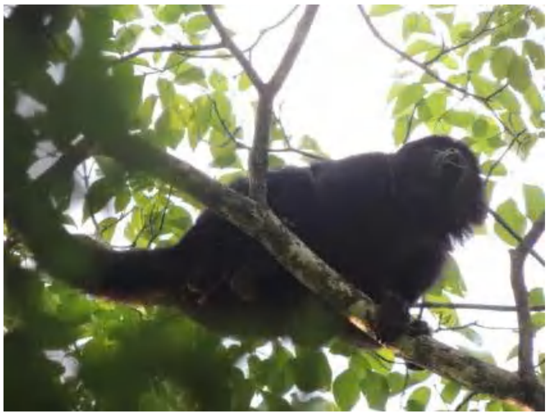


Figure 307 – *Alouatta caraya*

Figure 308 – *Cerdocyon thous*.

Figure 309 – *Pecari tajacu*.

Figure 310 – *Eira barbara*

Figure 311 – *Myrmecophaga tridactyla*

Figure 312 – *Myocastor coypus*

Figure 313 – *Leopardus tigrinus*.

Figure 314 – *Tapirus terrestres*

Figure 315 – *Sylvilagus brasiliensis*.

Final considerations on mammals

Biodiversity is the complex resulting from the variations of species and ecosystems existing in a given region, and its study has a direct importance for the preservation or conservation of species, because, understanding life as a whole, one has more conditions to preserve it.

There are several reasons why there is great interest in measuring diversity, mainly because of its usefulness in conservation biology and environmental assessment. In addition, the assessment of rare species is useful for directing conservation efforts and wildlife monitoring program.

The field studies of the first and second campaigns showed that the direct influence area (DIA) and the area directly affected (ADA) of the pulp mill are predominantly composed of open areas converted to pasture, with portions of forest remnants present under the domain of the savannah biome. However, it is evident that the areas of influence investigated are capable of maintaining species associated with well-structured environments, as is the case of the mammal fauna, which has been highlighted by the presence of stenozoic and alloanthropic species, as well as those threatened with extinction.

The mammals diagnosed in the study area present species that are relatively sensitive to human actions, such as the otter *Lontra longicaudis*, or even species related to forest environments, such as the *Eira barbara*. Specifically, for the site of the mill, euriatic and generalist species predominated, such as *Cerdocyon thous* and the *Dasypus novemcinctus*. It is important to note the presence of threatened mammals in the DIA and ADA, where 06 species are included in the IUCN list (2020-1) "Near Threatened" (NT), "Endangered" (EN), "Vulnerable" (VU) and "Threatened" (AM) and 03 in the national list of Resolution 632/2017.

Fauna Monitoring

The area of influence of the PARACEL pulp mill supports a considerable richness of wildlife, with the remaining forests in the study areas being of key importance for the establishment, maintenance and refuge of wildlife populations. The presence of threatened and endemic species and the strictly forestry habits associated with the remnants in the DIA and DAA indicate the extreme need to monitor the fauna, trying to better understand the effects that may be caused during the implementation and operation phase of the pulp mill. Thus, the Wildlife Monitoring Program aims to identify the possible impacts of the mill on local wildlife, and then propose, schedule and implement appropriate mitigation measures to reduce or eliminate the impacts on wildlife, especially endemic and/or threatened wildlife.

9.2.2.5.2.2 Birdlife

Richness

During the present diagnostic, 1821 individuals of the avifauna were registered, distributed among 181 species, 49 families and 24 orders, using the standardized methodology. The first sampling campaign, in October 2019 (dry season), counted 1001 individuals distributed among 134 species in the DIA and 80 species in the ADA. The second campaign, in March 2020 (rainy season), identified 820 individuals distributed among 89 species in the DIA and 57 species in the DAA of the pulp mill (**Figure 308**).

Among the species recorded, 50.8% correspond to non-passerine birds (n= 92), while 49.2% belong to the order Passeriformes (n= 89). Of the non-passerine birds, the family Psittacidae stood out in relation to the others, with 10 species registered, followed by the families Columbidae (n= 9) and Picidae (n= 8). In the case of the Passeriformes, the families Tyrannidae (n= 27), Thraupidae (n= 14) and Icteridae (n= 9) were the most representative. A high expressivity of the Tyrannidae is already expected, since they constitute the largest taxonomic family of birds in the Neotropics, covering about 18% of the passerines in South America (SICK, 1997).

The data obtained in the field correspond to 37.9% of the species studied by compiling secondary data for the region of the PARACEL pulp mill (n= 477). This difference may be related to the greater range of phytophysiognomies sampled, the use of varied methodologies and the larger time scale in the studies consulted. However, it is worth mentioning the field record of 4 species that do not appear in the secondary list of the region: *Herpsilochmus rufimarginatus*, *Conopophaga lineata*, *Attila phoenicurus*, and *Hylophilus poicilotis*.

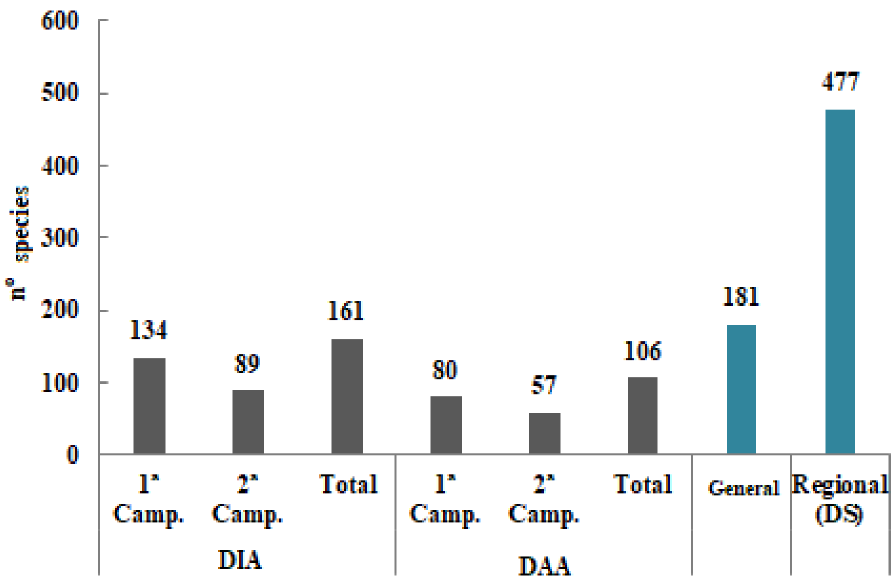


Figure 316 – Bird species richness registered in the DIA and DAA of the PARACEL pulp mill. DS - secondary data.

Abundance

The profile of a few common or dominant species with large numbers of individuals, associated with many rare species with few individuals is characteristic of avifaunal communities in the Neotropics (ODUM, 2009). In general, in nature, for the total number of groups, most of their components are rare (few individuals, small biomass, low productivity or other measure of importance), while few are dominant or common (BARROS, 2007).

Of the 87 species recorded in transect 01 of the DIA from the PARACEL pulp mill, 36.8% (n= 32) were recorded only once and 31% (n= 27) obtained an abundance that varied between 2 and 3 individuals. The most abundant species in the transect was *Psittacara leucophthalmus* with 58 individuals registered. In this case, it shall be noted that *P. leucophthalmus* is a gregarious species, and an encounter with a single band can outnumber isolated taxons. A similar pattern was observed in transect 02, where, of the 85 species found, 29 showed a single individual record, while only three species obtained a relatively high abundance: *Psittacara leucophthalmus*, with 65 individuals; *Thectocercus acuticaudatus*, with 53 individuals and *Amazona aestiva*, with 38 individuals found. In transect 03, of the 106 species recorded, only seven obtained an abundance equal to or greater than 10 individuals, with *Bubulcus ibis*, with 30 individuals found.

For the DAA from PARACEL's Pulp Mill, 56.25% of the 80 species found in transect 04 had an abundance of 1 to 2 individuals. The most abundant species in the transect were *Phacellodomus rufifrons*, with 20 individuals, and *Psittacara leucophthalmus*, with 18 individuals. Finally, for the 05 transect in the ADA, 65% had an abundance less than or equal to two individuals, while only *Psittacara leucophthalmus* had 87 individuals, being considered the most abundant species in the whole study area.

Frequency Occurrence

For the analysis of the distribution of the birds diagnosed in the DIA and DAA of the pulp mill, the frequency of appearance of each species in the sections sampled within the study area was calculated, in order to categorize them into five groups: 1) rare; 2) occasional; 3) frequent; 4) abundant and 5) very abundant (LINSDALE, 1928).

Thus, from the analysis of Figure below, it can be seen that most of the avifauna inventoried has a rare frequency of occurrence, constituting 72% of the records in the DIA and 53% of the records in the ADA. These species have occasional records in some of the sampled sections, which leads to the assumption that their dispersal capacity is relatively lower. Species classified as abundant and very abundant were more represented, and corresponded to those that occur more frequently in the sections sampled. Among them, Psittacara leucophthalmus, Lepidocolaptes angustirostris, Phacellodomus rufifrons and the Tyrannus melancholicus stand out.

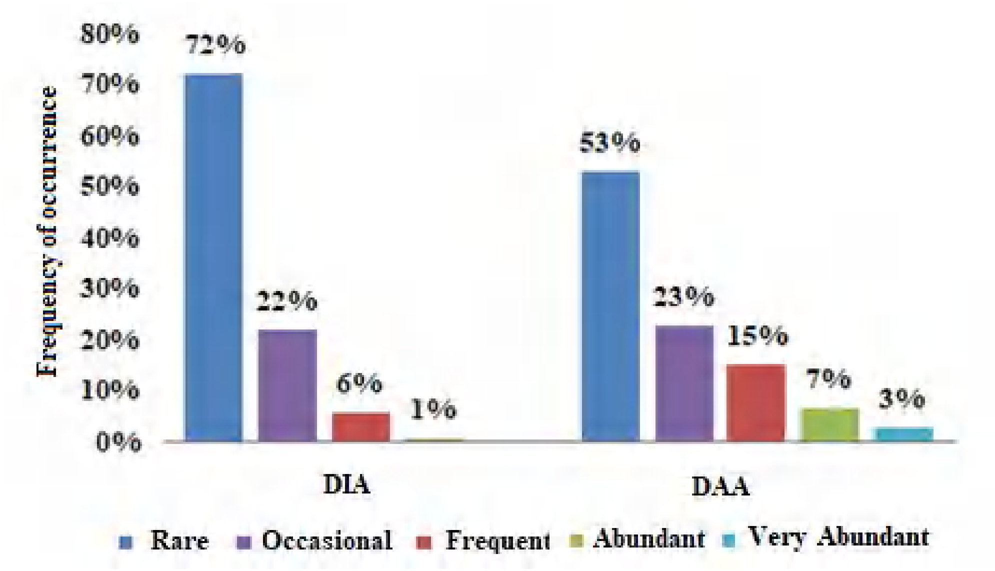


Figure 317 – Frequency of occurrence of bird species in DIA and DAA samples from the pulp mill.

<u>**Sample efficiency curve**</u>

From the analysis of Figure bellow, it can be seen that the sampling efficiency curves generated for the first and second campaigns did not reach their asymptotes, because they have a small tendency to stabilize. For the first campaign, in October 2019, a total of 161 bird species were recorded, and the Jackknife richness estimator estimated the occurrence of 233 species (PD ±29). For the second campaign, in March 2020, a total of 104 bird species were recorded, with the Jackknife estimating 144 species (PD ±17).

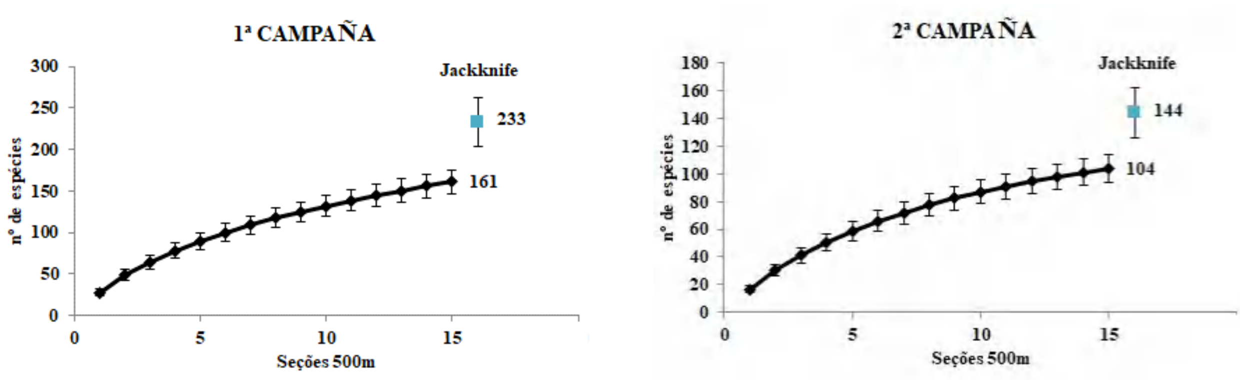


Figure 318 – Rarefaction curve and Jackknife estimator for the first and second sampling campaigns of the present study.

For the total of species studied in the two sampling campaigns (n= 181), it is observed that the rarefaction curve did not reach its asymptote either, estimating the addition of 56 more species (PD ±23) according to the Jackknife richness estimator (Figure 311). Therefore, the results indicate that, with the continuity of the studies, the number of species in the area of interest of the PARACEL pulp mill tends to increase.

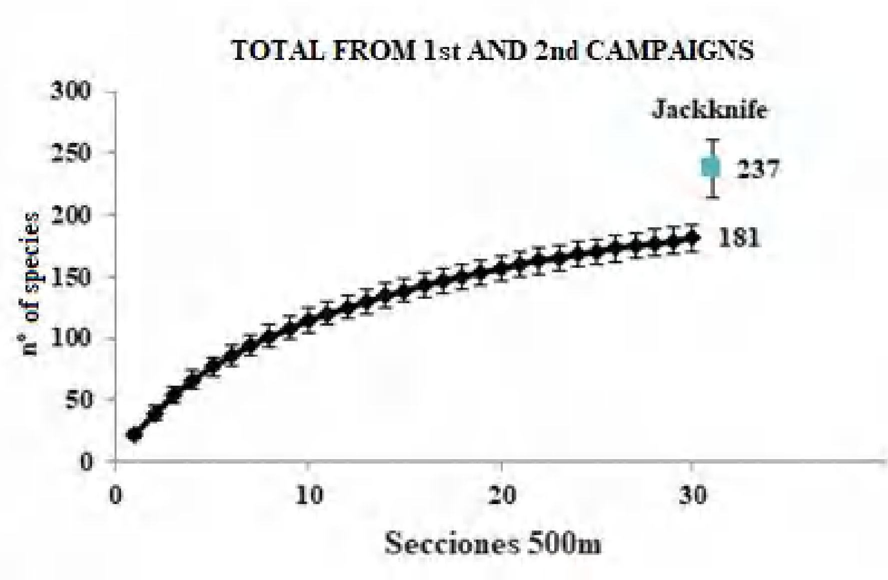


Figure 319 – Rarefaction curve and Jackknife estimator for the total species recorded in this study.

Diversity index

The table below presents the Shannon diversity (H') and Equitability (J') indices for each of the transects and the seasonality in the mill DIA and ADA.

For the PARACEL pulp mill DIA, 161 species were recorded, with a Shannon index showing high diversity for the area (H'= 4.33). Considering the sampling campaigns separately, 134 species were recorded in October 2019 (dry season), with a diversity H'= 4.19. Although sampling in the dry season registered less richness (n= 89) and diversity (H'= 3.91) compared to the rainy season, it was observed that the Shannon diversity index did not show abrupt differences between the campaigns.

For the ADA, there is also a high diversity of birds according to the Shannon index (H'= 3.80). As in the PARACEL pulp mill DIA, the campaign carried out in the dry season resulted in higher bird diversity, with Shannon H'= 3.96. However, records made during the rainy season showed significantly lower diversity (H'= 3.0), probably due to the presence of dominant specimens in the environment, as the Pielou Equivalence Index was low (J'= 0.74).

Table 28 – Shannon Diversity Index (H') and Pielou Equitability Index (J') in the DIA and DAA of the PARACEL pulp mill in the first and second sampling campaigns

Sample Area	Seasoning	Richness	Abundance	Shannon Diversity (H')	Pielou Equitability (J')
	1st Camp. (dry)	134	704	4,194	0,8563
DIA	2nd Camp (rain)	89	480	3,918	0,8729
	Total	161	1184	4,339	0,854
	1st Camp. (dry)	80	297	3,967	0,9053
ADA	2nd Camp. (rain)	89	340	3,021	0,7472
	Total	106	637	3,802	0,8153

The Pielou Equitability (J') shows that the taxonomic community recorded in the DIA and DAA is quite homogeneous, as it is predominantly composed of rare species with few recorded individuals. However, the occurrence of some dominant species is observed through the values presented by the index (J'), especially in the second sampling campaign in the DAA of the PARACEL pulp mill, with low equitability (J'= 0, 74). Among the dominant species found, it is worth mentioning the *Psittacara leucophthalmus*.

The Figure below provides a graphic representation of the Shannon and Equitability indices found during the present study in the DIA and DAA of the PARACEL pulp mill.

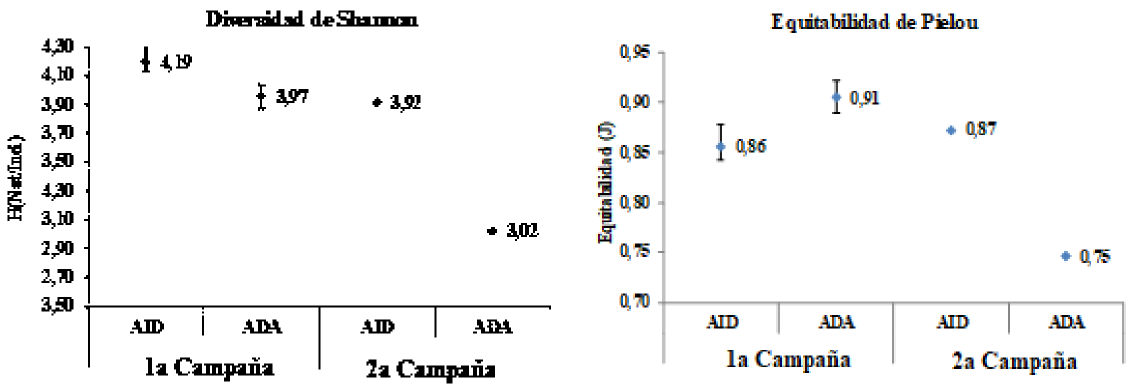


Figure 320 – Shannon Index (left) and Pielou Equitability (right) for the birdlife registered in the DIA and DAA of PARACEL pulp mill.

Ecological Categories

Preference for habitat

Knowledge of habitat preferences or characteristics that bind species and habitat is essential for wildlife management and conservation actions. Habitat preference corresponds to the place of preferential occupation of a given species, however, a bird classified as a forest may occur in open areas or vice versa.

From the analysis of Figure below, it is possible to observe that in both the DIA and the DAA of the pulp mill there is a dominance of bird species that usually inhabit the edges of forests, and correspond to 38% and 39% of the taxonomy inventoried in the DIA and the ADA respectively.

Field and open area birds obtained a similar representativeness to the species classified as forest in the study areas, as shown in Figure 313. Specifically, in the DIA, field and open area species correspond to 27% of the avifauna found, followed by 24% of the forest species. On the other hand, in the DAA of the PARACEL pulp mill 28% of the species are classified as forest, followed by 25% of the open area species.

Birds living preferably in humid environments were less representative, with 11% of the species recorded in DIA, and 8% of the DAA species.

With regard to the species known from the compilation of secondary data for the mill IIA, Figure 313 shows that 31% of the species are classified as forest species, followed by 27% of edge species, 26% of field and open area species, and 15% of wetland species.

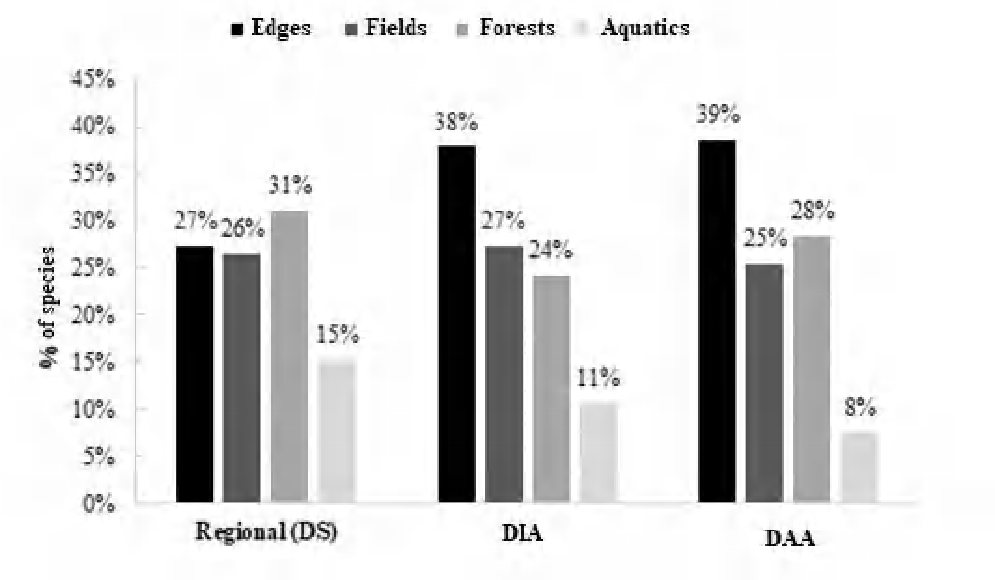


Figure 321 – Distribution of bird species by habitat preference SD - secondary data

Food Guilds

The species diagnosed in the areas of influence of the PARACEL pulp mill during the first and second campaigns were classified according to their food guilds. A food guild is defined as a group of organisms that use resources in a similar way, without considering their taxonomic relationship (JAKSIC, 1981). Thus, food is considered one of the most important aspects for determining the ecological and evolutionary processes within a community. The results obtained for regional and local birdlife are shown in Figure 314.

In the present study, ten categories of guilds were recorded for the diagnosed birdlife community: insectivores, frugivores, omnivores, carnivores, nectarivores, granivores, detritivores, piscivores, necrophages and macrophages. In general, 46% of the avifauna found in the areas of influence is considered insectivorous (n= 83). According to Bierregaard & Stouffer (1997), the high percentage of insectivorous birds is standard for the neotropical region, and the great abundance of small arthropods and insects is a resource used by several bird taxonomic groups. Among the species recorded in the field, the family Tyrannidae obtained the highest number of insectivorous representatives (n= 27), followed by the family Picidae (n= 8).

In the sequence, the most representative guild was that of omnivores, with 19% of the taxons inventoried (n= 34), highlighting the families Icteridae (n= 6) and Tinamidae (n= 5). Among the species included in this category, it is worth noting the registration in the DIA of the Rheidae, a specie typical of the pampas, closed and open forests of the Chaco (SICK, 1993). The American Rhea is classified as "Near Threatened" according to the IUCN global list (2020).

Birds have the largest number of frugivorous species in the Neotropics, with families highly dependent on fruits, such as Cracidae and Cotingidae, and others less dependent, such as Emberezidae and Tyrannidae (FADINI & MARCO JR., 2004). The fruit-eating guild indicates integrity to remaining native formations, as some fruit-eating species act as important seed dispersers (PHILLIPS, 1997). In general, frugivorous birds were represented by 10% in the areas of influence of the PARACEL pulp mill (n=18), with the Psittacidae family being the most representative in this category (55%). With respect to data obtained from literature on birds in the IIA of the pulp mill, a profile similar to that observed in the field is observed, with a predominance of insectivorous birds (47%), followed by omnivores (17%), frugivores (11%), carnivores (10%), granivores (7%) and piscivores (4%), as shown in Figure 314.

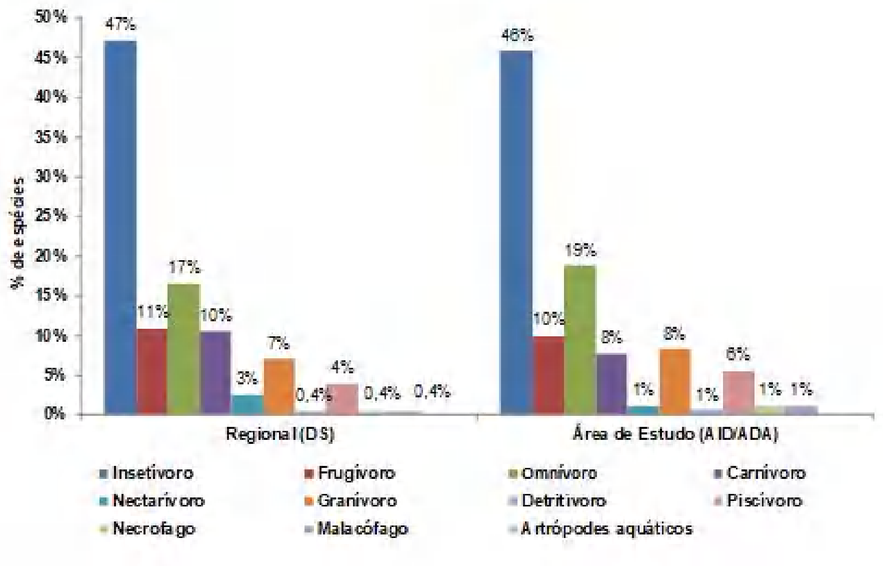


Figure 322 – Distribution of bird species by guild SD - secondary data.

Sensitivity

Using the sensitivity classification of Stotz et al (1996) as a database, the proportion of sensitive species in relation to changes in the environment was analyzed. From the analysis of Figure 315 it is possible to observe that both the DIA and the DAA of the PARACEL pulp mill have a predominance of species with low sensitivity to anthropic actions, with 67% and 70% of representativeness, respectively. These species have great plasticity (resistance) in terms of the impacts caused by anthropic activities and have a great capacity to adapt to modified environments (SICK, 1997).

Next, birds of average sensitivity obtained the second highest representation in the sample areas, with 31% of the total for DIA and 29% for ADA. Among the species included in this category is the Deville's Parrot (Pyrrhura devillei), classified as "near threatened" at the global level (IUCN, 2020). In the case of highly sensitive birds, one species was observed in the ADA, the Arasari Caripard (Pteroglossus castanotis); and two species in the ADA, the Yellow-billed Woodpecker (Piculus chrysochloros) and the Grey-headed Attila (Attila phoenicurus). It should be mentioned that Attila phoenicurus is classified as an "endangered species" by Resolution 254/2019 of the Ministry of the Environment and Sustainable Development of Paraguay.

As for the regional birdlife recorded through the compilation of secondary data, it was obtained that 51% of the bird species have a low sensitivity, followed by 41% of the medium sensitivity species and, to a lesser extent, 4% of the high sensitivity species. It should also be noted that, of the total species studied, 3% have no information on the level of sensitivity in the literature consulted.

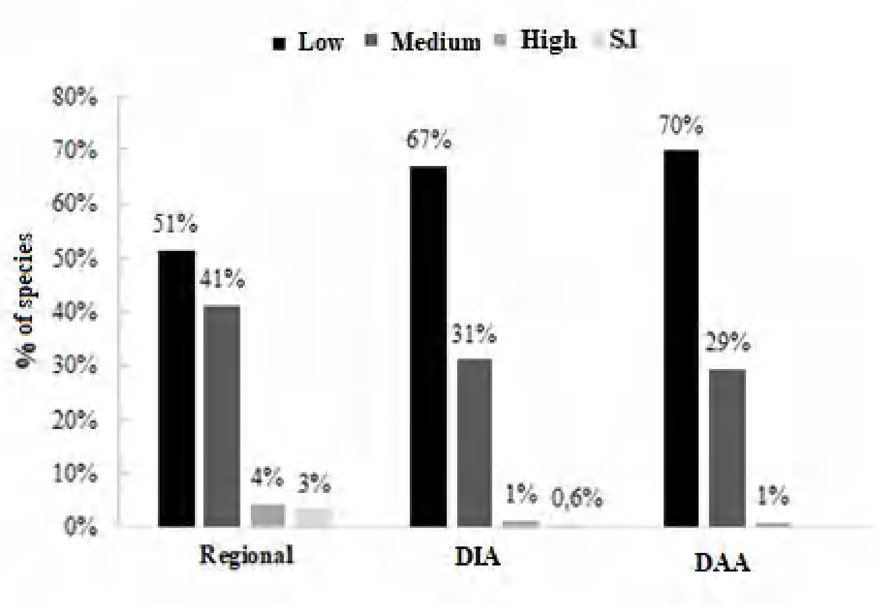


Figure 323 – Distribution of bird species by degree of sensitivity to environmental changes S.I - no information.

Bio-indicator species

Integral biological communities in need of conservation efforts can be identified through organisms considered bio-indicators, which play an important role in guiding mitigation measures. These indicator species fall into four main categories: 1) they are usually present in one or a few habitats; 2) they are relatively common; 3) they are easily detected; and 4) they are highly sensitive to environmental disturbances. Parker et al (1996) identified a group of bird species in the Chaco region that meet the requirements of the indicator, including 14 in Paraguay (GUYRA PARAGUAY, 2004).

Based on the 14 species listed in the literature (GUYRA PARAGUAY, 2004), none were identified in the areas of influence of the pulp mill during this assessment.

Rare species

For the classification of rare species, the list of Paraguayan avifauna species available in the global database Avibase (2017) was consulted.

A rare bird species was recorded in the AID of PARACEL's pulp mill, the *Attila phoenicurus*. The species can be found in the middle level and canopy of humid and secondary forests (RIDGELY & TUDOR, 1994). Its breeding period, between October and March (NACIF et al., 2018), occurs mainly in the Atlantic Forest of southeastern Brazil. Between March and September, the transition period is observed, when the species moves through central Brazil and the extreme north-east of Argentina, eastern Paraguay and Bolivia, until it reaches the wintering grounds in the north of the Brazilian Amazon and south-west Venezuela (GARCÍA et al., 2016). Given the scarce presence of *A. phoenicurus* in eastern Paraguay during the transition period, the species is considered locally rare.

Migratory species

During the present diagnosis, two species of migratory birds from the northern hemisphere were recorded: *Pluvialis dominica* and *Bartramia longicauda*.

Pluvialis dominica is a long-distance migratory bird that carries out one of the longest migrations in the world, traveling from its wintering grounds in southern South America to its breeding grounds on the tundra in North America. The migration takes place annually, when the bird migrates south between the months of September and November along the Atlantic Ocean, returning north through the center of the continent during the months of February to April (JOHNSON & CONNORS, 2010). Individuals generally arrive at their breeding grounds in northwestern Canada to northern Alaska between May and June (JOHNSON & CONNORS, 2010).

Bartramia longicauda is a specie that migrates long distances twice a year, covering up to 14,000 km from its breeding grounds in North America to wintering grounds in South America (HOUSTON & BOWEN, 2001; BLANCO & LÓPEZ-LANÚS, 2008). *B. longicauda* breeds in central North America and Alaska, and winters in southern South America, mainly in northwestern Argentina, Uruguay, Paraguay, southern Brazil and eastern Bolivia (BARROS, 2014).

Endangered, endemic or exotic species

The endangered species were classified in accordance with MADES Resolution 254/2019 of Paraguay and the IUCN global list (2020). Thus, seven species included in the above-mentioned lists were identified in the areas of influence of the PARACEL pulp mill, as set out in Table bellow.

Among the threatened birds, the presence of two species of undergrowth foraging and, therefore, dependent on the integrity of the forest should be highlighted: *Conophophaga lineata* and *Mionectes rufiventris*. Habitat loss and fragmentation, associated with a decline in environmental quality, characterize the main causes of the threat to these species.

The *Conopophaga lineata* is an insectivorous passerine that feeds on the understory of tropical and temperate forests in South America (SIGRIST, 2005), from Paraguay and northeast Argentina to northeast Brazil (SICK, 1997), and is common to the Atlantic Forest. Its wide distribution throughout the Atlantic Forest, generally in high abundance and easy to capture in mist nets, makes this species an important tool for studies on the effect of forest fragmentation in the Neotropics (DANTAS, et al., 2009).

Mionectes rufiventris is a tyranid found in Argentina, Brazil and Paraguay (STOTZ et al. 1996, SICK 1997). The species occurs in mixed groups (DEVELEY & PERES, 2000) both in tropical or subtropical lowland rainforests (MACHADO & FONSECA, 2000), and in mountain rainforests (BROOKS et al., 1999). Aguilar et al. (2000) considered *M. rufiventris* as a specie dedicated in nest building, all of them built under stream beds, fixed to the roots of trees. The high specificity of the nest site demonstrated by *M. rufiventris* denotes the importance of preserving stream beds and their associated forests (AGUILAR et al., 2000). However, it should be noted that, at present, the biology and behavior of the species are little explored.

Table 29 – Registered bird species threatened with extinction in the DIA and DAA of the Pulp Mill.

Taxon	Popular Name in Paraguay	PY (2019)	IUCN (2020)	Register
Rhea americana	Ñandú Común	-	NT	DIA
Pyrrhura devillei	Cotorra de Deville	AM	NT	DIA/ADA
Conopophaga lineata	Jejenero Rojizo	AM	LC	DIA
Mionectes rufiventris	Mosquero Ladrillito	AM	LC	DIA
Attila phoenicurus	Atila Cabecigrís	AM	LC	DIA
Hylophilus poicilotis	Verdillo Coronado	AM	LC	ADA
Cyanocorax cristatellus	Chara Crestada	AM	LC	DIA/ADA

Threat Categories: PY 2019 - Resolution n. 254/2019 of the Ministry of Environment and Sustainable Development (MADES, Paraguay). IUCN 2020 - The IUCN Red List of Threatened Species, version 2020-1 Legend: AM - threatened with extinction; NT - near threatened; LC - of little concern.

For the analysis of the endemic species of the Chaco, it was necessary to use the literature composed by Short (1975), Cracraft (1985) and Parker et al. (1996), which recognized 18 endemic species registered in Paraguay. Of these, two were diagnosed in the areas of influence of the pulp mill: *Ortalis canicollis* and *Xiphocolaptes major*.

The *Ortalis canicollis* is a forest cricket from southwestern South America and is found in the Chaco from eastern Bolivia to western Paraguay and northern Argentina (SICK, 1997), being relatively abundant (CAZIANI & PROTOMASTRO, 1994). According to Caziani and Protomastro (1994), *Ortalis canicollis* is the only year-round seed disperser in the Chaco. This fact highlights the importance of the ecological service provided by the specie, since seed dispersal allows for the integrity and regeneration of the forests.

With respect to exotic birds, one species was recorded in the DIA of PARACEL pulp mill, *Bubulcus ibis*. Native to the African continent, in its natural habitat the species lives associated with herds of large herbivores in the savannahs (BLAKER, 1969; DEAN & MACDONALD, 1981). Cattle Egret invaded the American continent at the end of the 19th century and, in both the American and African continents, has been expanding from the equatorial regions to higher latitudes (CROSBY, 1972; TELFAIR, 1993; VICENT, 1947).

Below is a list of the bird species recorded during the first and second sampling campaigns, followed by ecological data on food guilds, endemism, sensitivity, habitat and migratory habits. The categories of threat were based on MADES Resolution 254/2019 (Paraguay) and the IUCN Global List of Threatened Species 2020-1.

Table 30 – List of bird species recorded during the first and second sampling campaigns in October/2019 and March/2020.

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Order Rheiformes Forbes, 1884										
Family Rheidae Bonaparte, 1849										
Rhea americana (Linnaeus, 1758)	Ñandú Común	X			NT		B	ONI	C	
Order Tinamiformes Huxley, 1872										
Family Tinamidae Gray, 1840										
Crypturellus undulatus (Temminck, 1815)	Tinamú ondeado	X	X		LC		M	ONI	F	
Crypturellus parvirostris (Wagler, 1827)	Tinamú piquicorto	X	X		LC		B	ONI	F	
Crypturellus tataupa (Temminck, 1815)	Tinamú Tataupá	X			LC		B	ONI	F	
Rhynchotus rufescens (Temminck, 1815)	Tinamú alirrojo	X	X		LC		B	ONI	C	
Nothura maculosa (Temminck, 1815)	Tinamú chaqueño	X			LC		B	ONI	C	

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Order Anseriformes Linnaeus, 1758										
Family Anhimidae Stejneger, 1885										
Chauna torquata (Oken, 1816)	Chajá Común	X			LC		B	ONI	A	
Family Anatidae Leach, 1820										
Dendrocygna autumnalis (Linnaeus, 1758)	Suirirí Piquirrojo	X			LC		B	ONI	A	
Amazonetta brasiliensis (Gmelin, 1789)	Pato Brasileño	X	X		LC		B	ONI	A	
Order Galliformes Linnaeus, 1758										
Family Cracidae Rafinesque, 1815										
Ortalis canicollis (Wagler, 1830)	Chachalaca Charata		X		LC	CH	B	FRU	F	
Order Suliformes Sharpe, 1891										
Family Phalacrocoracidae Reichenbach, 1849										
Nannopterum brasilianus (Gmelin, 1789)	Cormorán Biguá	X			LC		B	PISC	A	
Family Anhingidae Reichenbach, 1849										
Anhinga anhinga (Linnaeus, 1766)	Anhinga Americana	X			LC		M	PISC	A	
Order Pelecaniformes Sharpe, 1891										
Family Ardeidae Leach, 1820										
Tigrisoma lineatum (Boddaert, 1783)	Avetigre Colorada	X			LC		M	CAR	A	
Butorides striata (Linnaeus, 1758)	Garcita Verdosa	X	X		LC		B	PISC	A	
Bubulcus ibis (Linnaeus, 1758)	Garcilla Bueyera	X			LC	EX	B	PISC	A	
Ardea cocoi Linnaeus, 1766	Garza Cuca	X	X		LC		B	PISC	A	
Ardea alba Linnaeus, 1758	Garceta Grande	X	X		LC		B	PISC	A	
Syrigma sibilatrix (Temminck, 1824)	Garza Chiflona	X	X		LC		M	INS	C	
Family Threskiornithidae Poche, 1904										
Theristicus caerulescens (Vieillot, 1817)	Bandurria Mora	X			LC		SI	MAL	A	
Theristicus caudatus (Boddaert, 1783)	Bandurria Común	X			LC		B	ONI	C	

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Platalea ajaja Linnaeus, 1758	Espátula Rosada	X			LC		M	PISC	A	
Order Cathartiformes Seebohm, 1890										
Family Cathartidae Lafresnaye, 1839										
Cathartes aura (Linnaeus, 1758)	Aura Gallipavo	X	X		LC		B	NECR	F	
Cathartes burrovianus Cassin, 1845	Aura Sabanera		X		LC		M	DET	F	
Coragyps atratus (Bechstein, 1793)	Zopilote Negro	X			LC		B	NECR	C	
Order Accipitriformes Bonaparte, 1831										
Family Accipitridae Vigors, 1824										
Chondrohierax uncinatus (Temminck, 1822)	Milano Picogarfio	X			LC		M	CAR	C	
Harpagus diodon (Temminck, 1823)	Milano Muslirrufo	X			LC		M	CAR	C	
Ictinia plumbea (Gmelin, 1788)	Elanio Plomizo	X			LC		M	INS	C	
Rostrhamus sociabilis (Vieillot, 1817)	Caracolero Común		X		LC		B	MAL	A	
Heterospizias meridionalis (Latham, 1790)	Busardo Sabanero	X	X		LC		B	CAR	C	
Urubitinga urubitinga (Gmelin, 1788)	Busardo Urubitinga	X			LC		M	CAR	F	
Rupornis magnirostris (Gmelin, 1788)	Busardo Caminero	X	X		LC		B	CAR	B	
Order Eurypygiformes Furbringer, 1888										
Family Rallidae Rafinesque, 1815										
Aramides ypecaha (Vieillot, 1819)	Cotara Ipacaá	X	X		LC		M	ONI	F	
Order Charadriiformes Furbringer, 1888										
Family Charadriidae Leach, 1820										
Vanellus chilensis (Molina, 1782)	Avefría Tero	X	X		LC		B	INS	C	
Pluvialis dominica (Statius Muller, 1776)	Chorlito Dorado Americano	X			LC		B	INS	A	VN

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Family Scolopacidae Rafinesque, 1815										
Bartramia longicauda (Bechstein, 1812)	Correlimos Batitú		X		LC		B	INS	A	VN
Family Jacanidae Chenu & Des Murs, 1854										
Jacana jacana (Linnaeus, 1766)	Jacana Suramericana	X	X		LC		B	INS	A	
Order Columbiformes Latham, 1790										
Family Columbidae Leach, 1820										
Columbina talpacoti (Temminck, 1811)	Columbina Colorada	X	X		LC		B	GRAN	B	
Columbina squammata (Lesson, 1831)	Tortolita Escamosa	X	X		LC		B	GRAN	B	
Columbina picui (Temminck, 1813)	Columbina Picuí	X	X		LC		B	GRAN	B	
Claravis pretiosa (Ferrari-Perez, 1886)	Tortolita Azulada	X	X		LC		B	GRAN	B	
Patagioenas picazuro (Temminck, 1813)	Paloma Picazuró	X	X		LC		M	FRU	B	
Patagioenas cayennensis (Bonnaterre, 1792)	Paloma Colorada	X			LC		M	FRU	F	
Zenaida auriculata (Des Murs, 1847)	Zenaida Torcaza	X	X		LC		B	GRAN	B	
Leptotila verreauxi Bonaparte, 1855	Paloma Montaraz Común	X	X		LC		B	GRAN	F	
Leptotila rufaxilla (Richard & Bernard, 1792)	Paloma Montaraz Frentiblanca	X			LC		M	GRAN	F	
Order Cuculiformes Wagler, 1830										
Family Cuculidae Leach, 1820										
Piaya cayana (Linnaeus, 1766)	Cuco-ardilla Común	X			LC		B	INS	F	
Coccyzus melacoryphus Vieillot, 1817	Cuclillo Canela		X		LC		B	INS	F	
Crotophaga major Gmelin, 1788	Garrapatero Mayor	X	X		LC		B	ONI	C	
Crotophaga ani Linnaeus, 1758	Garrapatero Aní	X	X		LC		B	ONI	C	
Guira guira (Gmelin, 1788)	Pirincho	X	X		LC		B	ONI	C	
Tapera naevia (Linnaeus, 1766)	Cuclillo Crespín	X	X		LC		B	INS	C	

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Order Strigiformes Wagler, 1830										
Family Strigidae Leach, 1820										
Pulsatrix perspicillata (Latham, 1790)	Lechuzón de Anteojos	X			LC		B	CAR	F	
Glaucidium brasilianum (Gmelin, 1788)	Mochuelo Caburé	X	X		LC		B	CAR	B	
Order Nyctibiiformes Yuri, Kimball, Harshman, Bowie, Braun, Chojnowski, Han, Hackett, Huddleston, Moore, Reddy, Sheldon, Steadman, Witt & Braun, 2013										
Family Nyctibiidae Chenu & Des Murs, 1851										
Nyctibius griseus (Gmelin, 1789)	Nictibio Urutaú	X			LC		B	INS	B	
Order Caprimulgiformes Ridgway, 1881										
Family Caprimulgidae Vigors, 1825										
Antrostomus rufus (Boddaert, 1783)	Chotacabras Colorado	X			LC		B	INS	B	
Nyctidromus albicollis (Gmelin, 1789)	Chotacabras Pauraque	X			LC		B	INS	B	
Order Apodiformes Peters, 1940										
Family Apodidae Olphe-Galliard, 1887										
Chaetura meridionalis Hellmayr, 1907	Vencejo de tormenta	X			LC		B	INS	C	
Family Trochilidae Vigors, 1825										
Phaethornis pretrei (Lesson & Delattre, 1839)	Ermitaño del Planalto	X			LC		B	NEC	B	
Hylocharis chrysura (Shaw, 1812)	Zafiro Bronceado	X	X		LC		M	NEC	F	
Order Trogoniformes A. O. U., 1886										

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Family Trogonidae Lesson, 1828										
Trogon curucui Linnaeus, 1766	Trogón Curucuí	X	X		LC		M	ONI	F	
Order Coraciiformes Forbes, 1844										
Family Alcedinidae Rafinesque, 1815										
Megaceryle torquata (Linnaeus, 1766)	Martín Gigante Neotropical	X	X		LC		B	PISC	A	
Chloroceryle amazona (Latham, 1790)	Martín Pescador Amazónico	X			LC		B	PISC	A	
Chloroceryle americana (Gmelin, 1788)	Martín Pescador Verde	X			LC		B	PISC	A	
Family Momotidae Gray, 1840										
Baryphthengus ruficapillus (Vieillot, 1818)	Momoto Yeruvá Oriental	X			LC		M	ONI	F	
Order Galbuliformes Fürbringer, 1888										
Family Bucconidae Horsfield, 1821										
Nystalus striatipectus (Sclater, 1854)	Buco Durmilí	X	X		-		M	INS	F	
Order Piciformes Meyer & Wolf, 1810										
Family Ramphastidae Vigors, 1825										
Ramphastos toco Statius Muller, 1776	Tucán Toco	X	X		LC		M	ONI	C	
Pteroglossus castanotis Gould, 1834	Arasarí Caripardo		X		LC		A	FRU	F	
Family Picidae Leach, 1820										
Picumnus cirratus Temminck, 1825	Carpinterito Variable	X	X		LC		B	INS	B	
Melanerpes candidus (Otto, 1796)	Carpintero Blanco	X	X		LC		B	INS	B	
Veniliornis passerinus (Linnaeus, 1766)	Carpintero Chico	X			LC		B	INS	B	
Piculus chrysochloros (Vieillot, 1818)	Carpintero Verdiamarillo	X			LC		A	INS	F	
Colaptes melanochloros (Gmelin, 1788)	Carpintero real norteño	X			LC		B	INS	F	

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Colaptes campestris (Vieillot, 1818)	Carpintero Campestre	X	X		LC		B	INS	C	
Celeus lugubris (Malherbe, 1851)	Carpintero Lúgubre	X			LC		M	INS	C	
Campephilus melanoleucos (Gmelin, 1788)	Picamaderos Barbinegro	X			LC		M	INS	B	
Order Cariamiformes Furbringer, 1888										
Family Cariamidae Bonaparte, 1850										
Cariama cristata (Linnaeus, 1766)	Chuña Patirroja	X	X		LC		B	ONI	C	
Order Falconiformes Bonaparte, 1831										
Family Falconidae Leach, 1820										
Caracara plancus (Miller, 1777)	Carancho meridional	X	X		LC		B	CAR	C	
Milvago chimachima (Vieillot, 1816)	Caracara Chimachima	X			LC		B	CAR	C	
Herpetotheres cachinnans (Linnaeus, 1758)	Halcón Reidor	X	X		LC		B	CAR	B	
Falco sparverius Linnaeus, 1758	Cernícalo Americano	X			LC		B	CAR	C	
Falco rufigularis Daudin, 1800	Halcón Murcielaguero		X		LC		B	CAR	C	
Falco femoralis Temminck, 1822	Halcón Aleto	X			LC		B	CAR	C	
Order Psittaciformes Wagler, 1830										
Family Psittacidae Rafinesque, 1815										
Thectocercus acuticaudatus (Vieillot, 1818)	Aratinga Cabeciazul	X	X		LC		M	FRU	C	
Psittacara leucophthalmus (Statius Muller, 1776)	Aratinga Ojiblanca	X	X		LC		B	FRU	B	
Aratinga nenday (Vieillot, 1823)	Aratinga Ñanday	X	X		LC		M	FRU	F	
Eupsittula aurea (Gmelin, 1788)	Aratinga Frentidorada	X	X		LC		M	FRU	B	
Pyrrhura devillei (Massena & Souancé, 1854)	Cotorra de Deville	X	X	AM	NT		M	FRU	F	
Myiopsitta monachus (Boddaert, 1783)	Cotorra Argentina	X			LC		B	FRU	C	
Forpus xanthopterygius (Spix, 1824)	Cotorrita Aliazul		X		LC		M	FRU	F	

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Brotogeris chiriri (Vieillot, 1818)	Catita Chirirí	X	X		LC		M	FRU	B	
Pionus maximiliani (Kuhl, 1820)	Loro Choclero	X	X		LC		M	FRU	F	
Amazona aestiva (Linnaeus, 1758)	Amazona Frentiazul	X	X		LC		M	FRU	B	
Order Passeriformes Linnaeus, 1758										
Family Thamnophilidae Swainson, 1824										
Herpsilochmus rufimarginatus (Temminck, 1822)	Tiluchí Alirrufo		X		LC		M	INS	F	
Thamnophilus doliatus (Linnaeus, 1764)	Batará Barrado	X			LC		B	INS	B	
Thamnophilus caerulescens Vieillot, 1816	Batará Variable	X			LC		B	INS	F	
Taraba major (Vieillot, 1816)	Batará Mayor	X	X		LC		B	INS	B	
Conopophaga lineata (Wied, 1831)	Jejenero Rojizo	X		AM	LC		M	INS	F	
Family Dendrocolaptidae Gray, 1840										
Sittasomus griseicapillus (Vieillot, 1818)	Trepatroncos Oliváceo	X			LC		M	INS	F	
Campylorhamphus trochilirostris (Lichtenstein, 1820)	Picoguadaña Piquirrojo	X			LC		M	INS	B	
Lepidocolaptes angustirostris (Vieillot, 1818)	Trepatroncos Chico	X	X		LC		B	INS	B	
Xiphocolaptes major (Vieillot, 1818)	Trepatroncos Colorado	X	X		LC	CH	M	INS	F	
Family Furnariidae Gray, 1840										
Furnarius rufus (Gmelin, 1788)	Hornero Común	X	X		LC		B	INS	C	
Phacellodomus rufifrons (Wied, 1821)	Espinero Común	X	X		LC		B	INS	B	
Schoeniophylax phryganophilus (Vieillot, 1817)	Pijuí Chotoy	X	X		LC		B	INS	B	
Synallaxis frontalis Pelzeln, 1859	Pijuí Frentigrís	X			LC		B	INS	B	
Family Tityridae Gray, 1840										
Tityra cayana (Linnaeus, 1766)	Titira Colinegro	X			LC		M	ONI	F	

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Pachyramphus polychopterus (Vieillot, 1818)	Anambé Aliblanco	X	X		LC		B	INS	F	
Pachyramphus validus (Lichtenstein, 1823)	Anambé grande	X	X		LC		M	INS	F	
Family Rhynchocyclidae Berlepsch, 1907										
Mionectes rufiventris Cabanis, 1846	Mosquero Ladrillito	X		AM	LC		M	INS	F	
Todirostrum cinereum (Linnaeus, 1766)	Titirijí Común	X			LC		B	INS	B	
Hemitriccus margaritaceiventer (d'Orbigny & Lafresnaye, 1837)	Titirijí Perlado	X	X		LC		M	INS	B	
Family Tyrannidae Vigors, 1825										
Camptostoma obsoletum (Temminck, 1824)	Mosquerito Silbón	X	X		LC		B	INS	B	
Elaenia chiriquensis Lawrence, 1865	Fiofío Belicoso	X	X		LC		B	INS	B	
Suiriri suiriri (Vieillot, 1818)	Fiofío Suirirí		X		LC		M	INS	B	
Myiopagis caniceps (Swainson, 1835)	Fiofío Gris	X			LC		M	INS	B	
Myiopagis viridicata (Vieillot, 1817)	Fiofío Verdoso	X	X		LC		B	INS	B	
Phaeomyias murina (Spix, 1825)	Piojito Pardo	X			LC		B	INS	B	
Attila phoenicurus Pelzeln, 1868	Atila Cabecigrís	X		AM	LC		A	INS	F	
Legatus leucophaius (Vieillot, 1818)	Mosquero Pirata	X	X		LC		B	INS	F	
Myiarchus ferox (Gmelin, 1789)	Copetón Feroz	X	X		LC		B	INS	C	
Myiarchus tyrannulus (Statius Muller, 1776)	Copetón Tiranillo	X	X		LC		M	INS	F	
Sirystes sibilator (Vieillot, 1818)	Mosquero Silbador	X			LC		M	INS	B	
Casiornis rufus (Vieillot, 1816)	Burlisto Castaño	X			LC		M	INS	B	
Pitangus sulphuratus (Linnaeus, 1766)	Bienteveo Común	X	X		LC		B	INS	B	
Machetornis rixosa (Vieillot, 1819)	Picabuey	X			LC		B	INS	C	
Myiodynastes maculatus (Statius Muller, 1776)	Bienteveo Rayado	X	X		LC		B	INS	F	
Megarynchus pitangua (Linnaeus, 1766)	Bienteveo Pitanguá	X			LC		B	INS	B	

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Tyrannus melancholicus Vieillot, 1819	Tirano Melancólico	X	X		LC		B	INS	B	
Tyrannus savana Vieillot, 1808	Tijereta Sabanera	X	X		LC		B	INS	C	
Griseotyrannus aurantioatrocristatus (d'Orbigny & Lafresnaye, 1837)	Tuquito Gris	X			LC		B	INS	C	
Empidonomus varius (Vieillot, 1818)	Tuquito Rayado		X		LC		B	INS	B	
Myiophobus fasciatus (Statius Muller, 1776)	Mosquero Estriado	X	X		LC		B	INS	B	
Sublegatus modestus (Wied, 1831)	Mosquero Matorralero Sureño	X	X		LC		M	INS	F	
Cnemotriccus fuscatus (Wied, 1831)	Mosquero Parduzco	X			LC		B	INS	F	
Lathrotriccus euleri (Cabanis, 1868)	Mosquero de Euler	X			LC		M	INS	F	
Xolmis cinereus (Vieillot, 1816)	Monjita Gris	X			LC		M	INS	C	
Xolmis velatus (Lichtenstein, 1823)	Monjita Velada	X	X		LC		M	INS	C	
Xolmis irupero (Vieillot, 1823)	Monjita Blanca	X			LC		B	INS	C	
Family Vireonidae Swainson, 1837										
Cyclarhis gujanensis (Gmelin, 1789)	Vireón Cejirrufo		X		LC		B	INS	F	
Hylophilus poicilotis Temminck, 1822	Verdillo Coronado		X	AM	LC		M	INS	F	
Vireo chivi (Vieillot, 1817)	Vireo Chiví	X	X		LC		B	INS	F	
Family Corvidae Leach, 1820										
Cyanocorax cyanomelas (Vieillot, 1818)	Chara Morada	X	X		LC		B	ONI	F	
*Cyanocorax cristatellus (Temminck, 1823)**	Chara Crestada	X	X	AM	LC		M	ONI	B	
Cyanocorax chrysops (Vieillot, 1818)	Chara Moñuda	X			LC		B	ONI	B	
Family Hirundinidae Rafinesque, 1815										
Progne tapera (Vieillot, 1817)	Golondrina Parda	X	X		LC		B	INS	C	
Family Troglodytidae Swainson, 1831										

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Campylorhynchus turdinus (Wied, 1831)	Cucarachero Turdino	X	X		LC		B	INS	B	
Cantorchilus guarayanus (d'Orbigny & Lafresnaye, 1837)	Cucarachero del Guarayos	X	X		LC		B	INS	B	
Family Polioptilidae Baird, 1858										
Polioptila dumicola (Vieillot, 1817)	Perlita Azul	X	X		LC		M	INS	F	
Family Turdidae Rafinesque, 1815										
Turdus leucomelas Vieillot, 1818	Zorzal Sabiá	X	X		LC		B	ONI	B	
Turdus rufiventris Vieillot, 1818	Zorzal Colorado	X			LC		B	ONI	B	
Turdus amaurochalinus Cabanis, 1850	Zorzal Chalchalero	X			LC		B	ONI	B	
Family Mimidae Bonaparte, 1853										
Mimus saturninus (Lichtenstein, 1823)	Sinsonte Calandria		X		LC		B	ONI	C	
Family Passerellidae Cabanis & Heine, 1850										
Zonotrichia capensis (Statius Muller, 1776)	Chingolo Común	X			LC		B	GRAN	C	
Ammodramus humeralis (Bosc, 1792)	Chingolo Pajonalero	X	X		LC		B	GRAN	C	
Family Parulidae Wetmore, Friedmann, Lincoln, Miller, Peters, van Rossem, Van Tyne & Zimmer 1947										
Setophaga pitiayumi (Vieillot, 1817)	Parula Pitiayumí	X			LC		M	INS	B	
Basileuterus culicivorus (Deppe, 1830)	Reinita Coronidorada	X			LC		M	INS	B	
Myiothlypis flaveola Baird, 1865	Reinita Amarillenta	X			LC		M	INS	B	
Family Icteridae Vigors, 1825										
Procacicus solitarius (Vieillot, 1816)	Cacique Solitario	X			LC		B	ONI	F	
Cacicus chrysopterus (Vigors, 1825)	Cacique Aliamarillo	X	X		LC		B	INS	B	

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Cacicus haemorrhous (Linnaeus, 1766)	Cacique Lomirrojo	X			LC		B	ONI	B	
Icterus pyrrhopterus (Vieillot, 1819)	Turpial Variable	X	X		LC		M	ONI	B	
Gnorimopsar chopi (Vieillot, 1819)	Chopí	X			LC		B	ONI	C	
Agelaioides badius (Vieillot, 1819)	Tordo Músico		X		LC		M	INS	C	
Molothrus oryzivorus (Gmelin, 1788)	Tordo Gigante	X			LC		B	ONI	C	
Molothrus bonariensis (Gmelin, 1789)	Tordo Renegrido	X			LC		B	ONI	C	
Sturnella superciliaris (Bonaparte, 1850)	Charrancito Amazónico		X		LC		B	INS	C	
Family Thraupidae Cabanis, 1847										
Paroaria coronata (Miller, 1776)	Cardenilla Crestada	X	X		LC		B	GRAN	B	
Paroaria capitata (d'Orbigny & Lafresnaye, 1837)	Cardenilla Piquigualda	X			LC		B	INS	B	
Tangara sayaca (Linnaeus, 1766)	Tangara Sayaca	X	X		LC		B	FRU	B	
Nemosia pileata (Boddaert, 1783)	Tangara Encapuchada		X		LC		B	FRU	F	
Conirostrum speciosum (Temminck, 1824)	Conirrostro Culirrufo	X	X		LC		B	INS	B	
Sicalis flaveola (Linnaeus, 1766)	Dorado	X	X		LC		B	GRAN	C	
Volatinia jacarina (Linnaeus, 1766)	Semillero Volatinero		X		LC		B	GRAN	C	
Coryphospingus cucullatus (Statius Muller, 1776)	Soldadito Crestirrojo	X	X		LC		B	INS	C	
Tachyphonus rufus (Boddaert, 1783)	Tangara Negra	X	X		LC		B	FRU	B	
Coereba flaveola (Linnaeus, 1758)	Platanero		X		LC		B	ONI	B	
Sporophila caerulescens (Vieillot, 1823)	Semillero Corbatita	X			LC		B	GRAN	C	
Sporophila angolensis (Linnaeus, 1766)	Semillero Curió		X		LC		B	GRAN	C	
Saltatricula atricollis (Vieillot, 1817)	Pepitero Gorjinegro	X	X		LC		M	GRAN	B	
Saltator coerulescens Vieillot, 1817	Pepitero Grisáceo	X			LC		B	ONI	C	
Family Fringillidae Leach, 1820										

Taxon	Popular Name in Paraguay	Register		Categories of Threat		End	Sens.	Guild	Habitat	Migr.
		DIA	ADA	PY (2019)	IUCN (2020)					
Euphonia chlorotica (Linnaeus, 1766)	Eufonia Golipúrpura	X	X		LC		B	FRU	B	

Categories of Threat PY 2019 - Resolution 254/2019 of the Ministry of Environment and Sustainable Development of Paraguay IUCN 2020 - The IUCN Red List of Threatened Species, version 2020.1. Legend: AM - threatened with extinction; NT - near threatened; LC - of little concern; Endemism (End.) - CH - Chaco; EX - exotic species. Sensitivity (Sen.): B - low; M - medium; A - high. Guilda: CAR - carnivore; DET - detritivore; FRU - frugivore; GR - granivore; INS - insetivore; MAL - malacophageal; NEC - nectarivore; NECR - nerophageal; ONI - omnivore; PISC - piscivore. Habitat: A - wet environments; B - fragmentary edge; C - fields and open areas; F - forest. Migration (Migr.): VN - northern traveller.

Photographic record

Figure 316 to Figure 369 shows the photographic record of some species diagnosed in the DIA and DAA of the PARACEL pulp mill.

Figure 324 – Amazona Frentiazul (*Amazona aestiva*).

Figure 325 – Pato Brasileño (*Amazoneta brasiliensis*).

Figure 326 – Cotara Ipacaá (*Aramides ypecaha*).

Figure 327 – Aratinga Ñanday (*Aratinga nenday*).

Figure 328 – Garza Cuca (*Ardea cocoi*).

Figure 329 – Correlimos Batitú (*Bartramia longicauda*).

Figure 330 – Cacique Aliamarillo (*Cacicus chrysopterus*).

Figure 331 – Cacique Lomirrojo (*Cacicus haemorrhous*).

Figure 332 – Picamaderos Barbinegro (*Campephilus melanoleucos*).

Figure 333 – Carancho meridional (*Caracara plancus*).

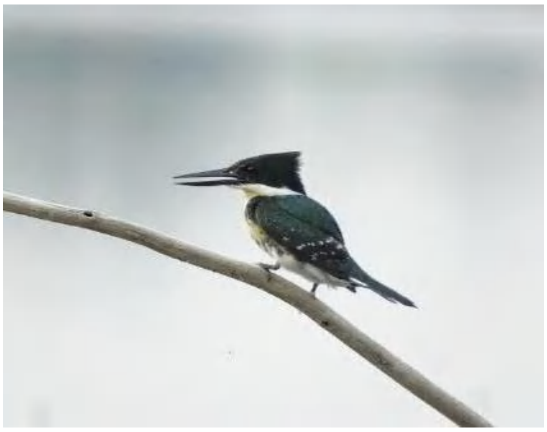


Figure 334 – Martín Pescador Verde (*Chloroceryle americana*).

Figure 335 – Milano Picogarfio (*Chondrohierax uncinatus*).

Figure 336 – Tortolita Azulada (*Claravis pretiosa*).

Figure 337 – Chara Morada (*Cyanocorax cyanomelas*).

Figure 338 – Suirirí Piquirrojo (*Dendrocygna autumnalis*).

Figure 339 – Hornero Común (*Furnarius rufus*).

Figure 340 – Busardo Sabanero (*Heterospizias meridionalis*).

Figure 341 – Zafiro Bronceado (*Hylocharis chrysura*).

Figure 342 – Jacana Suramericana (*Jacana jacana*).

Figure 343 – Mosquero Pirata (*Legatus leucophaius*).

Figure 344 – Trepatroncos Chico (*Lepidocolaptes angustirostris*).

Figure 345 – Sinsonte Calandria (*Mimus saturninus*).

Figure 346 – Bienteveo Rayado (*Myiodynastes maculatus*).

Figure 347 – Cormorán Biguá (*Nannopterum brasilianus*).

Figure 348 – Buco Durmilí (*Nystalus striatipectus*).

Figure 349 – Chachalaca Charata (*Ortalis canicollis*).

Figure 350 – Anambé grande (*Pachyramphus validus*).

Figure 351 – Paloma Colorada (*Patagioenas cayennensis*).

Figure 352 – Espinero Común (*Phacellodomus rufifrons*).

Figure 353 – Nido de *Phimosus infuscatus*

Figure 354 – Espátula Rosada (*Platalea ajaja*).

Figure 355 – Chorlito Dorado Americano (*Pluvialis dominica*).

Figure 356 – Cacique Solitario (*Procacicus solitarius*).

Figure 357 – Aratinga Ojiblanca (*Psittacara leucophthalmus*).

Figure 358 – Mosquero Silbador (*Sirystes sibilator*).

Figure 359 – Batará Variable (*Thamnophilus caerulescens*).

Figure 360 – Aratinga Cabeciazul (*Thectocercus acuticaudatus*).

Figure 361 – Bandurria Común (*Theristicus caudatus*).

Figure 362 – Titira Colinegro (*Tityra cayana*).

Figure 363 – Trogón Curucuí (*Trogon curucui*).

Figure 364 – Monjita Blanca (*Xolmis irupero*).

Figure 365 – Trepatroncos Colorado (*Xiphocolaptes major*).

Figure 366 – Tordo Músico (*Agelaioides badius*).

Figure 367 – Garcita Verdosa (*Butorides striata*).

Figure 368 – Halcón Murcielaguero (*Falco rufigularis*).

Figure 369 – Cernícalo Americano (*Falco sparverius*).

Figure 370 – Pirincho (*Guira guira*).

Figure 371 – Cardenilla Crestada (*Paroaria coronata*).

Figure 372 – Carpintero Verdiamarillo (*Piculus chrysochloros*).

Figure 373 – Lechuzón de Anteojos (*Pulsatrix perspicillata*).

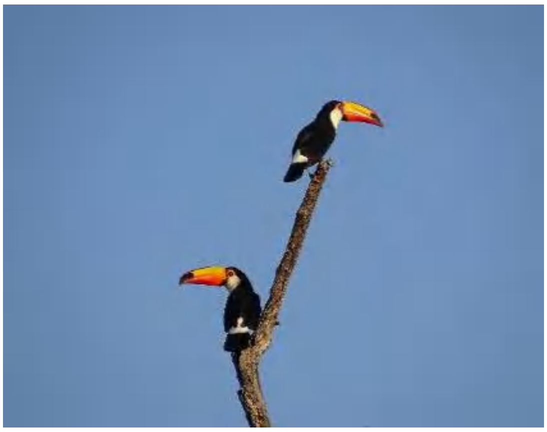


Figure 374 – Tucán Toco (*Ramphastos toco*).

Figure 375 – Ñandú Común (*Rhea americana*).

Figure 376 – Fiofío Suirirí (*Suiriri suiriri*).

Figure 377 – Paloma Picazuró (*Patagioenas picazuro*).

Final consideration about birdlife

The present diagnosis of the bird community in the areas of influence of the pulp mill was carried out in October 2019 (dry season) and March 2020 (rainy season), registering 181 species of birds distributed in 49 families and 24 orders. In the DIA 161 species were recorded, with a Shannon index that shows a high diversity for the area (H'= 4.33). In the DAA 106 species were recorded, with a diversity of H'= 3.80. The distribution of abundance among the species in the study areas corroborates the predictions for the neotropical regions, being relatively homogeneous, especially if we consider the Pielou Equivalence Index obtained for the DIA and the DAA from the PARACEL pulp mill (J'= 0, 85 and J'= 0, 81, respectively).

In general, it can be said that a large part of the diagnosed birdlife is considered synanthropic and not very sensitive to changes in the environment, with only three highly sensitive species being recorded during the present diagnosis: Pteroglossus castanotis, Piculus chrysochloros, Attila phoenicurus, the latter being considered rare in Paraguay. With respect to migratory birds, two long-distance migratory species have been recorded: Pluvialis dominica and Attila phoenicurus. Both species breed in tundra areas in the northern hemisphere, moving to their wintering grounds in southern South America.

The endemic birds of the Chaco, with a predominant phytophysiology in the areas of influence of the PARACEL pulp mill, were represented by two species during the study: Chachalaca Charata (Ortalis canicollis) and Trepatroncos Colorado (Xiphocolaptes major). Finally, as regards the endangered birds found in the sampled areas, seven species are included in the national (Resolution n. 254/2019) and/or global (IUCN, 2020) list: Greater Rhea or American Rhea, Pyrrhura deville), Conopophaga lineata, Mionectes rufiventris, Attila phoenicurus, Hylophilus poicilotis and CrCyanocorax cristatellus. Among the species mentioned, Conophophaga lineata and Mionectes rufiventris must be highlighted because they are underwood forest foragers and therefore dependent on the integrity of the forest.

9.2.2.5.2.3 Herpetofauna

Richness

During the two campaigns, 37 species of herpetofauna were recorded in the DAA (Area Directly Affected) and in the DIA (Direct Influence Area) (Figure 370), being 28 amphibians and nine reptiles. A total of 34 species were recorded in the DIA and 33 species in the ADA. Amphibians belong to the Order Anura and are divided into five families: Bufonidae (3 spp.), Hylidae (13 spp.), Leiuperidae (3 spp.), Leptodactylidae (8 spp.) and Microhylidae (1 sp.). The reptiles belong to three orders: Testudinae, represented by the family Testudinidae (1 spp.); Order Crocodilya, represented by the family Alligatoridae (1 spp.); Order Squamata, represented by five families: Teidae (1 spp.), Colubridae (1 spp.), Elapidae (1 spp.) Viperidae (1 spp.) and Dipsadidae (3 spp.). Among the species recorded during the study, none of them is considered endemic to the Chaco.

Most of the species recorded were in both the Direct and Indirect Areas of Influence. However, some species were unique to DIA at certain points: *Pithecopus azurea*, *Elachistocleis bicolor*, *Leptodeira annulata* e *Mussurana bicolor*. Reagrding DAA, following species exclusive registers: *Salvator merianae*, *Chironius quadricarinatus* e *Pseuduboa nigra*.

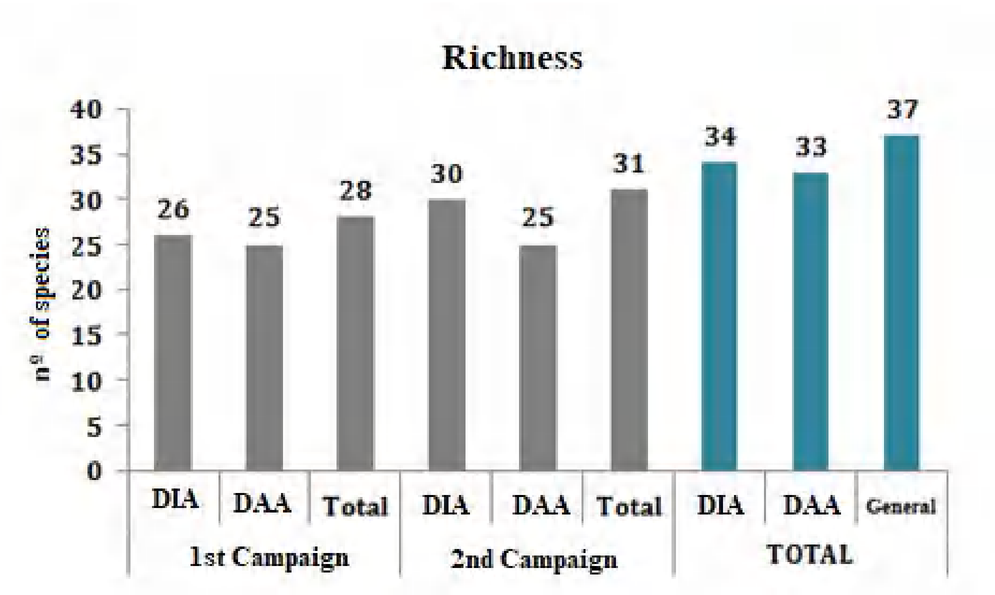


Figure 378 – Species richness of the herpetofauna recorded during the first and second sampling campaigns. SD - Secondary data.

Abundance

A total of 2015 individuals have been recorded for both the DAA and the DIA, with 1968 individuals for amphibians and 48 for reptiles. The most representative species of amphibians in terms of number of individuals were: *Leptodactylus podicipinus* (n= 260), *Leptodactylus latrans* (n= 204), *Leptodactylus fuscus* (n= 190), with 13,21%, 10,35% and 9,65%, respectively, of the total number of individuals sampled. The *Physalaemus biligonigerus* (n= 5) and *Elachistocleis bicolor* (n= 1), were the amphibians considered rare for the sample, with only 0.25% and 0.05%, respectively.

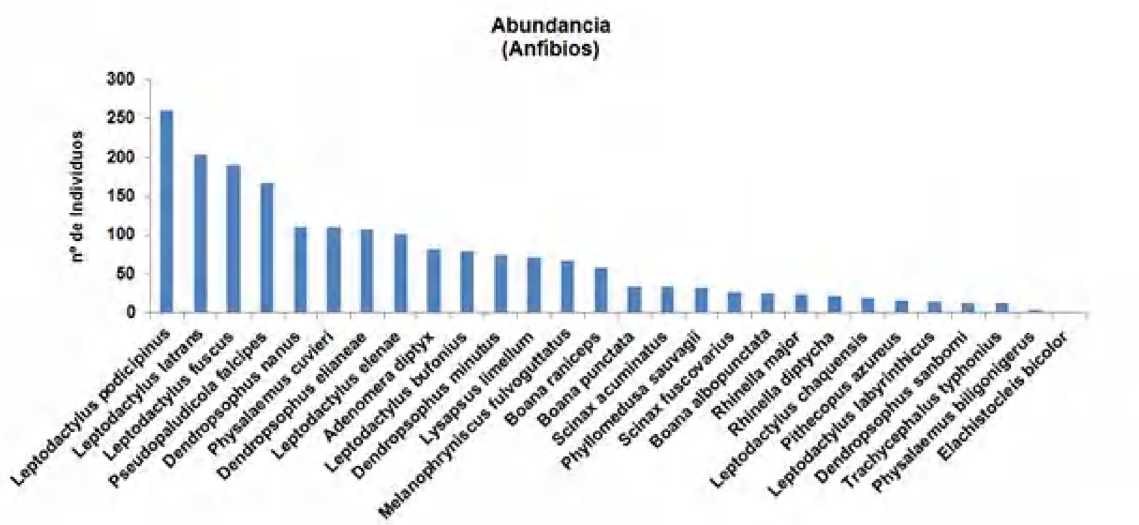


Figure 379 – Abundance of amphibian species recorded during the first and second sampling campaigns.

Among the reptiles, the most representative species were: *Bothrops diporus* (n=22) with 45,83% and *Caiman yacare* (n= 12) with 25%, the remaining reptiles had been represented with only three, two or one sample by specie, representing approximately 6,25%, 4,15% and 2,10% respectively.

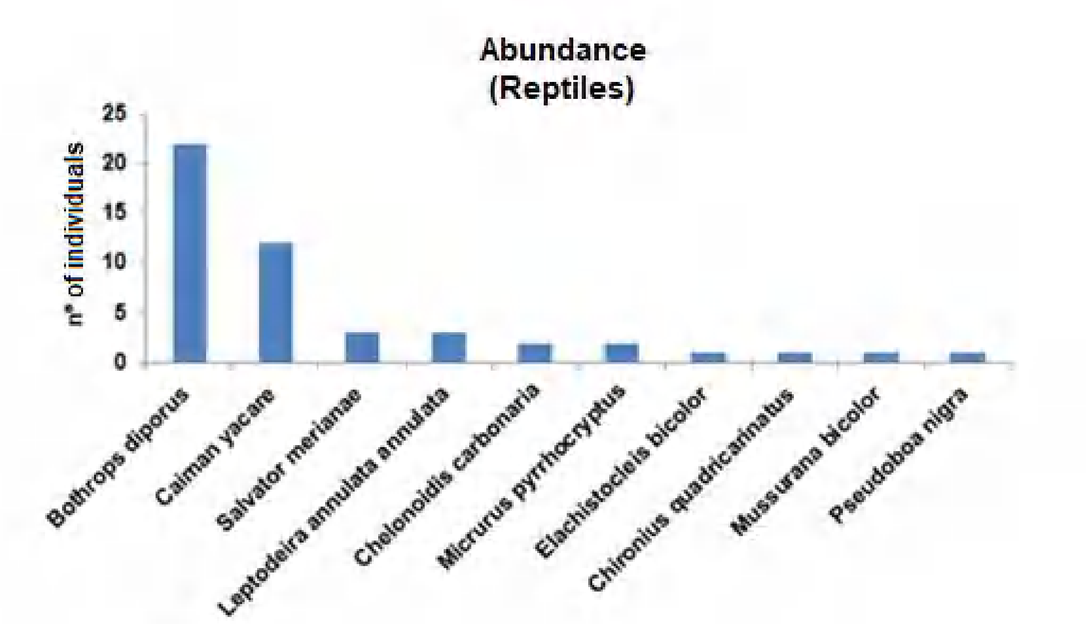


Figure 380 - Abundance of reptile species recorded during the first and second sampling campaigns.

Sample efficiency curve

The sample efficiency curve will then be presented, taking into account the data collected in both campaigns, using both methods (active search + point sampling), for both reptiles and amphibians. Since the number of amphibians recorded is much higher than that of reptiles, the two groups will be evaluated together.

It can be seen that the curve is still rising and has not reached the asymptote, indicating that new records can be made. The richness estimator (Jackknife 1) indicated that a total of 41 species could be observed (only four more species than those observed) (Figure 373). The Chao1 estimator indicated a number close to Jackknife 1, indicating 39 ± 2.0 species. Therefore, although the herpetofauna was very well sampled and represented in both campaigns, it is expected that, with further campaigns and sampling efforts, other representatives of the herpetofauna will be found, for both the DAA and the DIA.

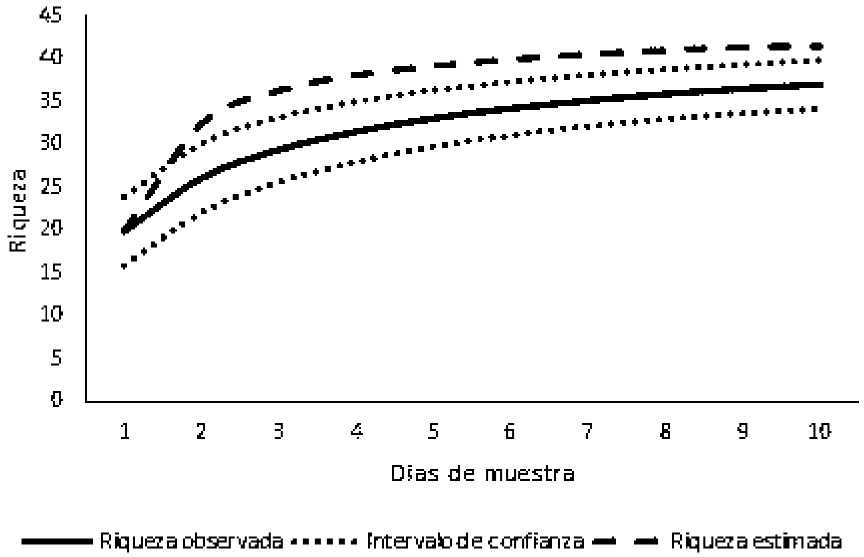


Figure 381 – Efficiency curve of the species sample and estimated richness (Jackknife 1) of the herpetofauna, based on 1000 randomized.

Diversity index

Taking into account the total data recorded in this campaign, the calculated Shannon diversity index was 3.03 and the equitability index was 0.8329, which indicates that the abundance of individuals is satisfactorily well distributed among the species, showing a low dominance (D'= 0.0633). The areas obtained a very similar richness, having a slight superiority for the direct influence area in the second campaign, 30 species and 26 species for the first campaign, the directly affected area obtained a richness of 25 species in both campaigns. The number of individuals recorded for all the areas combined was 2015.

Table 31 – Indexes obtained for registered herpetofauna during the first and second sampling campaigns.

	1st Campaign		2nd Campaign		TOTAL		
	DIA	ADA	DIA	ADA	DIA	ADA	General
Richness	26	25	30	25	34	33	37
Abundance	632	486	478	419	1113	909	2015
Dominance	0,07945	0,07567	0,07087	0,0959	0,06508	0,06783	0,0633
Diversity (Shannon)	2,729	2,79	2,928	2,721	2,983	2,98	3,03
Equitability	0,8376	0,8668	0,8608	0,8452	0,8391	0,8522	0,8329

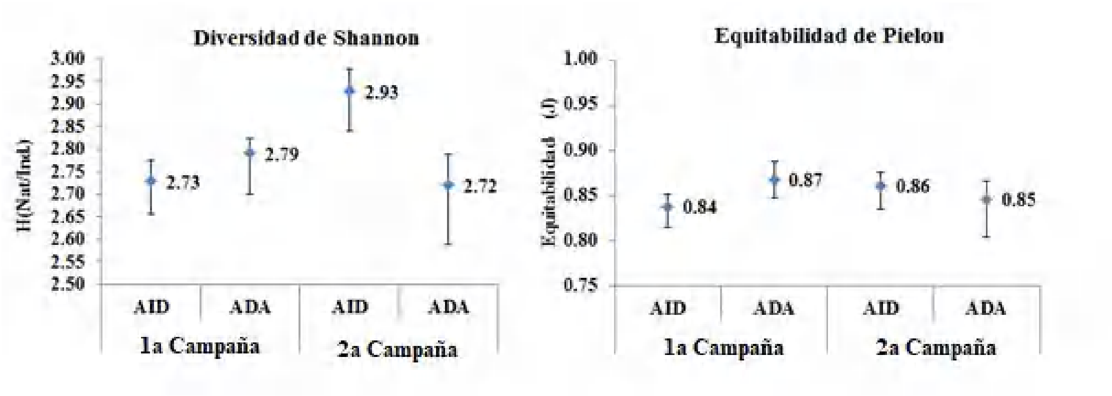


Figure 382 – Diversity and Equitability of the herpetofauna recorded during the first and second sampling campaigns.

Ecological Categories

Bioindicator species

Some species can be considered as bio-indicators of environmental quality, particularly with regard to their feeding habits or habitats. Among the amphibians, the painted toad, Melanophryniscus fulvoguttatus, stands out. This species occurs in eight departments of Paraguay, with diurnal and terrestrial habits. It is found in flooded areas and on the edges of water bodies in the regions of the Cerrado, the Atlantic Forest and the Chaco. The frogs Pithecopus azureus and Phyllomedusa sauvagii, have a nocturnal and arboreal habit and have a unique characteristic in their reproduction, in which they deposit their eggs in leaves on the water and in the future the tadpoles fall into the water by "dripping", that is to say, it is extremely dependent on vegetation around the water body.

In addition to being targeted for animal trafficking, to be used as a pet. For reptiles, the C. yacaré stands out as a great predator and has a great need to consume fish, birds, small mammals and even invertebrates. In the case of the snakes, the Micrurus pyrrhocryptus stands out, a species of discreet habits, mainly fossorial, that feeds mainly on other snakes, which makes it extremely indicative of the quality of the environment, since the environment must be balanced to have the capacity to sustain such a sensitive species with such a specific feeding habit.

Rare species

Some species were considered rare at diagnosis. Among the amphibians, the following should be highlighted: *Elachistocleis bicolor* where it obtained only one record in the two campaigns combined and was considered the rarest species for diagnosis among amphibians. Subsequently, *Physalaemus biligonigerus* was also considered rare with only five records in the second campaign. Amphibians: *T. tiphonius, D. sanborni and L. labyrinthicus* obtained an average of only 14 individuals and were also considered rare for the study. Among reptiles, it is common to obtain few records, as life history, food and population density may already justify the low records of the group. However, the few records of the following species stand out: *Pseudoboa nigra, Mussurana bicolor, Chironius quadricarinatus* e *Micrurus pyrrhocryptus,* which only got one record.

Endangered, endemic or exotic species

Although no species is considered endemic, three of them have some degree of threat or poor data. The toad *Rhinella diptycha* and *Dendropsophus elianae* are in danger of extinction, according to the list of animals threatened according to Resolution 433/2019, meanwhile that *Pithecopus azureus* was found as DD – Deficient Data, in accordance with International Union for Conservation of Nature Red List of Threatened Species (IUCN, 2020). It is not listed, but is highly threatened due to its commercial value, most notably *C. carbonaria*, a species widely used as food by hunters and widely used in wildlife trafficking, which is sold not only in Paraguay but all over the world.

The table bellow lists the herpetofauna species recorded during the first and second sampling campaigns, followed by the categories of threat and information on habitat preference, period of activity, abundance, song site, habitat and endemism.

Table 32 – List of herpetofauna species recorded during the first and second sampling campaigns in October/2019 and March/2020 respectively.

Taxon	Popular Name in Paraguay	Area of register		Threat categories		Habitat	Period of Activity	Abundance	Singing site	Habit	End.
		AID	ADA	PY (2019)	IUCN (2020)						
Order Anura		-	-								
Family Bufonidae		-	-								
Melanophryniscus fulvoguttatus (Mertens, 1937)	Sapito punteado (Toky to syry)	35	32		LC	AB	D	R	BL		MA
Rhinella major (Muller & Helmich, 1936)	Sapito mayor (Kururu'i)	16	8		-	AB/F	N	F	BL/RR	T	
Rhinella diptycha (Cope, 1862)	Cururú	15	8	EN	LC	AB/F	N	F	BL/RR	T	
Family Hylidae		-	-								
Dendropsophus elianeae (Napoli & Caramaschi, 2000)	Rana (Ju'i)	68	40	EN	LC	AB	N	F	BL	Ar	
Dendropsophus minutus (Peters, 1872)	Ranita amarilla comun	42	32		LC	AB	N	F	BL	Ar	
Dendropsophus nanus (Boulenger, 1889)	Ranita enana	67	44		LC	AB	N	F	BL	Ar	
Dendropsophus sanborni (Schmidt, 1944)	Ranita enana	4	10		LC	AB	N	F	BL	AR	
Boana albopunctata (Spix, 1824)	Ranita punteada	11	15		LC	AB	N	F	BL	Ar	
Boana punctata (Schneider, 1799)	Rana punteada	4	31		LC	AB	N	PF	BL/RR	AR	
Boana raniceps (Cope, 1862)	Rana arborea meridional	22	36		LC	AB	N	F	BL	Ar	
Pithecopus azureus (Cope, 1862)	Ranita mono chaqueña	16	-		DD	AB	N	PF	BL	Ar	
Phyllomedusa sauvagii (Boulenger, 1882)	Rana monito (Ju'i)	15	18		LC	AB	N	PF	BL	Ar	
Lysapsus limellum (Cope, 1862)	Ranita (Ju'i)	60	11		LC	AB	N	F	BL	Ar	
Scinax acuminatus (Cope, 1862)	Ranita (Ju'i)	16	18		LC	AB	N	PF	BL	Ar	MA
Scinax fuscovarius (A. Lutz, 1925)	Ranita (Ju'i)	12	15		LC	AB/F	N	F	BL	Ar	
Trachycephalus typhonius (Linnaeus, 1758)	Rana lechosa (Ju'i nekere)	6	7		-	AB/F	N	F	BL	AR	
Family Leiuperidae		-	-								
Physalaemus biligonigerus (Cope, 1861 "1860")	Rana llorona	3	2		LC	AB	N	PF	BL	Ar	

Taxon	Popular Name in Paraguay	Area of register		Threat categories		Habitat	Period of Activity	Abundance	Singing site	Habit	End.
		AID	ADA	PY (2019)	IUCN (2020)						
Physalaemus cuvieri (Fitzinger, 1826)	Rana perro	44	66		LC	AB	N	F	BL	T	
Pseudopaludicola falcipes (Hensel, 1867)	Ranita de Hensel o macaquito	113	54		LC	AB	D/N	F	BL	C	MA
Family Leptodactylidae		-	-								
Adenomera diptyx (Boettger, 1885)	Rana (Ju'i)	64	18		LC	AB	N	PF	BL	Ar	
Leptodactylus bufonius (Boulenger, 1894)	Rana hornera o rana ocico de pala	51	28		LC	AB	N	PF	BL	Ar	
Leptodactylus chaquensis (Cei, 1950)	Rana chaqueña o rana criolla	13	7		LC	AB	N	F	BL	C	
Leptodactylus elenae (Heyer, 1978)	Rana marmolada de labio blanco	36	65		LC	AB	N	F	BL	C	
Leptodactylus fuscus (Schneider, 1799)	Rana silbadora	112	78		LC	AB	N	F	BL	T	
Leptodactylus labyrinthicus (Spix, 1824)	Sapo toro laberintico	6	9		LC	AB	N	F	BL	T	
Leptodactylus latrans (Steffen, 1815) Leptodactylus ocellatus	Rana criolla	111	93		LC	AB/F	N	F	BL	T	
Leptodactylus podicipinus (Cope, 1862)	Rana de vientre moteado	122	138		LC	AB	N	F	BL	T	
Family Microhylidae		-	-								
Elachistocleis bicolor (Valenciennes in Guérin-Menéville, 1838)	Ranita aceituna o panza amarilla	1	-		LC	AB	N	F	BL	GT	
Order Testudines		-	-								
Family Testudinidae		-	-								
Chelonoidis carbonaria (Spix, 1824)	Tortuga terrestre	1	1			AB/F	D	R	NC	T	
Order Crocodilya		-	-								
Family Alligatoridae		-	-								
Caiman yacare (Daudin, 1802)	Jakare negro o jakare hú	3	9		LC	AB	D/N	F	NC	T/ Aq	
Order Squamata		-	-								
Family Teiidae		-	-								

Taxon	Popular Name in Paraguay	Area of register		Threat categories		Habitat	Period of Activity	Abundance	Singing site	Habit	End.
		AID	ADA	PY (2019)	IUCN (2020)						
Salvator merianae (Duméril & Bibron, 1839)	Lagarto overo	-	3		LC	AB/F	D	F	NC	T	
Family Colubridae		-	-								
Chironius quadricarinatus (Boie, 1827)	Mbói ysypo	-	1			AB/F	D	PF	NC	T/ Ar	
Family Elapidae		-	-								
Micrurus pyrrhocryptus (Cope, 1862)	Coral chaqueña	1	1		LC	AB/F	N	R	NC	T	
Family Viperidae		-	-								
Bothrops diporus (Cope, 1862)	Yarará chica	12	10		LC	AB/F	N	F	NC	T	
Family Dipsadidae		-	-								
Leptodeira annulata annulata (Linnaeus, 1758)	Falsa mapanare / Ojo de gato	3	-		LC	AB/F	D/N	F	-o-	AR /T	
Mussurana bicolor (Peracca, 1904)	Mussurana bicolor	1	-		LC	AB/F	N	PF	NC	T	
Pseudoboa nigra (Duméril, Bibron & Duméril, 1854)	Mussurana	-	1		LC	AB/F	N	F	-o-	T	

Legend: Threat Categories: PY – Paraguay 2019; **IUCN (2019)** – Lista Roja IUCN de Species Amenazadas de Extinción (versión 2019.2). **LC** – Least Concern; **DD** – Poor data. **Habitat: AB** – open area; **AF** – area forestal; **AB/F** – area open or forested (generalist). **Activity: D**- diurnal; **N** – nocturne. **Abundance: F** – frequent; **PF** – low frequent; **R** – rare. **Sítios de canto: BM** – bromélia; **BL** – lagoon edge; **CM** – piso del bosque; **RR**- remanso del río; **NC** – no canta. **Habit: Ar** – arbóreo; **C** – criptozóico; **T** – terrestre; **Aq** – aquatic. **End: Endemism:** Ch – Chaco

.

Photo Report

Figure 383 – *Melanophryniscus fulvoguttatus*

Figure 384 – *Rhinella major*

Figure 385 – *Rhinella diptycha*

Figure 386 – *Dendropsophus minutus*

Figure 387 – *Dendropsophus sanborni*

Figure 388 – *Boana albopunctata*

Figure 389 – *Boana punctata*

Figure 390 – *Pithecopus azurea*)

Figure 391 – *Phyllomedusa sauvagii*

Figure 392 – *Lysapsus limellum*

Figure 393 – *Scinax acuminatus*

Figure 394 – *Trachycephalus typhonius*

Figure 395 – *Physalaemus biligonigerus*

Figure 396 – *Leptodactylus bufonius*

Figure 397 – *Leptodactylus elenae*

Figure 398 – *Leptodactylus fuscus*

Figure 399 – *Leptodactylus latrans*

Figure 400 – *Elachistocleis bicolor*

Figure 401 – ***Chelonoidis carbonaria***

Figure 402 – ***Caiman yacare***

Figure 403 – ***Chironius quadricarinatus***

Figure 404 – ***Micrurus pyrrhocryptus***

Figure 405 – ***Bothrops diporus***

Figure 406 – ***Leptodeira annulata***

Figure 407 – *Mussurana bicolor*

Figure 408 – *Pseudoboa nigra*

Final considerations about herpetofauna

During the two campaigns, 37 species of herpetofauna were recorded in the DAA (Directly Affected Area) and the DIA (Area of Direct Influence), which are 28 anuria amphibians and nine reptiles. A total of 34 species were recorded in the DIA and 33 species in the ADA. Amphibians belong to the Order Anura and are divided into five families: Bufonidae (3 spp.), Hylidae (13 spp.), Leiuperidae (3 spp.), Leptodactylidae (8 spp.) and Microhylidae (1 sp.). The reptiles belong to three orders: Testudinae, represented by the family Testudinidae (1 spp.); Order Crocodilya, represented by the family Alligatoridae (1 spp.); Order Squamata, represented by five families: Teidae (1 spp.), Colubridae (1 spp.), Elapidae (1 spp.) Viperidae (1 spp.) and Dipsadidae (3 spp.).

Although the two campaigns took place at different times of the year (drought and rain), which would technically make two campaigns with a good sample sufficiency, the unfavorable weather for the rain campaign was certainly not enough for the campaign. With many dry lakes and the absence of rain, species that should be in the breeding period showed little or no vocal activity during the occasional sampling in the lakes. These data are corroborated by the similarity and superiority in the species record of the first campaign (dry), with a total of 28 species (1124 individuals) and 31 species (891 individuals) in the second campaign. Certainly, with new campaigns and sampling new species would be found (as also indicated in the indices and the rarefaction curve) and a better representation of the local herpetofauna could be obtained.

Three species have some degree of threat or poor data. The toad (Rhinella diptycha) and the *Dendropsophus elianae* are endangered, according to the Resolution 433/2019 (list of threatened animals), while *Pithecopus azureus* is listed as DD – Deficient Data, according to the International Union for Conservation of Nature - Red List of Threatened Species (IUCN, 2020).

9.2.2.5.2.4 Ichthyofauna

Richness

Fifty-eight species were identified belonging to 17 families of 4 orders in which Characiformes had the highest number of species representatives (32), followed by Siluriforms with 19 species. (**Figure 401**)

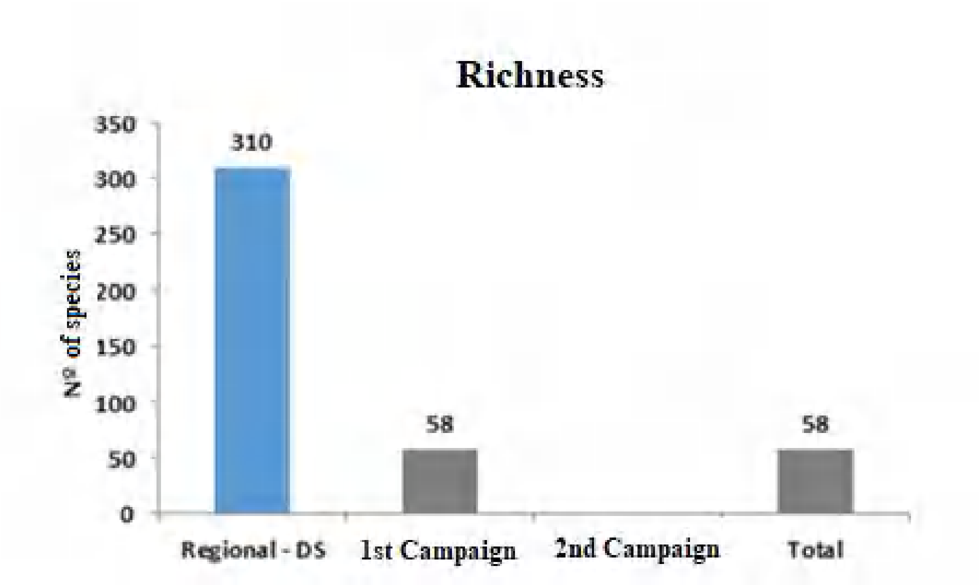


Figure 409 – Fish species richness recorded during the first monitoring campaign.

The occurrence behavior of diversity for the Neotropical drains is of greater richness and absolute number of species of the Characiform Orders followed by the Siluriforms, as has been pointed out since Lowe-McConnell (1999) (cf. also Beaumord, 1991).

The Characiform Order are present in all domains, both in lotic and lentic environments, being one of the largest groups of freshwater fish. Its success is related to the wide distribution and variability of feeding habits observed also in the great ecological and morphological diversification of the group (Moreira, 2007). A greater representativeness of the Characiformes Order is expected, so this group will be dominant among freshwater sources present in South America (Britski et al., 2007).

Of all the species found in the area sampled in this campaign, the Characiformes were the largest representative **Figure 402**, as well as the Characidae family, the largest family of this Order and which had the highest number of species captured (Lowe-mcconnell, 1999).

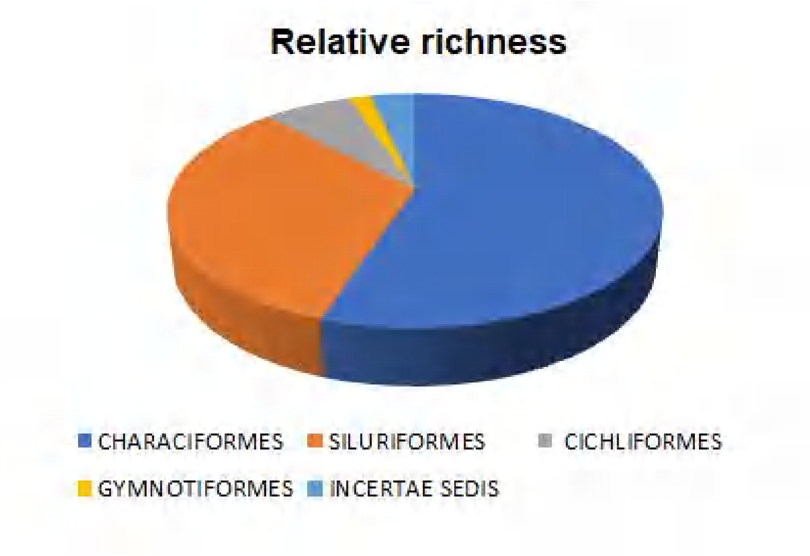


Figure 410 – Relative order richness of ichthyofauna recorded during the first sampling campaign.

Abundance

The quantitative analysis of ichthyofauna is presented by the results of numerical abundance (number of individuals) and relative abundance (%), as shown in Table bellow. A total of 443 individuals were caught during the campaign, with *Bryconamericus exodon* being the most abundant, with 55 individuals, representing 12.4% of the total fish caught, followed by *Aphyocharax anisitsi*, with 46 individuals, corresponding to 10.4%.

Table 33 – Results of relative abundance of ichthyofauna registered during the first sampling campaign.

Taxon	1st day	2nd day	3rd day	4th day	Total	Relative %
Abramites hypselonotus (Günther 1868)			1		1	0.2%
Acestrorhynchus pantaneiro Menezes 1992			1		1	0,2%
Apareiodon affinis (Steindachner 1879)	4		2		6	1,4%
Aphyocharax anisitsi Eigenmann & Kennedy 1903	6		39	1	46	10,4%
Astyanax lacustris (Lütken 1875)			3		3	0,7%
Astyanax sp.			1		1	0,2%
Bryconamericus exodon Eigenmann 1907	55				55	12,4%
Bujurquina vittata (Heckel 1840)			1		1	0,2%
Characidium laterale (Boulenger, 1895)	2				2	0,5%
Creagrutus meridionalis Vari & Harold 2001	1				1	0,2%
Crenicichla semifasciata (Heckel 1840)			1		1	0,2%
Crenicichla vittata Heckel 1840	2		3	1	6	1,4%
Curimatella dorsalis (Eigenmann & Eigenmann 1889)			2		2	0,5%
Eigenmannia trilineata López & Castello 1966			1		1	0,2%

Taxon	1st day	2nd day	3rd day	4th day	Total	Relative %
Galeocharax humeralis (Valenciennes 1834)	5		1	4	10	2,3%
Gasteropelecus sternicla (Linnaeus 1758)			1		1	0,2%
Gymnogeophagus balzanii (Perugia 1891)			1		1	0,2%
Hemiodus cf. *orthonops* Eigenmann & Kennedy 1903	6		2		8	1,8%
Hoplias malabaricus (Bloch 1794)			2	2	4	0,9%
Hypoptopoma inexspectatum (Holmberg 1893)	5		9		14	3,2%
Hypostomus cf. *boulengeri* (Eigenmann & Kennedy 1903)				1	1	0,2%
Hypostomus cf. *latifrons* Weber 1986	5		8	2	15	3,4%
Hypostomus sp1.	14		25		39	8,8%
Hypostomus sp2.	1		4		5	1,1%
Hypostomus sp3.			1		1	0,2%
Iheringichthys labrosus (Lütken 1874)		5	1	1	7	1,6%
Leporinus friderici (Bloch 1794)				1	1	0,2%
Leporinus striatus Kner 1858	1				1	0,2%
Loricaria sp.		3		2	5	1,1%
Loricariichthys platymetopon Isbrücker & Nijssen 1979		1			1	0,2%
Moenkhausia intermedia (Eigenmann 1908)			24	6	30	6,8%
Moenkhausia dichroura (Kner 1858)	2				2	0,5%
Myloplus levis (Eigenmann & McAtee 1907)			1		1	0,2%
Odontostilbe pequira (Steindachner 1882)	28		1	1	30	6,8%
Otocinclus vittatus Regan 1904	1		13		14	3,2%
Oxydoras kneri Bleeker 1862		1	2		3	0,7%
Phenacogaster jancupa Malabarba & Lucena 1995	2		2		4	0,9%
Pimelodella cf. *megalura* Miranda Ribeiro 1918	1				1	0,2%
Pimelodella gracilis (Valenciennes 1835)	4				4	0,9%
Plagioscion squamosissimus (Heckel 1840)				1	1	0,2%
Plagioscion ternetzi Boulenger 1895		1			1	0,2%
Psectrogaster curviventris Eigenmann & Kennedy 1903		1		6	7	1,6%
Pterygoplichthys ambrosettii (Holmberg 1893)		1			1	0,2%
Pygocentrus nattereri Kner 1858		1		1	2	0,5%
Pyxiloricaria menezesi Isbrücker & Nijssen 1984		1		5	6	1,4%
Rineloricaria cf. *parva* (Boulenger 1895)			2		2	0,5%
Roeboides affinis (Günther 1868)		6		1	7	1,6%
Roeboides cf. *microlepis* (Reinhardt 1851)				1	1	0,2%
Schizodon borellii (Boulenger 1900)			1		1	0,2%
Serrasalmus maculatus Kner 1858			2	1	3	0,7%
Spatuloricaria evansii (Boulenger 1892)			1	9	10	2,3%
Steindachnerina brevipinna (Eigenmann & Eigenmann 1889)			1		1	0,2%
Sturisoma barbatum (Kner 1853)		2		7	9	2,0%
Tetragonopterus argenteus Cuvier 1816	2			1	3	0,7%
Thoracocharax stellatus (Kner 1858)	16				16	3,6%
Trachydoras paraguayensis (Eigenmann & Ward 1907)		12		20	32	7,2%
Triportheus nematurus (Kner 1858)		3		2	5	1,1%

Taxon	1st day	2nd day	3rd day	4th day	Total	Relative %
Triportheus pantanensis Malabarba 2004			5		5	1,1%
Total	**163**	**38**	**165**	**77**	**443**	**100,0%**

Sample efficiency curve

The scarcity curve was developed by extrapolating data on the number of species and the number of individuals, to analyze the sampling effort of the collection campaign. Through the graph with the richness and abundance data it is possible to observe that the number of species increases as more individuals are captured. In this first campaign a total of 443 individuals were captured. Possibly, with the increase of the capture of individuals, new species can be captured (**Figure 403**).

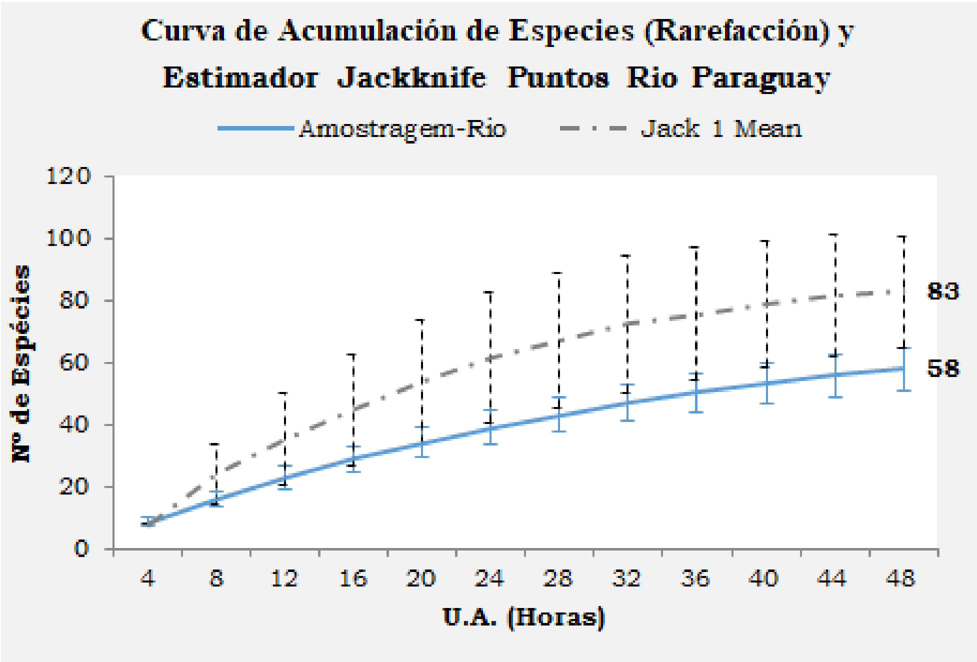


Figure 411 – Rarefaction curve of ichthyofauna species recorded during the first sampling campaign.

As shown in the graph, the Jackknife 1 richness estimator indicates a potential richness of 83 species, compared to 58 identified in the first collection campaign, showing an increasing trend. Thus, with the continuity of the studies, the number of species recorded tends to increase. This occurs because tropical communities tend to be formed by many individuals of few species (common species) and few individuals of many species (rare species). Therefore, the probability of capturing rare species tends to increase with greater sampling effort.

Diversity index

The Shannon H diversity index (3.3) indicates that there is great local diversity. Community equitability (0.81) is also expressed by the low dominance index (0.057), where the two estimators range from 0 to 1.

With these results, it can be deduced that the set of fish in the region of the collection is diverse and with notable abundance.

Table 34 – List of ichthyofauna species recorded during the first sampling campaign in March/2020.

Taxon	Popular Name in Paraguay	General	Day 1	Day 2	Day 3	Day 4	Guild	Status	Status fishbase	Categories of Threat	
										IUCN (2018)	PY
CHARACIFORMES											
Family Acestrorhynchidae											
Acestrorhynchus pantaneiro Menezes, 1992	Pira jagua	1			1		GEN/CA	AUT/NA	Native	Not valued	NC
Family Anostomidae											
Abramites hypselonotus (Günther, 1868)	Jiki	1			1		GEN/HE		Native	NA	NC
Leporinus friderici (Bloch, 1794)	Boga	1				1	GEN/HE-CA	AUT/NA	Native	NA	NC
Leporinus striatus (Kner, 1858)	Boguita rayada	1	1				GEN/HE-CA	AUT/NA	Native	NA	NC
Schizodon borellii (Boulenger, 1900)	Boga fina	1			1		HE	AUT/NA	Native	NA	NC
Family Characidae											
Astyanax lacustris (Lütken, 1875)	Mojarra	3			3		GEN/ON	AUT/NA	Native	NA	NC
Astyanax sp.	-	1			1		GEN/ON	AUT/NA	Native	NA	
Moenkhausia dichroura (Kner, 1858)	Mojarra	2	2				ON		Native	NA	NC
Moenkhausia intermedia Eigenmann, 1908	Mojarra cola de tijera	30			24	6	ON		Native	NA	NC
SubFamily Aphyocharacinae											
Aphyocharax anisitsi (Eigenmann & Kennedy, 1903)	Tetra de atletas rojas	46	6		39	1	GEN/ON	ALO/NA	Native	NA	NC
SubFamily Characinae											
Galeocharax humeralis (Valenciennes, 1834)	Dientudo	10	5	0	1	4	CA		Native	NA	NC
Phenacogaster tegatus (Eigenmann, 1911)	-	4	2		2		CA		Native	NA	NC
Roeboides cf. *affinis* (Guenther, 1868)	Dientudo jorobado	7		6		1	CA			NA	NC
Roeboides cf. *microlepis* (Reinhardt, 1851)	Dientudo	1				1	CA		Native	NA	NC

Taxon	Popular Name in Paraguay	General	Day 1	Day 2	Day 3	Day 4	Guild	Status	Status fishbase	Categories of Threat	
										IUCN (2018)	PY
SubFamily Cheirodontinae											
Odontostilbe pequira (Steindachner, 1882)	Pequira	30	28		1	1	GEN/ON	AUT/NA	Native	NA	NC
SubFamily Stevardiinae											
Bryconamericus exodon Eigenmann, 1907	Mojarra, Piky	55	55				IN		Native	NA	NC
Creagrutus paraguayensis Mahnert & Géry, 1988	-	1	1				ON		Native	NA	NC
SubFamily Tetragonopterinae											
Tetragonopterus argenteus Cuvier, 1816	Relojito	3	2			1	ON		Native	NA	NC
Family Crenuchidae											
Characidium laterale (Boulenger, 1895)	-	2	2				IN	AUT/NA	Native	NA	NC
Family Curimatidae											
Curimatella dorsalis (Eigenmann & Eigenmann, 1889)	Sabalito, blanquillo, boguita	2			2		Detr		Native	NA	NC
Psectrogaster curviventris Eigenmann & Kennedy, 1903	Sabalito, llorona, blanquillo, gritón	7		1		6	Dent		Native	NA	NC
Steindachnerina brevipinna (Eigenmann & Eigenmann, 1889)	Sabalito, blanquillo, huevada	1			1		Dent		Native	NA	NC
Family Erythrinidae											
Hoplias malabaricus (Bloch, 1794)	Tararira tarey'i	4			2	2	GEN/CA	AUT/NA	Native	NA	NC
Family Gasteropelecidae											
Gasteropelecus sternicla (Linnaeus, 1758)	Pez hacha común	1			1		Ins/Inv		.	NA	NC
Thoracocharax stellatus (Kner, 1858)	Pechito, chirola, medallita, pez volador	16	16				Ins/Inv		Native	NA	NC
Family Hemiodontidae											
Hemiodus cf. *orthonops* Eigenmann & Kennedy, 1903	Sardina de río	8	6		2		ON		Native	NA	NC
Family Parodontidae											

Taxon	Popular Name in Paraguay	General	Day 1	Day 2	Day 3	Day 4	Guild	Status	Status fishbase	Categories of Threat	
										IUCN (2018)	PY
Apareiodon affinis (Steindachner, 1879)	Virolito	6	4		2		ON	Nativo	Native	NA	NC
Family Serrasalmidae											
Myloplus levis (Eigenmann & McAtee, 1907)	Palometa	1			1		HE		Native	NA	NC
Pygocentrus nattereri Kner, 1858	Piraña roja, piraña mora, palometa	2		1		1	CA		Native	NA	NC
Serrasalmus maculatus Kner, 1858	Piraña, pirái	3			2	1	CA		Native	NA	NC
Family Triportheidae											
Triportheus nematurus (Kner, 1858)	Golondrina, machete, pirá güirá, chape	5		3		2	Ins/Inv		Native	NA	NC
Triportheus pantanensis Malabarba, 2004	Golondrina	5			5		Ins/Inv		Native	NE	NC
Order Gymnotiformes											
Family Sternopygidae											
Eigenmannia trilineata (López & Castello, 1966)	Banderita	1			1		GEN/IS-CA	AUT/NA	Native	NA	NC
Order Siluriformes											
Family Doradidae											
Oxydoras kneri Bleeker, 1862	Armado chancho	3		1	2		ON		Native	NA	NC
Trachydoras paraguayensis (Eigenmann & Ward, 1907)	Armado	32		12		20	ON		Native	NA	NC
Family Heptapteridae											
Pimelodella cf. *megalura* Miranda Ribeiro, 1918	Mandi´i	1	1				INS/INV		Native	NA	NC
Pimelodella gracilis (Valenciennes, 1835)	Bragecito, bagre cantor	4	4				ON		Native	NA	NC
Family Loricariidae											
SubFamily Hypostominae											
Hypoptopoma inexspectatum (Holmberg, 1893)	Limpiafondos, vieja del agua, vieja	14	5		9		Detri		Native	NA	NC

Taxon	Popular Name in Paraguay	General	Day 1	Day 2	Day 3	Day 4	Guild	Status	Status fishbase	Categories of Threat	
										IUCN (2018)	PY
Hypostomus cf. *boulengeri* (Eigenmann & Kennedy, 1903)	Vieja de agua	1				1	Detri		Native	NA	NC
Hypostomus cf. *latifrons* Weber, 1986	Vieja de agua	15	5		8	2	Detri		NE	NA	NC
Hypostomus sp1.	Vieja de agua	1			1		Detri		.		
Hypostomus sp2.	Vieja de agua	39	14		25		Detri		.		
Hypostomus sp2.	Vieja de agua	5	1		4		Detri		.		
Pterygoplichthys ambrosettii (Holmberg, 1893)	Vieja de agua	1		1			DETR	ALO/NA	Native	NA	NC
SubFamily Hypoptopomatinae											
Otocinclus vittatus Regan, 1904	Limpiavidrios	14	1		13		HER		Native	NA	NC
SubFamily Loricariinae											
Loricaria sp.	Cascarudo	5		3		2			.		
Loricariichthys platymetopon Isbruecker & Nijssen, 1979	Vieja de agua	1		1			DETR		Native	NA	NC
Pyxiloricaria menezesi Isbrücker & Nijssen, 1984	Vieja de agua	6		1		5	DETR		NE	NA	NC
Rineloricaria cf. *parva* (Boulenger, 1895)	Vieja del agua, viejita cola de látigo	2			2		DETR		Native	NA	NC
Spatuloricaria evansii (Boulenger, 1892)	Vieja	10			1	9	DETR		NE	NA	NC
Sturisoma barbatum (Kner, 1853)	Vieja de agua	9		2		7	DETR		NE	NA	NC
Family Pimelodidae											
Iheringichthys labrosus (Luetken, 1874)	Bagre picudo, bagre trompudo	7		5	1	1	ON		Native	NA	NC
Order CICHLIFORMES											
Family Ciclidae											
Bujurquina vittata (Heckel, 1840)	Acara, takype	1			1		ON		Native	NA	NC
Crenicichla semifasciata (Heckel, 1840)	Chanchita	1			1		CA		Native	NA	NC
Crenicichla vittata Heckel, 1840	Cabeza Amarga Colorado	6	2		3	1	CA		Native	NA	NC

Taxon	Popular Name in Paraguay	General	Day 1	Day 2	Day 3	Day 4	Guild	Status	Status fishbase	Categories of Threat	
										IUCN (2018)	PY
Gymnogeophagus balzanii (Perugia, 1891)	Chanchita	1			1		ON		Native	NA	NC
INCERTAE SEDIS											
Plagioscion squamosissimus (Heckel, 1840)	Corvina de río, pescada da Piauí	1				1	CA		Native	NA	NC
Plagioscion ternetzi Boulenger, 1895	Corvina de río	1		1			CA		Native	NA	NC

Legend: Food guild (detritivores (DETR); generalists (GEN); insetivores (INS); invertivores (INV); herbivores (HE); omnivores (ON) and piscivores (PISC); Status according to fishbase (native/non-native); Threat categories according to IUCN Not Evaluated (NA), PY Nothing appears (NC).

Ecological Categories

Food Guilds

The following characteristics were selected for the food guilds (detritivores; generalists; insectivores; invertors; herbivores; omnivores and piscivores). Invertivorous fish are likely to be favored by the increased availability of food, as flooding favors the abundance of benthic invertebrates (Neckles et al., 1990; Aspin et al., 2018). Similarly, omnivorous fish, being generalists, may be favored by the overall increase in resource availability provided by more intense flooding, as fish have more access to floodplain compartments and allochthonous resources (Junk et al., 1997; Balcombe et al., 2005; Quirino et al., 2018; Castello et al., 2019; Liu et al., 2019). Herbivorous fish can be favored in long-lasting droughts, as flooding fragments and reduces the appearance of macrophyte and biomass shoals (Bulla et al., 2011; Schneider et al., 2018), so in periods of drought these shoals tend to be more durable, favoring feeding. For fishermen's associations, during droughts the isolation and confinement of fish in floodplain enclosures (Rodríguez and Lewis; 1997; Thomaz et al., 2007; Pusey et al., 2016), can benefit from greater success in the predatory activities of fish species.

In tropical regions, generalist and/or opportunist species predominate, promoted by the wide and variable supply of resources (Lowe McConnell 1999, Araújo-Lima et al 1995). According to Schoener (1971) generalist species are those that have a wide spectrum of food and/or a high variation of food. Already opportunistic species feed on rare sources of their diet or use abundant and unusual food sources (Gerking 1994). As an example of this behavior, omnivorous fish also combine intake of plant and animal elements. Plant items do not require as much effort to obtain as animal items, but they have a high energy value (Montgomery & Targett, 1992). And studies of the ecomorphology of the species Pimelodus and Rhamdia are examples of omnivores that feed at great depths and have a nocturnal habit (Lolis & Andrian 1996, Souza & Barella 2009).

Species of economic interest

Larger fishes are of great economic and sporting interest such as the *Prochilodus lineatus*, *Salminus brasiliensis*, *Pseudoplatystoma corruscans*, *Pseudoplatystoma reticulatum*, *Piaractus mesopotamicus*, *Leporinus friderici* and *Brycon hilarii* are some of the most notable species of Pantanal ichthyofauna. This is due, in part, to the large size of these species, which are valuable for both amateur and professional fishing (Catella, 2004).

Poorly documented but no less important, small fish species up to 15 cm in length are essential for feeding because they are links in the food chain or directly make up the food preference of larger species, without which many large species could not exist. Small fish are organisms whose biological richness has not yet been adequately assessed (Sabino and Prado, 2006).

Bioindicators species

Fish are good bioindicators of environmental water quality, due to aspects of clustering, such as the inclusion of different groups of different trophic levels (Flores and MAlabarba, 2007). Knowledge of biodiversity, especially of fish, due to the various positions this group occupies in a food chain, and knowledge of how spatial and temporal variation behaviours work, is a great biological tool to evaluate the quality of the environment (Teixeira et al., 2005). Species such as Astyanax, Hyphessobrycon and

Piabina, are generally considered to be environmental bioindicators (Bennemann et al. 2006).

Migratory species

Migratory fish species may be favored by longer flooding times, with increased water flow and connection of breeding areas. (Vasconcelos et al., 2014; Oliveira et al., 2015). Fish settle in certain environments due to a set of biotic and abiotic factors that occur at that time. Factors such as the availability of shelter, feeding and reproduction sites are essential for the establishment of these species (Bennemann; Shibatta; Garavello, 2000).

The *Leporinus friderici* migrates to adulthood. Most individuals of this species reside in rivers and large streams as adults and can occasionally be found in smaller streams in the juvenile stage (Pompeu & Godinho 2003). The flooding period is one of the determining factors in the recruitment of species, especially migratory ones (Gomes & Agostinho, 1997; Agostinho et al., 2004c). Populations may suffer declines due to the loss of essential habitats that are necessary to complete their life cycles (Agostinho et al., 1999; Ceregato & Petrere Jr., 2003).

Rare species

In the case of rare species, no cases were recorded in the first ichthyofauna campaign either.

Endangered, endemic or exotic species

Data generated during the international workshop on the assessment of fish extinction risk in the lower Plata river basin, held in 2008, assessed the conservation status of freshwater species present in Paraguay (Baigún et al., 2012), using the IUCN criteria (2010). Eleven species were assessed as threatened in the lower Plata river basin, four of which are found in Paraguay, as endangered species *Gymnogeophagus setequedas* (Malabarba and Pavanelli 1992), and *Hypostomus dlouhyi* (Weber 1985), in the vulnerable category *Ancistrus piriformis* (Muller 1989) and *Brycon orbignyanus* (Valenciennes, 1850) species with occurrence records for the Paraná river basin in Paraguay. Two species also cited as vulnerable and with possible presence in Paraguay are *Salminus hilarii* (Valenciennes 1850) and *Zungaro jahu* (Ihering 1898).

Of the species caught in the March 2020 campaign, none is included in the IUCN's list of endangered species (2018), or Paraguay's List of Endangered Fauna. Since exotic species cause significant impacts on regional fauna due to their rapid population explosion, they threaten native species, increasing environmental stress and competition (Augustine, 1993 and 1996; Buckup, 1998).

Plagioscion squamosissimus, found in the collection area is a species that was introduced in several basins, becoming abundant in several regions. The species adapts easily to various situations/environments due to its high plasticity, and therefore is present in several rivers. Young individuals feed essentially on insects and while adults feed on fish, a notable trophic ontogeny (Hahn and others 1997b; Hahn and others 1999).

Photographic report

Figure 412 – *Acestrorhynchus pantaneiro*

Figure 413 – *Gymnogeophagus balzanii*

Figure 414 – *Hypostomus cf. boulengeri*

Figure 415 – *Oxydoras kneri*

Figure 416 – *Myloplus levis*

Figure 417 – *Creagrutus meridionalis*

Figure 418 – *Loricaria sp.*

Figure 419 – *Pterygoplichthys ambrosettii*

Figure 420 – *Pygocentrus nattereri*

Figure 421 – *Thoracocharax stellatus*

Figure 422 – *Plagioscion squamosissimus*

Figure 423 – *Psectrogaster curviventris*

Final Considerations on Ichthyofauna

This ichthyofaunal study conducted in the area of influence of the PARACEL pulp mill shows that the richness and diversity of species is high, despite the advanced state of degradation of their biotypes and the constant impacts to which these populations are submitted, which demonstrates the need to implement conservation strategies, since the implementation of the PARACEL pulp mill in the area may cause another impact on the local ichthyofauna.

9.2.2.6 Aquatic Organisms (Phytoplankton, Zooplankton and Zoobenthos)

9.2.2.6.1 Regional Characterization (IIA)

The characterization of aquatic biota (phytoplankton and benthic invertebrates) in the Area of Indirect Influence - IIA of the PARACEL pulp mill was based on secondary data from the specialized literature, focusing on academic studies and publications provided by government agencies.

The mill's IIA is located in the Paraguay River basin, whose drainage area includes transboundary regions, receiving input from several tributaries, including the Verde River on the right bank, Aguaray Guazu, Manduvirá, Aquidabán and Ypané on the left bank. Among them, Aquidaban and Ypané are the main tributaries of the IIA. Details of the IIA's delimitation of the biotic environment are included in a separate chapter of this EIA. The general aspects of the aquatic communities assessed, and the results obtained in the secondary data study are discussed below.

A) <u>Phytoplankton</u>

General aspects

The phytoplankton community brings together microscopic organisms that live in the surface layers of the water, moving with the current. This community includes algae and cyanobacteria, primitive autotrophic beings formerly known as blue algae.

Phytoplankton performs photosynthesis and plays a role in the aquatic environment similar to that of plants in the terrestrial environment. Algae and cyanobacteria assimilate the mineral nutrients available in the water, especially nitrogen and phosphorus, tending to develop more in lentic environments, with high luminosity and enriched with mineral salts.

The predominance of certain groups of phytoplankton is the result of the dynamics of the interactions between the physiological characteristics of the organisms and abiotic factors. In tropical regions, underwater radiation and the availability of mineral nutrients, mainly phosphorus and nitrogen, are of particular importance. These factors influence the productivity of phytoplankton organisms, with repercussions on the composition and abundance of other links in the aquatic food chain, such as zooplankton, benthic invertebrates and the fish community. Due to their short life cycle, phytoplankton organisms respond quickly to environmental changes, making them efficient indicators of water quality (REYNOLDS, 1997).

Results obtained

In September 1997, the Paraguay river basin, in the stretch between the Negro and Aquidabán rivers, was the object of the technical-scientific expedition called AquaRAP, coordinated by the conservationist entity CI (Conservation International). The results of the initiative, in which several researchers from different specialties participated, were published in a collection of chapters that summarize the increased knowledge of regional biodiversity. According to the authors, this region was selected because it is sparsely populated and under-researched, and has suffered relatively little anthropogenic disturbance (CHERNOFF, et al, 2001). Thirty-five stations were evaluated, 14 of which were distributed along the Paraguay River, including points upstream and in the IIA of the project in question. In this study, water quality, phytoplankton and benthic invertebrates were studied, among others.

According to the authors, the waters of the Paraguay River are generally slightly acidic (pH 6.0-6.5), with low oxygen levels (<6.0 mg/L), low electrical conductivity (60-100 µS/cm) and temperatures between 24-27° C. Preliminary analysis of phytoplankton indicated a wide diversity of this group, with the registration of species of *Chlorophyta*, *Euglenophyta*, *Chrysophyta*, *Bacillariophyta* and *Cyanophyta*. According to the authors, detailed identification at the specific level was in progress (CHERNOFF, et al, 2001), which made it impossible to compile a list of this work.

Santos (2016) carried out an extensive study of phytoplankton in the main watercourses of Paraguayan territory, including the points inserted in the IIA and in the bordering regions of this area, with emphasis on two of the main tributaries of the Paraguay River, the Aquidabán and Ypané Rivers, and two points of the Paraguay River.

Throughout the sampling network, 148 samples were collected between 2009 and 2012, resulting in the registration of 431 taxons, with the greatest richness attributed to the green *algae Chlorophyceae*, with 253 species, followed by the diatoms *Bacillariophyceae* (117) and *Cyanophyceae* (42).

In particular, points of interest on the Paraguay River were reported to be richer in Bacillariophyceae diatoms, including taxons of the genera Eunotia, Gomphonema, Rhopalodia and Surirella. This group is quite representative in continental aquatic ecosystems, both in terms of richness and abundance of algae species (HOEK et al. 1995).

The algae Zygnematophyceae and Euglenophyceae stood out secondarily for their greater diversity, bringing together taxons of the genera Staurastrum and Spirogyra (*zignemaficae*), Euglena and Phacus (*euglenophyceae*).

The group Cyanophyceae presented a low representativeness in terms of richness, registering only the species *Oscillatoria princeps*, which is a positive aspect, since cyanobacteria are capable of forming blooms with potential production of toxins. According to Sant'anna and others (2006), the same cyanobacteria can produce several cyanotoxins, as is the case with *Oscillatoria*.

The list of taxons registered in the Paraguay River and its tributaries is shown in the following table. It should be noted that the present study reviewed the phytoplankton taxonomic classification of the taxons presented in the Santos study (2016), using the global online database Algaebase (GUIRRY and GUIRRY, 2020).

Table 35 – Taxonomic composition of phytoplankton in the Paraguay River and tributaries

Taxonomic composition	Paraguay river*	Aquidabán river	Ypané river
Bacillariophyceae			
Cymbella cuspidata			X
Eunotia sp.	x		
Gomphonema af. *acutiusculum*	x		
Gomphonema af. *parvulum*		x	
Nitzschia levidensis			x
Rhopalodia parallela	x		
Surirella af. *arcta*	x		
Surirella sp.		x	

Taxonomic composition	Paraguay river*	Aquidabán river	Ypané river
Tabellaria fenestrata			x
Chlorophyceae			
Characium ornithocephalum var. *ornithocephalum*	x		
Trebouxiophyceae			
Oocystis solitaria	x		
Rhopalosolen cylindricus	x		
Zygnematophyceae			
Cosmarium pseudoconnatum var. *pseudoconnatum*			x
Gymnozyga moniliformis			x
Pleurotaenium ehrenbergii var. *elongatum*		x	
Staurastrum limneticum var. *cornutum*			x
Staurastrum minnesotense	x		
Spirogyra crassa	x		
Spirogyra cylindrica		x	
Spirogyra distenta	x		
Cyanophyceae			
Oscillatoria princeps	x		
Euglenophyceae			
Euglena oxyuris var. *minor*	x		
Euglena spirogyra	x		
Phacus longicauda	x		
Total de táxons	**14**	**4**	**6**

Source: Adapted from Santos (2016). * Coordinates of the points: Aquidaban river (S23 02,680 W57 00,698), Ypané (S23 25,438 W56 29,575 and S23 25,431 W56 29,602) and Paraguay (IIA: S23 27,362 W57 27,026 and downstream IIA - S26 51,298 W58 18,690).

Silva and others (2000) evaluated the phytoplankton community in the portion of the Upper Paraguay River, upstream of the limits of the Area of Indirect Influence, in Brazilian territory, in the city of Corumbá, with monthly collections made from January 1996 to February 1997, at a point on the Paraguay River, which made it possible to follow the spatial variation of this community in this watercourse.

According to the authors, algae belonging to the class Chlorophyceae predominated in number of taxons in the Paraguay River, followed by the Euglenophyceae. The highest phytoplankton densities occurred between February and April, with density fluctuations attributed to seasonal variations.

The algae of the class Cryptophyceae were numerically dominant, with the species Cryptomonas brasiliensis predominating. This group, according to Reynolds (1984), has a high metabolic activity and a high rate of production/biomass, which indicates a great adaptability and efficiency in the use of nutrients in extreme conditions of high luminosity, being considered opportunistic, developing mainly in adverse conditions to other species (KLAVENESS, 1988).

B) <u>Benthic invertebrates</u>

General aspects

In the ecological aspect of the aquatic environment, the benthic fauna, that is, the one that lives under or on top of the substrate, plays a preponderant role in the recycling of organic compounds, participating in the redistribution of the background material and contributing to the decomposition of potentially polluting substances. Benthic invertebrates can inhabit the coastal and deep water region, including mainly species of the groups Insecta (insects), Annelida (annelids), Nematoda (cylindrical worms), Crustacea (crustaceans) and Mollusca (bivalves and gastropods).

This community includes organisms of various trophic levels, from primary consumers to top predators, which also exhibit a wide variety of feeding habits, including collecting members (reservoir and filter consumers), scrapers, grinders, predators and parasites. This group of organisms represents an important link in the food web of aquatic systems, transferring energy from various trophic levels and feeding numerous species of fish and birds.

Benthic organisms are bio-indicators because they are abundant in all types of aquatic systems, have low mobility, and are selective in their habitat, reflecting more accurately possible imbalances, either through the introduction of polluting and contaminating compounds into water bodies, or through the physical alteration of the substrate caused, for example, by the transport of solids in the drainage area. The use of the benthic community also allows the temporary assessment of changes caused by disturbances in the aquatic environment, since, during its relatively long life cycle (from weeks to years), it responds continuously to variations in the environment, showing a wide variety of tolerance to pollution.

The distribution and abundance of benthic organisms are influenced by biogeographical aspects and characteristics of the environment, such as the type of sediment, organic matter content, depth, physical and chemical parameters of the water and the presence of macrophytes (CARVALHO & UIEDA, 2004). SMITH et al., 2003. VIDAL-ABARCA et al., 2004 apud ABÍLIO et al., 2007).

In this sense, some factors are important for the maintenance of benthic fauna diversity, highlighting the availability of oxygen, which tends to be limited in the deepest layers of aquatic ecosystems; the preservation of the substrate at the bottom, which corresponds to the place of fixation and refuge of most of these organisms; and the maintenance of riparian forests (protectors of water resources), which provide stability to the margins of watercourses and contribute to the introduction of food necessary for the survival of these beings.

Results obtained

Galeano Molinas (2018) conducted a survey of the benthic community in the Guasú stream region, located in an urban area of the Central Department of Paraguay, covering five sampling points, two of which were distributed on the Paraguay River and are limited to the project's IIA. In this study, samples were collected in two different periods (November 2017 and April 2018), covering the spring and autumn. In all campaigns, 254 individuals from the benthic community, members of the Insecta class, were recorded, distributed in six orders, of which Diptera was the most diverse, as shown in the table below.

The author concluded that only the families Chironomidae and Culicidae were recorded in both periods and were also more prominent in terms of abundance. Other families, such as Corixidae, Gerridae, Stratiomidae, Caenidae and Psychodidae, were also reported as indicators of water quality.

The application of the environmental indicator (BMWP Index - Biological Monitoring Working Group) indicated the critical water quality at the sampled sites. In addition, water samples were collected, and the Water Quality Index applied, according to the methodologies proposed by Brown (1970) and Lopez et al (2016), which showed water quality between Reasonable and Poor. The author pointed out that the association of these indicators showed that the low diversity of the benthic community in the points studied is due to anthropic changes (GALEANO MOLINAS, 2018), a condition that tends to affect benthic aquatic organisms, favoring the predominance of the taxons that are more resistant to environmental disturbances and changes.

The experiment called AquaRAP, carried out in September 1997, included studies of the benthic community in the Paraguay river basin, in the area between the Negro and Aquidabán rivers (CHERNOFF, et al., 2001). For the benthic community, 33 stations were evaluated, 14 of which were distributed along the Paraguay river, including points upstream and in the IIA of the PARACEL pulp mill.

In this study a total of 2,213 individuals from the benthic community were captured at the 33 sampling stations. Diptera larvae of the family Chironomidae and Oligochaeta ringidae were the dominant groups at 27 stations, representing respectively 52% and 35% of the organisms recorded. Other groups detected in smaller numbers are Odonata, Trichoptera, Ephemeroptera, Ceratopogonidae, Corixidae, Ostracoda, Bivalvia, Nematoda, Hirudinea, among others.

Among the larvae of Chironomidae, the most abundant were the taxons *Nimbocera paulensis*, *Polypedilum*, *Chironomus*, *Ablabesmyia*, *Goeldichironomus*, *Fissimentum desiccatum*, *Harnischia*, *Nilothauma*, *Parachironomus*, *Stenochironomus*, *Asheum*, *Coelotanypus* y *Djalmabatista.*

According to the authors, the diversity of benthic invertebrates can be considered high compared to other river basins in South America. Most recorded genres were considered typical of herbaceous swamps, lagoons, lakes and slower portions of streams and rivers. In sites rich in decomposing vegetation, the diversity of benthic organisms was lower, as was the case in some stations of the Paraguay River, where *Chironomus larvae* predominated, a typical group of habitats rich in decomposing organic matter, with low oxygen concentrations.

It should be noted that the work mentioned does not include a detailed list of all the taxons by environment monitored and sampled. However, Appendix 8 of the above-mentioned study (CHERNOFF, et al, 2001) presents the main taxon of the benthic community recorded in the sample as a whole. Thus, the list presented in the following table does not reflect all the data studied in the study, but it does provide a general overview of the benthic community living in the Paraguay river basin. In the preparation of this table, the taxonomic classification of benthic invertebrates was reviewed using the ITIS - Advanced Search and Report - Integrated Taxonomic System platform as a basis.

Table 36 – Taxonomic composition of benthic invertebrates in the Paraguay River and tributaries.

Taxonomic Composition	Paraguay river and tributaries	Arroyo Guasú and Paraguay river
	Chernoff, *et al.* (2001)	Galeano Molinas (2018)*
Phylum Annelida		
Class Clitellata		
SubClass Hirudinea	X	
SubClass Oligochaeta	X	
Phylum Arthropoda		
SubPhylum Crustacea		
Class Ostracoda	X	
Class Branchiopoda		
Order Laevicaudata	X	
SubPhylum Hexapoda		
Class Insecta		
Order Coleoptera	X	
Family Hydrophilidae		X
Order Diptera		
Family Ceratopogonidae	X	
Family Chaoboridae		
Chaoborus sp.	X	
Family Chironomidae		X
Subfamilia Chironominae		
Tribo Chironomini		
Asheum sp.	X	
Beardius sp.	X	
Chironomus sp.	X	
Cryptochironomus sp.	X	
Polypedilum sp.	X	
Tribo Tanytarsini		
Nimbocera sp.	X	
Subfamilia Tanypodinae		
Ablabesmyia sp.	X	
Family Tipulidae	X	
Family Culicidae		X
Family Muscidae		X
Family Psychodidae		X
Family Stratiomyidae		X
Order Ephemeroptera	X	
Family Caenidae		X
Order Hemiptera		
Family Corixidae	X	X
Family Gerridae		X
Order Odonata	X	
Order Trichoptera	X	
Order Lepidoptera		
Family Crambidae		X
Order Megaloptera		

Taxonomic Composition	Paraguay river and tributaries	Arroyo Guasú and Paraguay river
	Chernoff, *et al.* (2001)	**Galeano Molinas (2018)***
Family Sialidae		X
Phylum Mollusca		
Class Bivalvia	X	
Class Gastropoda	X	
Phylum Nematoda	X	
Phylum Platyhelminthes	X	
Total de táxons	**23**	**11**

Source: Adapted from Chernoff, et al (2001) and Galeano Molinas (2018) *Observation: Coordinates of the points of interest in the study by Galeano Molinas (2018): P03 25º24'18,34 "S e 57º34'18,92 "W e P04 - 25º24'36,50" S e 57º34'54,74 "W.

9.2.2.6.2 Local Characterization (DIA and ADA)

Methods

The Direct Influence Area (DIA) is located in the department of Concepción, covering the Paraguay River, about 10 km upstream from the urban center of Concepción. The area directly affected (ADA) of the project includes the proposed pulp mill on the left bank of the Paraguay River.

The assessment of aquatic biota (phytoplankton and benthic invertebrates), within the framework of the DIA and DAA of PARACEL pulp mill, was carried out on the basis of two sampling campaigns, conducted during the rainy season, the first on October 17, 2019, in the spring, and the second on March 5, 2020, in the summer.

The collection and analysis of aquatic biota was carried out by Econsult Environmental Studies. This laboratory is accredited according to ABNT NBR ISO/IEC 17025, by the General Accreditation Coordination - Cgcre of the National Institute of Metrology, Standardization and Industrial Quality - INMETRO, of Brazil.

Below is the characterization of the sampling and details of the procedures adopted in the area and laboratory, as well as the indicators adopted for the evaluation of the aquatic communities.

A. Monitoring network

For the evaluation of the phytoplankton and zoobenthos communities, two sampling points have been selected in the Paraguay River, located upstream and downstream from the future PARACEL pulp mill. The following table and figure show the location of the sampling points.

Based on the monitoring results, the inclusion of new points can be evaluated in the future.

Table 37 – Network for sampling aquatic biota in the Paraguay River and its tributary.

Point	Location	Geographical Coordinates (Time zone 21J)	
		North	East
P01	Paraguay River, upstream of the future PARACEL pulp mill	7.428.366	446.452
P02	Paraguay River, downstream from the future PARACEL pulp mill	7.424.505	449.700

Figure 424 – Sampling network of the aquatic biota in the Paraguay River and its tributary.

Source: Google Earth (2020).

B. Monitoring of Samples and Laboratory Analysis Procedures

The samples of the aquatic biota were made with the help of a boat. Before taking the samples, the following information was recorded about the river and its surroundings at each collection point, in order to help interpret the analytical results: identification of the point with the codes adopted by the project, geographic location with the GPS, date and time of collection, predominant weather condition during collection, occurrence of rain in the last 24 hours, approximate width of the water body and state of preservation of the forest protecting the waterway, and photographic record.

The field work also included direct measurements to determine the following variables: air temperature (thermometer), depth and transparency (Secchi's disc equipped with a tape measure and a depth meter) and current speed (flow meter).

The equipment used in the field was duly calibrated in the laboratory of the Brazilian Calibration Network (RBC, in Spanish and Portuguese) and verified with traceable parameters to ensure the accuracy and precision of the data obtained. Some of the field procedures are illustrated in the following figures. The chains of custody are shown in

Annex I. The procedures adopted in the area and in the laboratory for each of the aquatic communities assessed are detailed below.

Figure 425 – Measuring transparency with the Secchi disk.

Figure 426 – Measurement of depth.

<u>Phytoplankton</u>

The methodology used for phytoplankton collection and analysis was based on the Standard Methods for the Examination of Water and Wastewater, 23rd ed.

At each collection point, a quantitative sample of phytoplankton was taken from the surface by direct immersion in a stainless steel container, which was directed to a 250 mL cylinder. The qualitative phytoplankton sample was obtained by horizontal dragging, using a plankton net with a 20 µm mesh opening.

To preserve the qualitative samples, a solution of 2% formalin neutralized with sodium bicarbonate was applied. Lugol drops were added to the quantitative samples. The collection vials were homogenized, labeled and sent to the laboratory.

In the laboratory, taxonomic identification of the phytoplankton was based on the specific literature of each group of algae and cyanobacteria, such as Bicudo & Menezes (2006), Sant'Anna et al. (2012), Round & Crawford (1990), among others. The process of identification occurred whenever possible at the species level, from the analysis of the population, using a binocular microscope.

Quantification of phytoplankton followed the method of chambered sedimentation, described by Utermöhl (1958). The sedimentation time varied according to the concentration of material in the sample and the volume analysed. The count limit was established by listing 100 individuals of the most abundant taxon (LUND, 1958). Each cell, cenobium, colony or filament was considered as an individual.

The results of phytoplankton density were expressed in organisms per milliliter (org./ml). In addition, the cyanobacterial cell count was also considered, taking into account that this parameter is governed by Resolution n. 222/2002. The phytoplankton test reports are presented in Annex II. The figures below illustrate some of the procedures for the collection and analysis of phytoplankton.

Figure 427 – The 20 µm network for qualitative sampling.

Figure 428 – Horizontal phytoplankton dragging.

Figure 429 – Conservation of the quantitative phytoplankton sample.

Figure 430 – Phytoplankton sample conditioning.

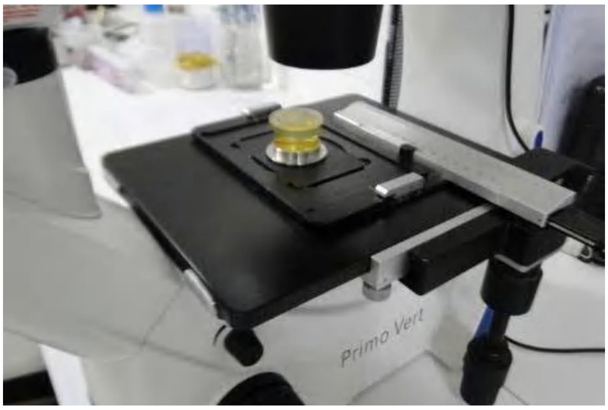


Figure 431 – Utermöhl camera sample.

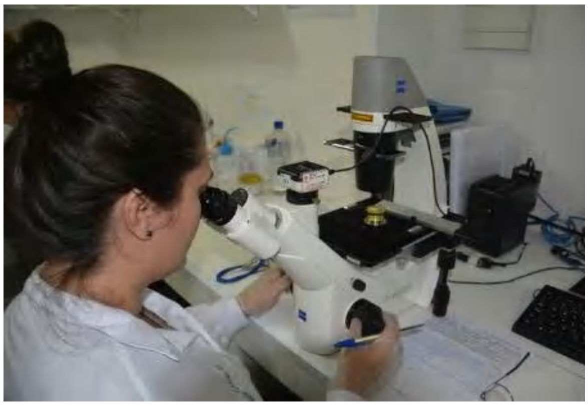


Figure 432 – Identification and quantification of phytoplankton.

Benthic Invertebrates

The methodology used for the collection and analysis of benthic invertebrates was based on the Standard Methods for the Examination of Water and Wastewater, 23rd ed.

At each collection point, benthic invertebrate samples were taken in triplicate, using the Petersen bottom collector (Area = 0.058 m^2). The collected sediment was washed in the field with the help of 250 µm mesh sieves. The material retained in the mesh was conditioned and preserved in 70% alcohol, previously colored with 0.1% Rose Bengal. The collection vials were homogenized, labeled and sent to the laboratory.

In the laboratory, the organisms were examined in square Petri dishes with the help of a stereomicroscope. Subsequently, taxonomic identification was performed in the stereomicroscope, according to the group of benthic invertebrates detected in the sample, using the identification keys and descriptions available in the specialized literature, such as Trivinho-Strixino & Strixino (2011), Brinkhurst & Marchese (1989) and Simone (2006), Hamada, et al. Mugnai et al (2010), Latini et al (2016), Mansur et al (2012) and Santos (2018).

The qualitative analysis identified all invertebrate groups present in the samples. The density of the benthic community in each replicate (sample) was obtained using the following formula (WELCH, 1948):

$$N = \frac{X}{A\ .\ S}$$

Where:

N= number of individuals /m^2
X= number of organisms counted in the sample.
A= sampler area (m^2)
S= launch/collection number

The density at each point was calculated by averaging the density of the three replicates, expressing the results in organisms per square meter (org./m^2).

Figure 433 – The Petersen dredger used to collect benthic invertebrates.

Figure 434 – The washing of the sediments on a sieve with an aperture of 250 µm.

Figure 435 – Analysis of benthic organisms.

Figure 436 – Identification with the stereomicroscope.

C. Data analysis

The following indices were adopted in the evaluation of the results of the phytoplankton and benthic communities.

<u>**Qualitative Analysis**</u>

Taxonomic composition, taxonomic richness and relative richness

The taxonomic composition includes the characterization of the taxons present in the samples. Taxon richness is obtained by counting the number of taxons recorded at each point. For the richness, the integration of the data obtained in the quantitative sampling is also considered. Relative richness, expressed as a percentage, presents the proportion of the number of taxons in each group inventoried. In the richness analysis, each species, morphospecies and organism could not be identified at a specific level as a taxon.

Geographical Distribution and Frequency of Occurrence

The spatial distribution of the organisms in the sampling network was examined according to the presence or absence of a given taxon at the collection points.

Exotic, Threatened and Important Species

The presence of exotic species was assessed and the Paraguayan Biodiversity Conservation Action Plan (SEAM, 2016) and the International List of Threatened Species (IUCN, 2020) were consulted for the analysis of the occurrence of threatened taxons of the fauna.

Quantitative Analysis

Density and relative abundance of planktonic and benthic communities

The density represents the amount of organisms present in the samples per sampled volume. The relative abundance indicates the numerical proportion of each group or taxon present in the sample under consideration and is calculated by the following formula:

$$AR = n \,.100 \,/N$$

Where:

AR = relative abundance;
n = total number of organisms in the group or taxon;
N = total number of organisms in the sample.

Diversity indexes

The Shannon-Wiener diversity index relates the number of taxons and the distribution of abundance among different taxons in a specific sample and is calculated by the following formula:

$$H' = -\sum pi.\log_2 pi \qquad \text{y} \qquad pi = \frac{n}{N}$$

where:

H'= The Shannon-Wiener Diversity Index, in bit.ind^{-1};
pi= relative abundance;
n = number of individuals collected from each taxon;
N = total number of individuals collected in the sample.

The Equitability index refers to the distribution of individuals among species, being proportional to diversity and inversely proportional to dominance. The measure of equitability compares Shannon-Wiener diversity with the distribution of observed species. This index is obtained through the equation:

$$J = H' / H'\,max$$

where:

J = Equitability
H' = Shannon-Wiener index
H' max = maximum diversity

Similarity Index

In the case of planktonic and benthic communities, the degree of similarity between the collection points was evaluated on the basis of the Bray-Curtis index. The similarity matrix was compared with a co-kinetic matrix in order to increase the reliability of the conclusions drawn from the interpretation of the dendrogram (KOPP et al., 2007). Values of 0.70 or more were adopted as a fidelity criterion (ROHLF, 1970).

Principal Component Analysis - PCA

Principal Component Analysis (PCA) was used to rank the physical and chemical parameters of water with phytoplankton density, considering the most representative taxons in terms of density. The benthic community was related to the sediment data. The physical-chemical data of water and sediments used in this analysis were obtained from the water quality diagnosis, based on the results of the first and second campaigns, presented in the chapter on physical environment diagnosis. For the correlation analyses, the PAST (Paleontological Statistics) version 2.17c (HAMMER et al., 2001).

Biological Monitoring Work Party Score System (BMWP index)

The assessment of the benthic community used the BMWP index, a metric that classifies invertebrate families into different groups, following a gradient of lower tolerance of organisms to organic contamination, regardless of the density found.

Each family corresponds to a score, which ranges from 10 to 1, with the highest values attributed to the families that are most sensitive to contamination. Since this index only requires identification at the family level, it is considered practical, easy to apply and useful for monitoring. The results obtained are added up and the final score acquired is classified into five classes, which correspond to the following categories: Excellent, Good, Fair, Bad and Poor.

9.2.2.6.3 Results obtained

The following is a description of the Paraguay River and the results of the aquatic communities, based on the data obtained in the two campaigns carried out during the rainy season, in October 2019, in the spring, and in March 2020, in the summer.

A. Characterization of Sampling Points

The following is a description of the sites sampled. The field records obtained are summarized in the table below. During both collections, the weather remained clear and rainy, with the occurrence of rain being recorded during the collection and in the previous 24 hours. The air temperature oscillated between 24.2ºC and 28.2ºC, both at point P01, in the first and second season, respectively.

Table 38 – Field records and *in-situ* monitoring on the Paraguay River

Field records	Paraguay river			
	P01		P02	
	1st C	2nd C	1st C	2nd C
Date of collection	17/10/2019	05/03/2020	17/10/2019	05/03/2020
Time of collection	16h00	09h00	14h50	09h55
Weather conditions in the campaign	Good	Good	Good	Good
Rain in the last 24 hours	No	No	No	No
Protective Forest	Partially Altered		Partially Altered	
Air temperature (ºC)	28,2	24,2	27,1	26,1
Approximate width (m)	1.500	1.400	950	900
Depth (m)	5,7	5,4	4,3	3,8
Transparency (m)	0,4	0,3	0,4	0,3
Current velocity (m/s)	0,4	0,3	0,4	0,2

The Paraguay River is a large watercourse and, in the DIA and ADA, it acts as a water boundary between the Departments of Presidente Hayes, on the right bank, and Concepción, on the left bank, observing the formation of meanders in this course. The nearest urban area (Concepción) is about 10 km downstream from point P02. In general, the riparian forest in the sampled sections is partially altered.

The width of this watercourse, in the sections evaluated, varied between 900 (P02) and 1,500 m (P01), with a depth of between 3.8 m and 5.7 m. Transparency was maintained at around 0.4 m in both collections. The current speed was high, reaching a maximum of 0.4 m/s, at both points, in the first campaign. The photographic record of the sampling points is as follows.

Figure 437 - Point P01: Paraguay river, upstream from PARACEL pulp mill, in campaign 1.

Figure 438 – Point P01: Paraguay river, upstream from PARACEL pulp mill, in campaign 2.

Figure 439 – Point P02: Paraguay river, downstream from PARACEL pulp mill, in campaign 1.

Figure 440 – Ponto P02: Paraguay river, downstream from PARACEL pulp mill, in campaign 2.

B. Phytoplankton

<u>Qualitative Analysis</u>

Taxonomic composition, taxonomic richness and relative richness

The consolidated results of the two sampling campaigns, conducted in October 2019, during the dry season, and March 2020, during the rainy season, showed the presence of 71 phytoplankton taxons in the Paraguay River, belonging to 11 taxonomic classes: Bacillariophyceae (20), Cyanophyceae (14), Chlorophyceae (12), Euglenophyceae (7) Conjugatophyceae (6), Coscinodiscophyceae (5), Mediophyceae (2), Cryptophyceae (2), Dinophyceae (1), Chrysophyceae (1) and Trebouxiophyceae (1).

The phytoplankton community recorded in this watercourse was predominantly formed by diatoms of bacillariumphyceae (class Bacillariophyceae), accounting for 28.2% of the total richness of the taxon, followed by cyanobacteria (class Cyanophyceae), with 19.7% of the total diversity sampled, as shown in the figure below.

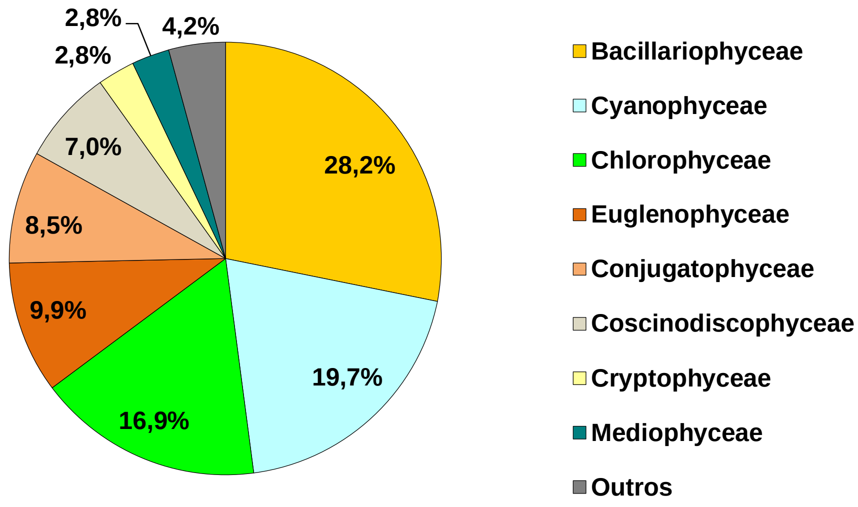


Figure 441 – Phytoplankton richness by taxonomic group in the Paraguay river - 1st C (October/2019) and 2nd C (Mar/20).

Obs: The group "Others" comprises the classes Chrysophyceae, Dinophyceae and Trebouxiophyceae.

The class Bacillariophyceae belongs to the group of diatoms, together with the Coscinodiscophyceae and Mediophyceae, which individually contributed 7% and 2.8% of the collected taxon, respectively, with diatoms accounting for 38% of the richness.

Diatoms add species that have a high rate of sedimentation in the aquatic environment, due to the composition of their cell wall, which is constituted by silica. As mentioned, this group is quite representative in inland aquatic ecosystems, both in terms of richness and abundance of algae species (HOEK et al. 1995).

In the Paraguay River, bacillaryophytes were represented by specimens of the genres *Achnanthes, Amphipleura, Amphora, Cymbella, Diadesmis, Eunotia, Fragilaria, Gyrosigma, Navicula, Nitzschia, Pinnularia, Stauroneis, Surirella, Synedra, Tabellaria y Ulnaria*, and an unidentified organism of the *Naviculaceae* family at the gender level. The class *Conscinodiscophyceae* brought together the genre *Aulacoseira* and *Melosira* and the class *Mediophyceae* taxon of the genre *Cyclotella* and *Thalassiosira*.

Cyanobacteria (class *Cyanophyceae*), the second most special taxonomic group (19.7%), include species that have efficient survival strategies due to their ecological and physiological characteristics (PAERL, 1988). Among the key factors for their reproductive success and development is the stability of the water column due to the presence of gaseous vacuoles (aerotopes) in several species, which allows the cells to regulate their fluctuation in response to the availability of light and nutrients (KLEMER & KONOPKA, 1989).

Some species in this group have the ability to assimilate nitrogen gas directly from the atmosphere, which is an advantage in environments with lower availability of nitrogen compounds. Among the competitive advantages of cyanobacteria, the lower herbivore pressure of zooplankton can also be mentioned (OLIVER & GANF, 2000). In this class, some specimens are recognized for their ability to produce toxins, which can cause interference in water quality and aquatic environment, especially when they form blossoms, as has been mentioned. However, it should be noted that the density of this class was inexpressive in the sample mesh, as detailed in the subtopic of quantitative analysis.

Chlorophyceae was the third class with the highest number of taxons (16.9%) in the Paraguay River, with the presence of eight genera, of which Monoraphidium with four species, followed by Desmodesmus and Pediastrum, with two taxons each.

This group includes green algae, cosmopolitan organisms that present an immense morphological variety. Most of them are typical of fresh water and may have planktonic and benthic habits, growing in environments of broad-spectrum salinity and eutrophication. According to Henry (1999), chlorophylls are one of the most ecologically important groups in inland aquatic ecosystems.

Euglenophyceae (*euglenophyceae*), responsible for 9.9% of the taxons sampled, were the fourth richest group, with specimens of the genera *Euglena*, *Lepocinclis*, *Phacus*, *Strombomonas y Trachelomonas* presents in Paraguay river.

This class comprises unicellular and filamentous animals, predominantly inhabitants of continental water systems. In general, these organisms tend to excel in waters rich in organic substances, due to the excessive development of aquatic macrophytes or the release of untreated effluent, especially in low-current environments with availability of nitrogen compounds. The possibility of moving through the flow is also an adaptation of this group in environments with high turbidity, which allows them to use the nutrients accumulated in deeper layers and then return to the euphotic region (BRANCO, 1986).

Conjugate algae (conjugatophyceae) were represented by taxon of the genera *Cosmarium, Closterium, Closteriopsis, Gonatozygon and Haplotaenium,* which account for 8.5% of the total taxon sampled, making up an extremely diverse group that is practically exclusive to these environments (GUIRY, 2013). This class includes a large number of species typical of oligotrophic aquatic systems, but there are representatives related to eutrophic systems, both in the planktonic and the peripheral communities (COESEL, 1982 apud MELO & SOUZA, 2009; SILVA, 1999).

The other classes recorded in the Paraguay River, including Cryptophyceae, Chrysophyceae, Dinophyceae e Trebouxiophyceae, had a smaller relative share in phytoplankton richness, which individually represented values equal to or less than 2.8% of the total taxons collected.

The analysis of richness by point points to similarities between the sampling points, considering the two campaigns carried out, with a minimum of 30 taxons at point P02, in the Paraguay river, downstream of the future PARACEL pulp mill, and a maximum of 33, in the upstream segment, in both collections, as shown in the figure below. As for the distribution of taxonomic groups among the qualitative samples of the two segments sampled in the Paraguay river, there was a greater participation of *bacillariumphytic diatoms*, followed by cyanobacteria.

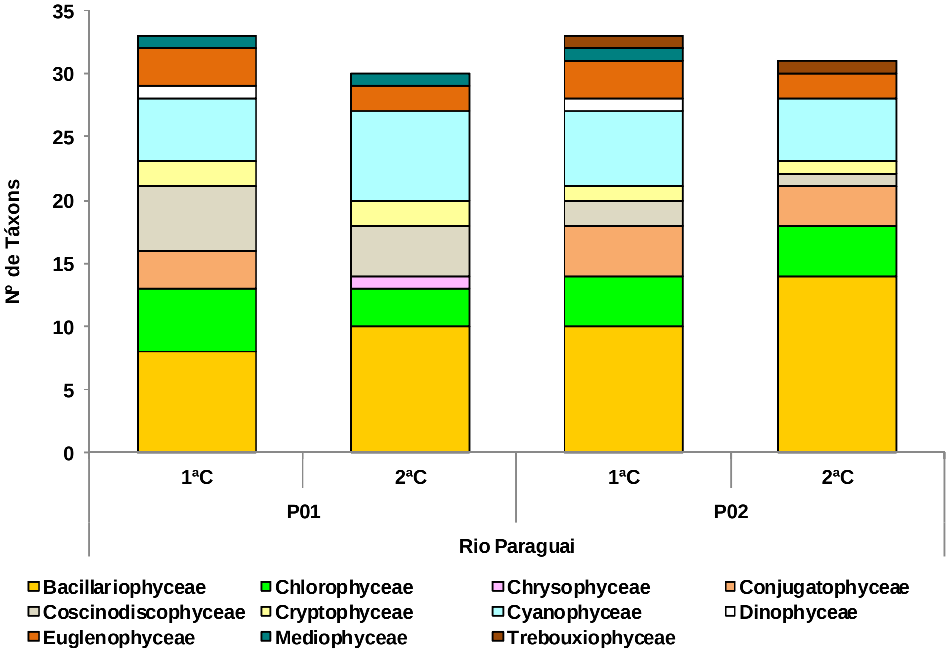


Figure 442 – Phytoplankton richness by sampling point in the Paraguay River - 1st C (Oct/2019) and 2nd C (Mar/20).

Spatial distribution and frequency of occurrence

The following table shows the spatial distribution and frequency of phytoplankton emergence in the first (October/2019) and second campaigns (March/2020).

Among the 71 inventoried taxons, the diatoms Diadesmis sp., Gyrosigma sp., Nitzschia sp., Aulacoseira granulata, a cyanobacteria Phormidium sp. and an unidentified taxon at genus level of the class Cryptophyceae occurred at all collection points in both seasons (100% frequency), being considered very frequent, according to the classification of Souza et al. (2009).

Another 31 taxons were classified as frequent (occurrence between 50% and 80%), seven of which occurred in 75% of the samples, corresponding to the diatoms Eunotia sp., Surirella sp, Ulnaria ulna e Melosira varians, the chlorophyll Monoraphidium arcuatum, the conjugate algae Gonatozygon sp. and the euglenophyceae Strombomonas sp. The others (34 taxons) were limited to one point (25%).

Among the taxons that stood out in terms of frequency, examples of the genera Nitzschia, Eunotia and Surirella were also found in the survey carried out by Santos (2016), in the main waterways of Paraguayan territory. The following is a photographic record of two phytoplankton specimens recorded in the Paraguay River.

Figure 443 – Chlorophycea - *Monoraphidium contortum.*

Source: Econsult (2020).

Figure 444 – Mediophyceae *Thalassiosira* sp.

Table 39 – Spatial distribution and frequency of phytoplankton emergence in the Paraguay River - 1st C (Oct/2019) and 2nd C (Mar/20).

Taxonomic Composition	Paraguay river				Occurrence	Frequency of Occurrence
	P01		P02			
	1st C	2nd C	1st C	2nd C		
Bacillariophyceae						
Achnanthes sp.					1	25
Amphipleura sp.					1	25
Amphora sp.					1	25
Cymbella sp.					2	50
Diadesmis sp.					4	100
Eunotia sp.					3	75
Fragilaria sp.					2	50
Gyrosigma sp.					4	100
Naviculaceae					2	50
Navicula sp.					1	25
Nitzschia sp.					4	100
Pinnularia sp.					2	50
Stauroneis sp.					2	50
Surirella tenera					2	50
Surirella sp.					3	75
Synedra goulardii					2	50
Synedra sp.					1	25
Tabellaria sp.					1	25
Ulnaria acus					1	25
Ulnaria ulna					3	75
Subtotal	**8**	**10**	**10**	**14**		
Chlorophyceae						
Chlamydomonas sp.					1	25
Desmodesmus armatus					1	25
Desmodesmus sp.					2	50
Eutetramorus sp.					1	25
Monactinus simplex					1	25
Monoraphidium arcuatum					3	75
Monoraphidium contortum					1	25
Monoraphidium irregulare					1	25
Monoraphidium griffithii					1	25
Pediastrum duplex					2	50
Pediastrum duplex var. *duplex*					1	25
Scenedesmus acuminatus					1	25
Subtotal	**5**	**4**	**3**	**4**		
Chrysophyceae						
Dinobryon sp.					1	25
Subtotal	**-**	**-**	**1**	**-**		
Conjugatophyceae						
Cosmarium sp.					1	25

Taxonomic Composition	Paraguay river				Occurrence	Frequency of Occurrence
	P01		P02			
	1st C	2nd C	1st C	2nd C		
Closterium setaceum		■		■	2	50
Closterium sp.		■		■	2	50
Closteriopsis sp.		■			1	25
Gonatozygon sp.	■	■		■	3	75
Haplotaenium sp.	■				1	25
Subtotal	**3**	**4**	**-**	**3**		
Coscinodiscophyceae						
Aulacoseira ambigua	■		■		2	50
Aulacoseira granulata var. *angustissima*	■				1	25
Aulacoseira granulate	■	■	■	■	4	100
Aulacoseira sp.	■		■		2	50
Melosira varians	■	■	■		3	75
Subtotal	**5**	**2**	**4**	**1**		
Cryptophyceae						
Cryptophyceae	■	■	■	■	4	100
Cryptomonas sp.	■		■		2	50
Subtotal	**2**	**1**	**2**	**1**		
Cyanophyceae						
Aphanocapsa sp.		■		■	2	50
Geitlerinema sp.		■	■		2	50
Komvophoron schmidlei			■		1	25
Merismopedia sp.				■	1	25
Merismopedia glauca	■				1	25
Microcystis sp.		■		■	2	50
Oscillatoria sp.		■			1	25
Phormidium aerugineo-caeruleum			■		1	25
Phormidium tergestinum	■		■		2	50
Phormidium sp.	■	■	■	■	4	100
Planktolyngbya sp.	■		■		2	50
Planktothrix sp.		■		■	2	50
Pseudanabaena sp.			■		1	25
Synechococcales	■				1	25
Subtotal	**5**	**6**	**7**	**5**		
Dinophyceae						
Peridinium sp.	■	■			2	50
Subtotal	**1**	**1**	**-**	**0**		
Euglenophyceae						
Euglena sp.	■				1	25
Lepocinclis acus	■				1	25
Lepocinclis sp.	■				1	25
Phacus longicauda var. tortus			■		1	25
Strombomonas sp.		■	■	■	3	75
Trachelomonas volvocina		■		■	2	50

Taxonomic Composition	Paraguay river				Occurrence	Frequency of Occurrence
	P01		P02			
	1st C	2nd C	1st C	2nd C		
Trachelomonas volvocinopsis					1	25
Subtotal	**3**	**3**	**2**	**2**		
Mediophyceae						
Cyclotella sp.					1	25
Thalassiosira sp.					2	50
Subtotal	**1**	**1**	**1**	**0**		
Trebouxiophyceae						
Dictyosphaerium sp.					2	50
Subtotal	**-**	**1**	**-**	**1**		
Total por Punto	**33**	**33**	**30**	**31**		
Total en la Campaña	**71**					

Indicator species

Among the species registered in the Paraguay River, algae of the genus Trachelomonas, such as T.volvocinopsis, have a shell formed almost exclusively of iron hydroxide and manganese, being an indicator of the precipitation of these elements in aquatic systems (BRANCO, 1986).

Monoraphidium algae are considered resistant to organic and chemical pollution (SLADECEK, 1973), presenting species related to water bodies with different trophic levels.

Quantitative Analysis

Density and Relative abundance

The quantitative analysis of phytoplankton in the Paraguay River included the results of density (org/mL) and relative abundance (%) of the taxonomic classes. Phytoplankton density in aquatic ecosystems is the result of the dynamics of interactions between physiological characteristics of organisms and abiotic factors, which influence the primary productivity of phytoplankton, with reflection on the composition and abundance of zooplankton and benthic beings.

In the Paraguay River, phytoplankton density significantly varied between campaigns, being higher in the first campaign (spring), carried out in October 2019, in both points monitored, reaching 813 org./mL at point P01 and 752 org./mL at point P02.

In the second campaign, conducted in March 2020, in the summer, the phytoplankton density was lower, with values of 19 org/mL at point P01 and 11 org/mL at point P02.

The low density results of the March 2020 campaign were maintained at the same level as those proposed by Silva et al. (2000), in the portion of the Upper Paraguay river during the flooding season (48 org/mL), which the authors indicated as the lowest density among the samples taken, which was attributed to the dilution effect of the flooding cycle.

Densities in the October 2019 campaign in the Paraguay River were around the order of magnitude reported by Domitrovic (2002) in Upper Paraguay, which recorded lower phytoplankton density values in winter, averaging between 731 and 878 org/mL. However, it should be noted that the studies mentioned presented a much greater sampling effort than this diagnosis.

In terms of abundance, algae of the class Cryptophyceae were exceptional, mainly in the first season, contributing with 746 org./mL at point P01 and 666 org./mL at point P02, attributed to Cryptomonas sp and an unidentified taxon. Silva et al. (2000) also reported a predominance of Cryptophyceae in the Paraguay River, as detailed in the IIA.

As mentioned, algae Cryptophyceae are considered opportunistic in quantity when densities of other algae decrease (KLAVENESS, 1988). They have low light tolerance and are generally found in rivers and small lakes (ISAKSSON, 1998). Studies by Oliveira and Calheiros (2000) associated the dominance of Cryptophyceae with adverse conditions for the development of other groups.

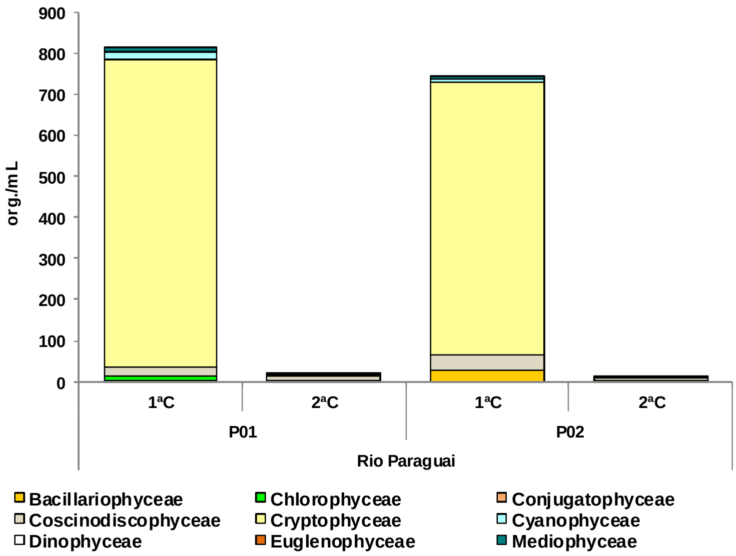


Figure 445 – Phytoplankton density in the Paraguay river – 1stC (Oct/19) and 2ndC (Mar/20).

In summary, the most abundant group in the first campaign in the two points analysed was Cryptophyceae, with a relative abundance of 92% at point P01 and 90% at point P02. In the second campaign (March 2020), the diatoms of Coscinodiscophyceae were more numerically representative, reaching 53% and 64%, at points P01 and P02, with emphasis on the species Aulacoseira granulata. The others had a low representativeness in terms of abundance, as shown in the following figure.

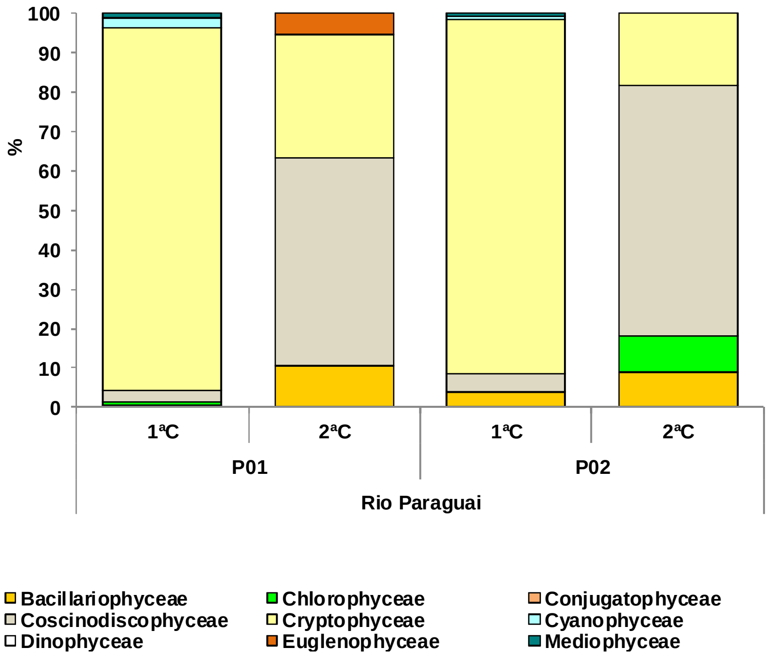


Figure 446 – Relative abundance of phytoplankton in Paraguay river – 1stC (Oct/19) and 2ndC (Mar/20).

As mentioned, the phytoplankton analysis also included cyanobacterial cell counts. In the Paraguay river, in both collections and at both points, the densities of this group were low, reaching maximum values in the first campaign, with a maximum of 264 cells per mL (P01), as shown in the following figure.

Article 11 of SEAM Resolution n. 222/02, based on WHO guidelines (World Health Organization - 1999), suggests rigorous surveillance of lakes when cyanobacterial cell densities reach 100,000 cells/mL. Although the Paraguay River is a lotic environment, it should be noted that the values recorded in the two campaigns are much lower than those foreseen in this resolution. This result is a positive aspect, considering that this group has taxons producing cyanotoxin, which can cause damage to aquatic biota and water quality, especially that intended for human supply, when present in large quantities.

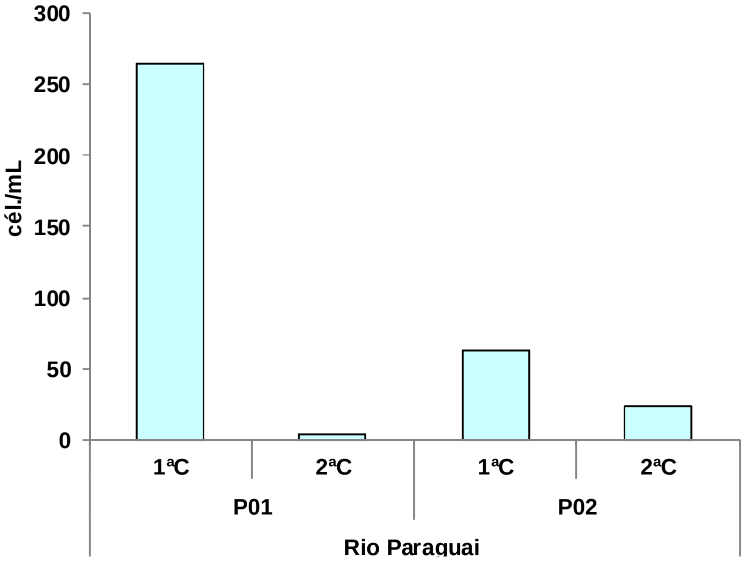


Figure 447 – Density of cyanobacteria in the Paraguay River – 1stC (Oct/19) and 2ndC (Mar/20).

Table 40 – Density and relative abundance of phytoplankton in the Paraguay River - 1stC (Oct/19) and 2ndC (Mar/20).

Taxonomic Composition	Paraguay river							
	P01				P02			
	1stC		2ndC		1stC		2ndC	
	org./mL	%	org./mL	%	org./mL	%	org./mL	%
Bacillariophyceae								
Achnanthes sp.	-	-	-	-	-	-	<1	-
Amphora sp.	-	-	-	-	4	0,54	-	-
Cymbella sp.	-	-	<1	-	-	-	<1	-
Eunotia sp.	4	0,49	-	-	-	-	<1	-
Naviculaceae	-	-	1	5	-	-	<1	-
Navicula sp.	-	-	-	-	-	-	<1	-
Nitzschia sp.	-	-	1	5	24	3,23	1	9
Surirella sp.	-	-	<1	-	-	-	-	-
Synedra goulardii	-	-	<1	-	-	-	<1	-
Synedra sp.	-	-	-	-	-	-	<1	-
Subtotal	**4**	**0,49**	**2**	**11**	**28**	**3,77**	**1**	**9**
Chlorophyceae								
Desmodesmus sp.	-	-	-	-	-	-	<1	-
Monoraphidium arcuatum	4	0,49	<1	-	-	-	1	9
Monoraphidium contortum	4	0,49	-	-	-	-	-	-
Monoraphidium irregulare	-	-	<1	-	-	-	-	-
Subtotal	**8**	**0,98**	**-**	**-**	**-**	**-**	**1**	**9**
Conjugatophyceae								
Closteriopsis sp.	-	-	<1	-	-	-	-	-

Taxonomic Composition	Paraguay river							
	P01				P02			
	1stC		2ndC		1stC		2ndC	
	org./mL	%	org./mL	%	org./mL	%	org./mL	%
Subtotal	**-**	**-**	**0**	**-**	**-**	**-**	**-**	
Coscinodiscophyceae								
Aulacoseira ambigua	-	-	-	-	24	3,23	-	-
Aulacoseira granulata var. *angustissima*	7	0,86	-	-	-	-	-	-
Aulacoseira granulata	-	-	10	53	-	-	7	64
Aulacoseira sp.	18	2,21	-	-	12	1,62	-	-
Subtotal	**25**	**3,08**	**10**	**53**	**36**	**4,85**	**7**	**64**
Cryptophyceae								
Cryptophyceae	616	75,77	6	32	556	74,93	2	18
Cryptomonas sp.	130	15,99	-	-	110	14,82	-	-
Subtotal	**746**	**91,76**	**6**	**32**	**666**	**89,76**	**2**	**18**
Cyanophyceae								
Aphanocapsa sp.	-	-	-	-	-	-	<1	-
Geitlerinema sp.	-	-	<1	-	-	-	-	-
Komvophoron schmidlei	-		-	-	4	0,54	-	-
Phormidium sp.	4	0,49	-	-	-	-	<1	-
Planktolyngbya sp.	11	1,35	-	-	4	0,54	-	-
Synechococcales	4	0,49	-		-	-	-	-
Subtotal	**19**	**2,34**	**0**	**-**	**8**	**1,08**	**0**	**-**
Dinophyceae								
Peridinium sp.	-	-	<1	-	-	-	-	-
Subtotal	**-**	**-**	**0**	**-**	**-**	**-**	**-**	
Euglenophyceae								
Trachelomonas volvocina	-	-	1	5	-	-	<1	-
Subtotal	**-**	**-**	**1**	**5**	**-**	**-**	**0**	**-**
Mediophyceae								
Cyclotella sp.	-	-	-	-	4	0,54	-	-
Thalassiosira sp.	11	1,35	<1	-	-	-	-	-
Subtotal	**11**	**1,35**	**-**	**-**	**4**	**0,54**	**-**	**-**
Total	**813**	**100**	**19**	**100**	**742**	**100**	**11**	**100**

Diversity and Equitability index

The figure below presents the results of the phytoplankton community diversity and equity indices sampled in the October 2019 and March 2020 campaigns.

In the first campaign, phytoplankton diversity in the Paraguay River ranged from 1.26 bits.ind-1 at point P01 to 1.29 bits.ind-1 at point P02. In the second campaign, an increase in diversity was observed, with 3.06 bits.ind-1 at point P01 and 3.47 bits.ind-1 at point P02.

The lower value of diversity in the first campaign is a consequence of the high relative abundance of Cryptophyceae. A similar behavior was observed in terms of equity, whose values remained low (<0.5), in the first campaign, with an increase in the second collection (>0.8), reflecting the better distribution of the taxons in the samples.

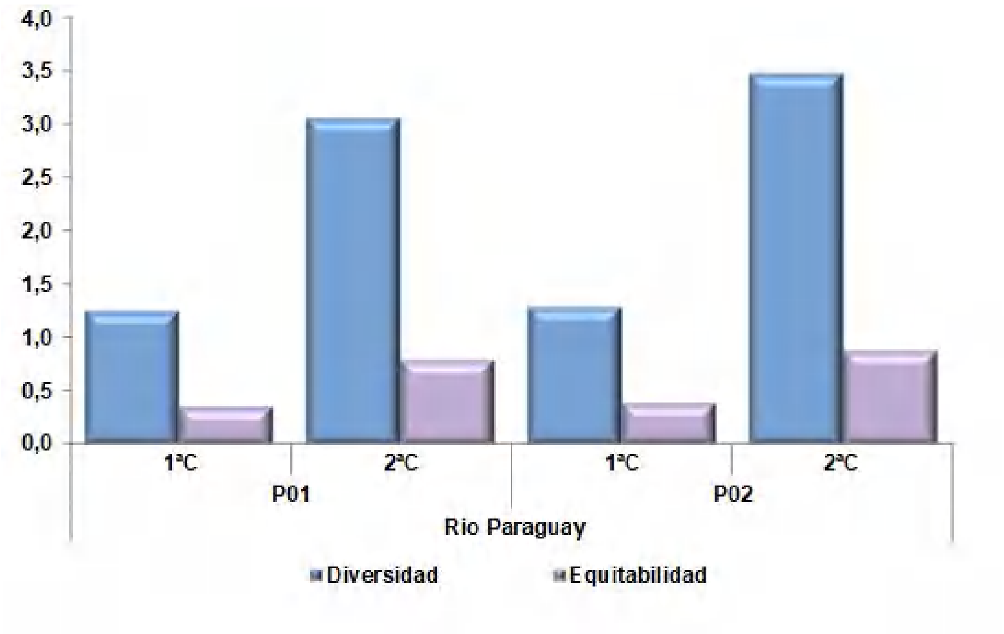


Figure 448 – Phytoplankton diversity and equity indices in the Paraguay river - 1stC (Oct/19) and 2ndC (Mar/20).

Similarity index

The evaluation of the similarity of the phytoplankton community, sampled in the two campaigns carried out in the Paraguay River, was based on the Bray-Curtis similarity index.

The results of this indicator indicate a high level of similarity between the points and the campaigns, and that the segregation of the samples into two main groups was influenced according to the sampling campaign, with the highest similarity between points P01 and P02, in the first campaign, with a similarity of approximately 85%. In the second cluster, which gathered the points P01 and P02 from the March 2020 collection, the similarity was approximately 60%. These clusters are a consequence of similar density behaviours in the same campaign, with a high cryptophysical density in the first campaign and a higher abundance of diatoms in the second one.

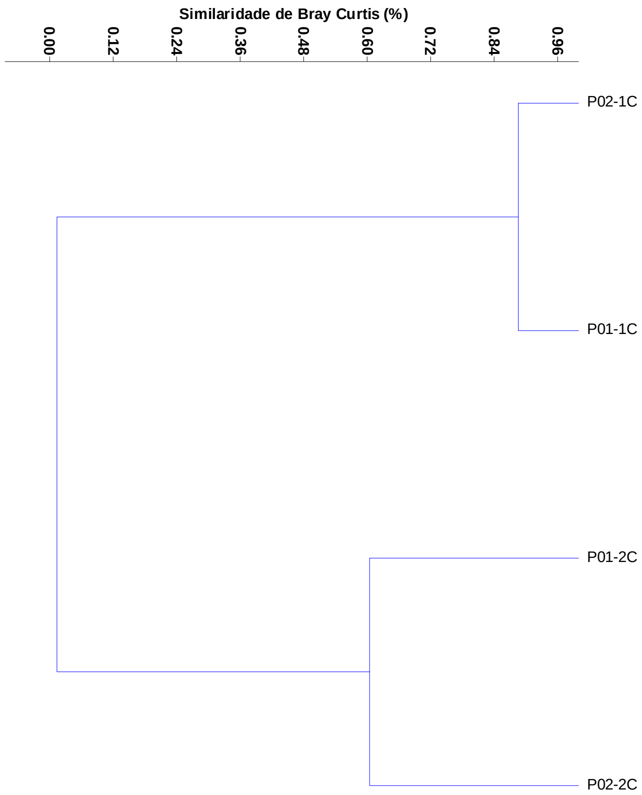


Figure 449 – Phytoplankton similarity in Paraguay River - 1st C (Oct/19) and 2ndC (Mar/20).

Coefficient = 0,999.

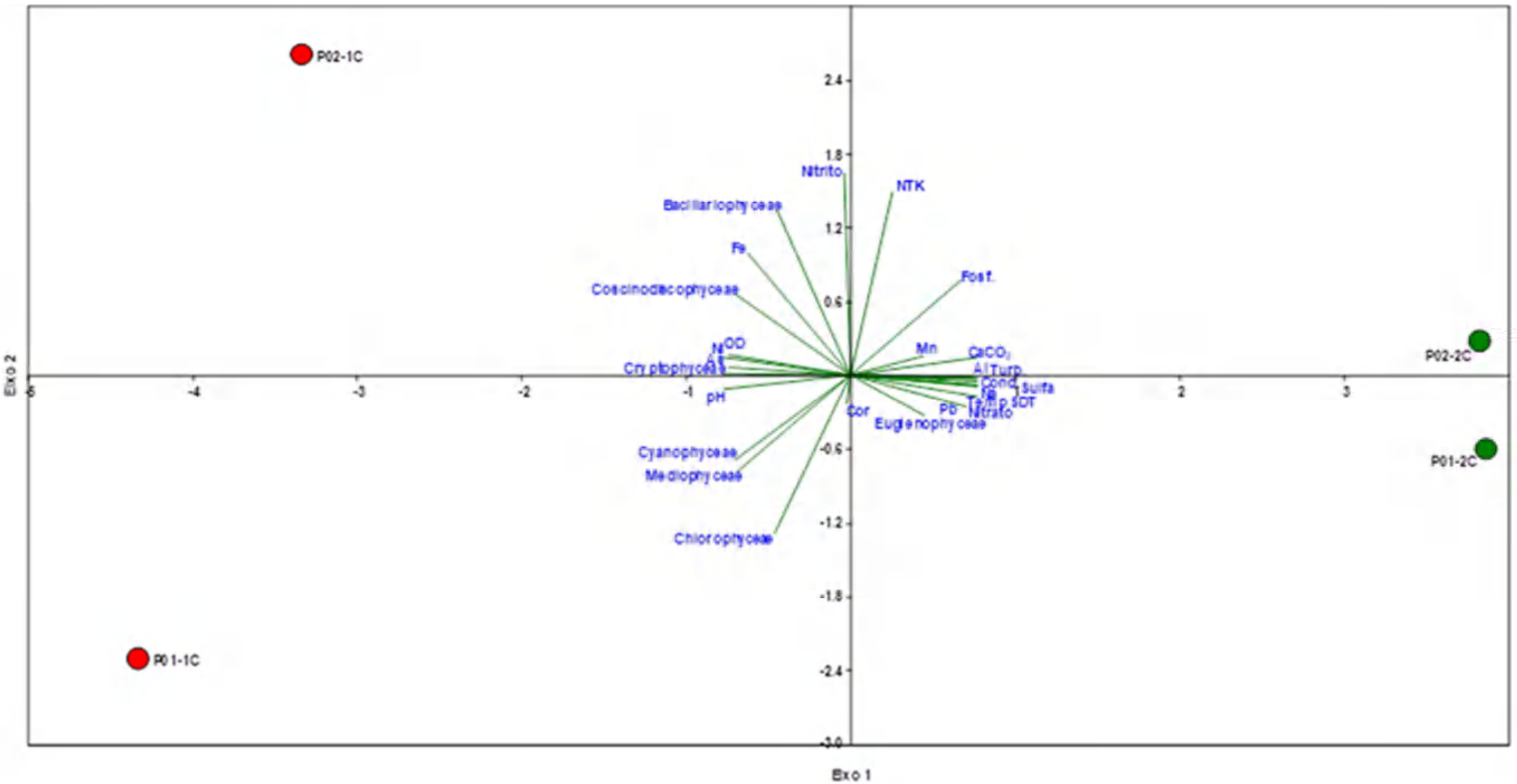
Principal Component Analysis (PCA)

The results of the ordering of the sample points according to the densities of the phytoplankton communities and the abiotic variables of the quality of the surface waters (PCA) in the first two campaigns carried out in October 2019 and March 2020, respectively, showed that the 1 and 2 represented 88.7% of the variability of the data, with the first being responsible for 73.2% and the second for 15.5%.

The first component showed a strong positive correlation mainly with abiotic variables, such as water conductivity and temperature, and a negative correlation mainly with cryptophytic algae density. The latter correlation is mainly responsible for the horizontal differentiation of the points, where the points referred to the first campaign, characterized by the high density of these algae, are on the left and the points referred to the second campaign are on the right (Figure 442).

The second main component was mainly correlated with the concentration of nitrites in surface waters. In general, nitrite levels were in compliance with the legal standard (SEAM Resolution n. 222/02) in the Paraguay river during the sampling campaigns. However, high concentrations of phosphorus were detected in this watercourse, with extrapolation of the legal norm, in the sampling. In general, the nutrients cited did not have a strong relationship with the results of phytoplankton.

Figure 450 – Principal Component Analysis (PCA) of the phytoplankton community and abiotic variables in the Paraguay River - 1stC (Oct/19) and 2ndC (Mar/20).



Legend: Al - Dissolved Aluminum As - Total Arsenic, Pb - Total Lead, Ni - Total Nickel, Fe- Dissolved Iron and Mn - Total Manganese. CaCO3 - Total Hardness. Total Kjeldahl Nitrogen - NTK. Dissolved Oxygen = OD. Fosf= Total Phosphorus. SDT - Total Dissolved Solids. Cond- Conductivity. Turb = Turbidity.

C. Benthic Community

Qualitative Analysis

Taxonomic Composition, Taxon Richness and Relative Richness

In the diagnosis of benthic invertebrates, carried out in October 2019 and March 2020, samples were taken from a total of 11 taxons, belonging to the following taxonomic groups: phylum Annelida - class Clitellata (2 taxons), phylum Arthropoda - sub-phylum Hexapoda (7 taxons), phylum Mollusca (1 taxon) and phylum Nematoda (1 taxon).

The main representatives of benthic invertebrates were the immature forms of aquatic insects (class Insecta), which accounted for 63.6% of the total taxons inventoried for this group of organisms.

The second most relevant group in terms of richness were the annelids, represented by the Oligochaeta and Hirudinea subclasses, which together constituted 18.2% of the richness of the community. A smaller proportion of molluscs and nematode worms were obtained, each with 9.1% of the taxon identified in the sampling network. The following figure shows the relative richness of this community by taxonomic group.

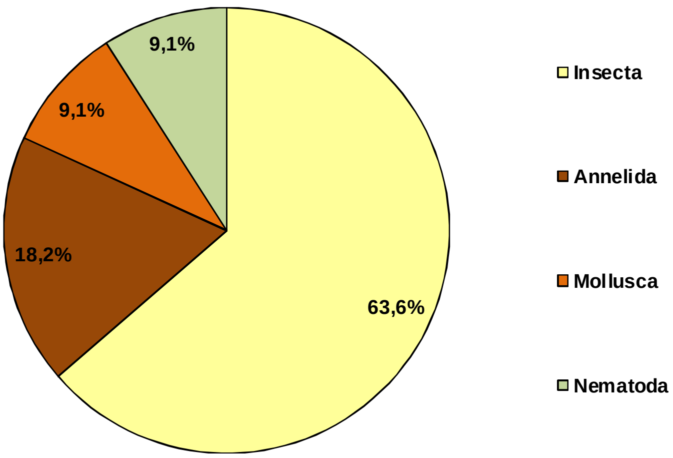


Figure 451 – Relative richness of benthic invertebrates in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20).

The insects were represented by the order Diptera (Diptera), including the families Ceratopogonidae and Chironomidae, among which the latter showed greater taxonomic richness, with six taxons.

Popularly known as flies and mosquitoes, diptera constitute an important part of the benthic fauna of lentic and lotic aquatic environments, and can even appear in brackish waters (COSTA et al., 2003). Adults of this order lay eggs on the surface of the water or in substrates and give rise to a high number of larvae which generally colonise sandy and muddy sediments, as well as aquatic vegetation. These organisms spend part of their life or their entire cycle associated with the bottom substrate and for some of them the larval stage is longer than the adult stage.

Larvae of the family Chironomidae (chironomidae) are generally omnivorous opportunists, feeding on algae, small animals and waste, and playing an important role in the decomposition of organic matter. Some of them are equipped with special organs, such as external gills, and manage to survive in polluted waters and in environments with low concentrations of dissolved oxygen (ROSSARO, 1991 apud OLIVEIRA, 2005). According to Coffman and Ferrington (1996), the family Chironomidae is the most taxonomically rich group, being the most distributed and often the most abundant aquatic insects in inland water ecosystems.

The family Ceratopogonidae, recorded only at point P02 downstream of the PARACEL pulp mill, is characterized by larvae with a predatory habit, which feed on microorganisms. At this stage of development, some representatives are tolerant to anthropic disturbances, which correspond to bioindicators of water quality (CALLISTO et al. 2001). In adults, there are taxon that can act as vectors of nematoids, protozoa and pathogens that affect human health.

Among annelids, the Oligochaeta subclass (oligophytes) and the Hirudinea subclass (hirudians) each had a single taxon, and the only recorded individual of the Hirudinea subclass belonged to the family Glossiphoniidae.

In general, oligochaetes can be used as indicators of pollution in the aquatic environment, as they are commonly found in environments rich in organic substances and with low concentrations of dissolved oxygen, which characterizes a competitive advantage over other species in the community (DORNFELD et al., 2006).

Hirudines are common in calm waters or low flow bodies of water, live preferably on the margins, attached to substrates (logs, rocks, etc.) and, like trace elements, withstand conditions of low oxygen concentration and live in places with high organic matter content (ROLDÁN, 1992 apud PARESCHI, 2008).

The representatives of phylum Mollusc (molluscs) were only recorded at point P02, in the two sampling campaigns. All individuals sampled belonged to the species Limnoperna fortunei (class Bivalvia, family Mytilidae), an invasive alien species known by the popular name of golden mussel.

The phylum nematode (nematodes) was recorded only in the first season, at point P01. Most nematode species live freely and feed on sedimentary matter; many are detrital, others live in or on dead organisms or excrements, but several are parasites on a wide range of plant and animal hosts.

As shown in the following graph, insects prevail in the Paraguay River, with a lower participation, in qualitative terms, of the other groups. Both insects and oligochaetes were common to both sample points and to both campaigns. It can be seen that point P02 tends to be richer (maximum of six taxons) than point P01 (maximum of four taxons), and that the March 2020 campaign was slightly richer than that of October 2019 in the two sections evaluated in the Paraguay river.

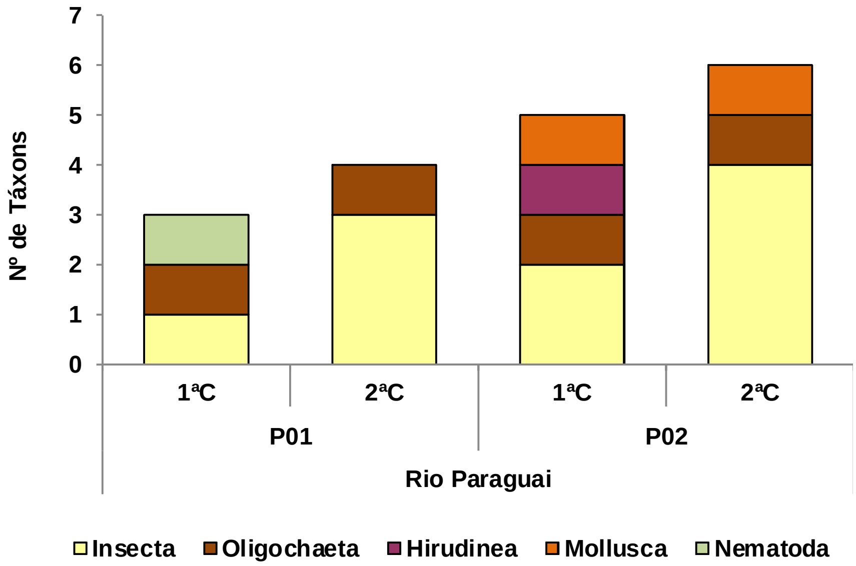


Figure 452 – Benthic invertebrate taxon richness by sampling point in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20).

In general, taxon richness was low in the sampled section. However, this low richness cannot be attributed to the low quality of the water, since it was detected in studies of well-oxygenated water quality (DO > 5.0 mg/L), with pH tending to neutral, low concentration of organic matter, expressed in terms of BOD (< 5.0 mg/L) and reduced rates of thermotolerant coliforms, complying with the standards determined by SEAM Resolution 222/2002 for class 2 waters, which increase is indicative of contamination by domestic wastewater. There was also no evidence of pesticide contamination in the waters or sediments of the Paraguay River.

In a specific study of the fauna of the chironomids of Upper Paraguay, Aburaya and Callil (2007) recorded 34 morphospecies of chironomids, distributed in three subfamilies and with high densities of the genus Polypedilum. According to the authors, the hydrological regime and flood dynamics are the main structuring factors of the benthic communities in this basin.

Analyzing the invertebrate fauna of the Paraguay River, in an extensive sampling network, Magalhães (2001) listed 13 species of crustaceans (Decapoda), five families of gastropods and three families of bivalves (Mollusca), and 34 families of insects, belonging to 10 orders. The author associated the greatest richness found with sites colonized by aquatic vegetation. It is important to note, however, that the studies mentioned above presented a much greater sampling effort than this, with a sample mesh of more than 50 collection points in one case and monthly collections throughout the hydrological cycle in the other.

Spatial Distribution and Frequency of Occurrence

The following table shows the spatial distribution and frequency of occurrence of benthic invertebrates recorded in the sediments of the sample points of the assessed water body.

The subclass Oligochaeta, as well as the family Chironomidae, was generally present in all samples, as is common in inland lotic environments. Among the family Chironomidae, representatives of the subfamily Chironominae were more frequent, being present at both sampling points, while the subfamilies Orthocladiinae and Tanypodinae had their records restricted to point P02 and point P01, respectively.

In a study conducted along the Paraguay River, Barbosa et al. (2001) recorded that the family Chironomidae was the most frequent and abundant representative of benthic fauna in the samples, representing about 52% of all fauna sampled, followed by the subclass Oligochaeta, which represented 35% of all fauna in the inventory.

The results obtained in the present study, although less rich than those recorded in the literature, corroborate those found by the other authors, which show communities structured mainly by the family Chironomidae and the subclass Oligochaeta. The following is a photographic record of some taxons registered in the Paraguay River.

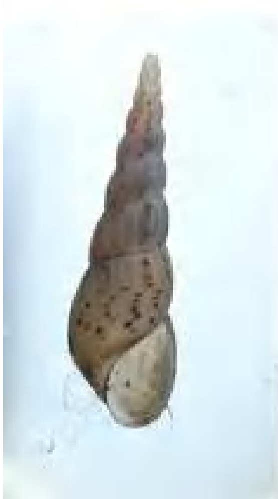


Figure 453 – *Limnoperna fortunei*.

Figure 454 – *Chironomideae*.

Figure 455 – Diptera from the family *Ceratopogonidae*.

Figure 456 – Anelid *Oligochaeta*.

Source: Econsult (2020).

Table 41 – Spatial distribution and frequency of occurrence of benthic invertebrates in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20).

Taxonomic composition	Paraguay river				Ocurrence	Frequency of occurrence ficlo(%)
	P01		P02			
	1stC	2ndC	1stC	2nd C		
Phylum ANNELIDA						
Class Clitellata						
Subclass Hirudinea						
Order Rhynchobdellida						
Family Glossiphoniidae					1	25
Subclass Oligochaeta					4	100
Subtotal	**1**	**1**	**2**	**1**		

Taxonomic composition	Paraguay river				Ocurrence	Frequency of occurrence ficlo(%)
	P01		P02			
	1^{st}C	2^{nd}C	1^{st}C	2^{nd} C		
PhylumARTHROPODA						
Subphylum HEXAPODA						
Class Insecta						
Order Diptera						
Family Ceratopogonidae					2	50
Family Chironomidae					1	25
Sub-Family Chironominae					1	25
Tribo Chironomini						
Cryptochironomus					2	50
Polypedilum					2	50
Sub-Family Orthocladiinae						
Orthocladiinae N.I.					1	25
Sub-Family Tanypodinae						
Tanypodinae N.I.					1	25
Subtotal	**1**	**3**	**2**	**4**		
Phylum MOLLUSCA						
Clase Bivalvia						
Subclase Pteriomorphia						
Order Mytilida						
Family Mytilidae						
Limnoperna fortunei					2	50
Subtotal	**-**	**-**	**1**	**1**		
Phylum NEMATODA					1	25
Subtotal	**1**	**-**	**-**	**-**		
Total por Punto	**3**	**4**	**5**	**6**		
Total en la Campaña	**11**					

Exotic species

The presence of the bivalve mollusc known as the *Limnoperna fortunei*, an invasive species originating in Asia and accidentally introduced into South America by the ballast water of merchant ships, was recorded in the Paraguay River, downstream from the future PARACEL pulp mill (P02). In South America, this species has been causing economic losses, mainly in the hydroelectric and public supply sectors, due to the formation of incrustations in infrastructure equipment.

The incrustations formed by the golden mussel are voluminous, several individuals overlap adhering to the substrate and to each other, by the filaments they secrete, thus forming compact agglomerates (MANSUR et al., 2012).

According to Pestana and others (2010), the *Limnoperna fortunei* arrived in South America in 1991 and rapidly expanded its distribution, reaching the Paraguay River in 1997/98. The presence of the golden mussel in the sampled section indicates the susceptibility to invasion of this bivalve in the case of the installation of structures for capture in the river. In general, monitoring the distribution of this community is a measure that allows for the establishment of management and control strategies, if necessary.

Endangered Species

It should be noted that the benthic invertebrates of the Paraguay River recorded in October/2019 and March/2020 are common organisms, with a wide continental distribution, and are not included in the international list of threatened species (IUCN, 2020). According to the Action Plan for the Conservation of Biodiversity in Paraguay (SEAM, 2016), there is no list of threatened aquatic invertebrate species in Paraguay.

Indicator species

This study did not record insects of the orders Ephemeroptera, Plecoptera or Tricoptera, commonly used in monitoring programs as indicator organisms of good water quality due to their restricted environmental requirements. In general, the taxon sampled in these two campaigns are considered to have a wide range of tolerance to variations in their natural habitats and to loss of water quality.

Quantitative analysis

Density and relative abundance

In the quantitative evaluation of benthic invertebrates, in the campaigns carried out in October 2019 and March 2020, the density (org./m²) and relative abundance (%) of the organisms collected were considered, according to the results presented in the following table. The following figure shows the variation of the density parameter of all taxonomic groups, for each point and in each campaign.

In the Paraguay river, the highest densities of organisms were found at point P01, at the first station, with 2,884 org/m2, the great majority composed of larvae of the family Chironomidae (2,850 org/m2). Similarly, in the following season, this family was numerically dominant at this same site, with 115 org/m2 of a total of 166 org/m2.

Point P02, in turn, showed a community numerically dominated by the bivalve L. fortunei during the first season, when this species had a density of 672 org/m2, representing 74% of the organisms recorded in the samples. In the following season, in March 2020, the number of bivalves sampled was quite low, not exceeding 26 org/m2, and the community was again numerically dominated by the family Chironomidae.

These values of larval density of chironomids are not uncommon in the Paraguay River. Aburaya and Callil (2007) recorded frequent densities in the upper Paraguay River between 1,000 and 10,000 ind/m2, mainly for Polypedilum.

Table 42 – Density and relative abundance of benthic invertebrates per sampling point in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20).

Taxonomic composition	Paraguay river							
	P01				P02			
	1stC		2ndC		1stC		2ndC	
	org./m²	%	org./m²	%	org./m²	%	org./m²	%
Phylum ANNELIDA	-	-	-	-	-	-	-	-
Class Clitellata	-	-	-	-	-	-	-	-
Subclass Hirudinea	-	-	-	-	-	-	-	-
Order Rhynchobdellida	-	-	-	-	-	-	-	-
Family Glossiphoniidae	-	-	-	-	17	1,9	-	-
Subclass Oligochaeta	17	0,59	52	31	138	15,1	57	18,4
Subtotal	**17**	**0,59**	**52**	**31**	**155**	**17**	**57**	**18**
Phylum ARTHROPODA	-	-	-	-	-	-	-	-
Subfilo HEXAPODA	-	-	-	-	-	-	-	-
Class Insecta	-	-	-	-	-	-	-	-
Order Diptera	-	-	-	-	-	-	-	-
Family Ceratopogonidae	-	-	-	-	26	2,8	17	5,4
Family Chironomidae	-	-	-	-	61	6,6	-	-
Sub-Family Chironominae	2.850	98,82	-	-	-	-	-	-
Tribo Chironomini	-	-	-	-	-	-	-	-
Cryptochironomus	-	-	69	41,5	-	-	80	25,7
Polypedilum	-	-	29	17,3	-	-	98	31,3
Sub-Family Orthocladiinae	-	-	-	-	-	-	-	-
Orthocladiinae N.I.	-	-	-	-	-	-	35	11
Sub-Family Tanypodinae	-	-	-	-	-	-	-	-
Tanypodinae N.I.	-	-	17	10,2	-	-	-	-
Subtotal	**2.850**	**98,8**	**115**	**69**	**86**	**9**	**230**	**73**
Phylum MOLLUSCA	-	-	-	-	-	-	-	-
Class Bivalvia	-	-	-	-	-	-	-	-
Subclass Pteriomorphia	-	-	-	-	-	-	-	-
Order Mytilida	-	-	-	-	-	-	-	-
Family Mytilidae	-	-	-	-	-	-	-	-
Limnoperna fortunei	-	-	-	-	672	73,6	26	8,2
Subtotal	-	-	-	-	**672**	**74**	**26**	**8,2**
Phylum NEMATODA	17	0,59	-	-	-	-	-	-
Subtotal	**17**	**0,59**	-	-	-	-	-	-
Total	**2.884**	**100**	**166**	**100**	**913**	**100**	**312**	**100**

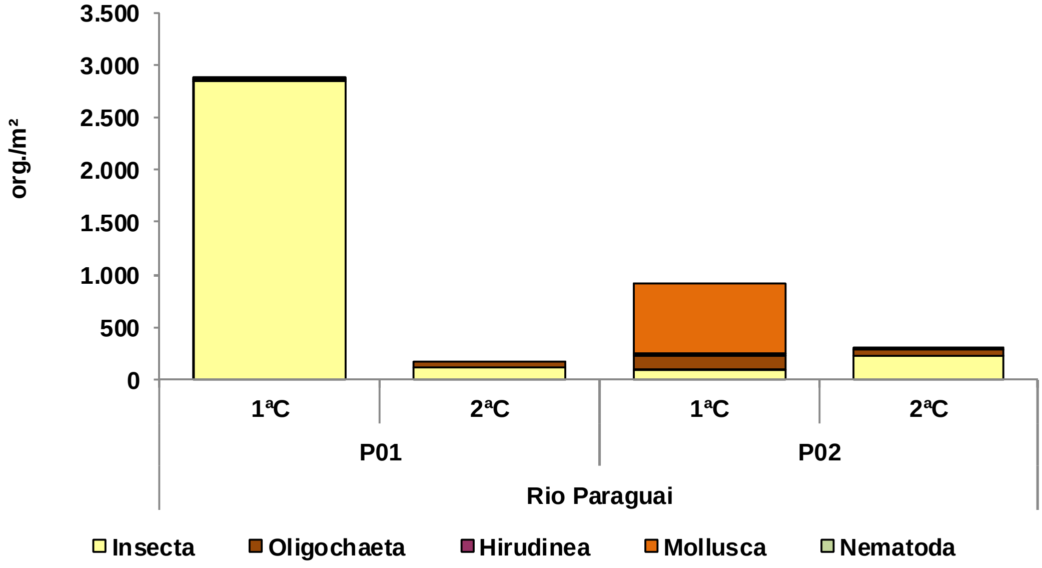


Figure 457 – Benthic invertebrate density per sampling point - 1stC (Oct/2019) and 2ndC (Mar/20).

The following figure shows the relative abundance of each taxonomic group at the sampling points during the two seasons. It is remarkable that insects have a numerical dominance above 70% in most of the samples, with the exception of point P02 in the first season, when there was dominance of the bivalve L. fortunei.

Oligochets maintained their relatively stable participation in most samples, except at P01 during the first campaign, when the high number of chironomids contributed to their percentage in the community being only around 1%. Both the Hirudinea subclass and the Nematoda phylum had low abundance in the samples. These results are consistent with the conclusions of Barbosa et al (2001), which determined that the family Chironomidae was numerically dominant in samples taken in 35 different locations between the regions of Alto and Bajo Paraguay and the tributaries of its basin.

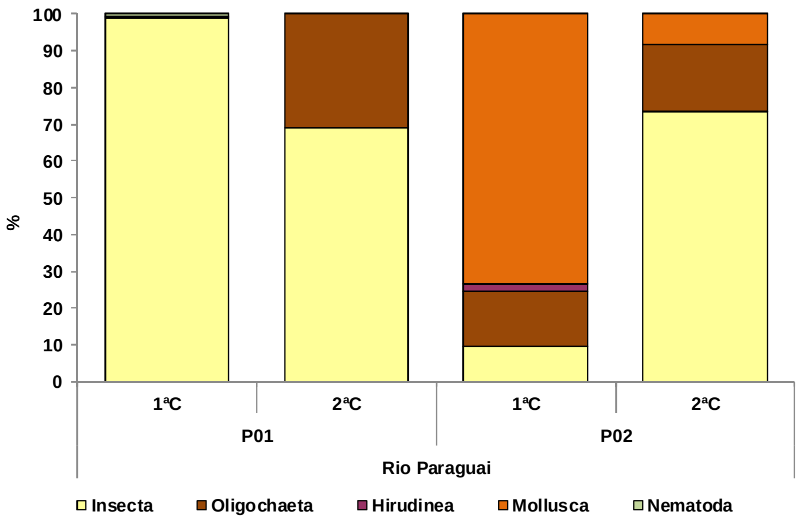


Figure 458 – Relative abundance of benthic invertebrates in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20).

Diversity and Equitability

In the Paraguay river, as shown in Figure 451, diversity and equitability were low at point P01 in the first season, which is due to the high abundance of the family Chironomidae relative to the other faunal groups sampled. In the other samples, the diversity presented higher values, which varied between 1.25 bits/ind-1 (P02, October/2019) and 2.35 bits/ind-1 (P02, March/2020).

Equitability, in turn, varied between 0.54 (P02, October/2019) and 0.91 (P01 and P02, March/2020). For the two sample points, diversity and equitability were higher in the second campaign than in the first.

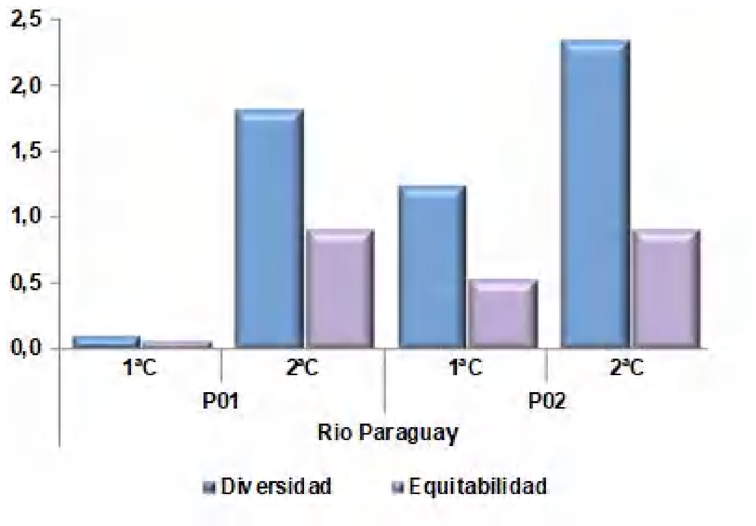


Figure 459 – Diversity and equitability of benthic invertebrates in the Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20).

Similarity index

The assessment of the similarity patterns of the zoobenthic community in the sample grid, taking into account the samples of October 2019 and March 2020, was based on the Bray-Curtis similarity index.

The results of this indicator point to the formation of a group formed by the samples collected in March 2020 (2nd campaign) and a greater differentiation between the samples collected in October 2019 (1st campaign). This result reflects the data recorded in the 1st campaign, when the high density of the family Chironomidae at point P01 and the high density of the bivalve L. fortunei at point P02 strongly distinguished these two sampling sites, while in the 2nd campaign the communities were much more similar at both points.

The similarity of the communities in relation to the collection period indicates that seasonality is a determining factor in their structuring. According to Bergier and Resende (2010), the dynamics of floods are especially determined by the rainy season, which, in the case of the central part of South America, where the Paraguay River basin is located, is concentrated from October to March and, depending on its distribution, intensity and duration, causes clear changes in the landscape. Several authors discuss the importance of the flood of the Paraguay River Basin in changes in water quality (CALHEIROS and FERREIRA, 1996), in the structure and distribution of plant species (DAMASCENO Jr. and others, 2005; SOUZA and others, 2011) and animals, including aquatic fauna (ALHO and SABINO, 2012).

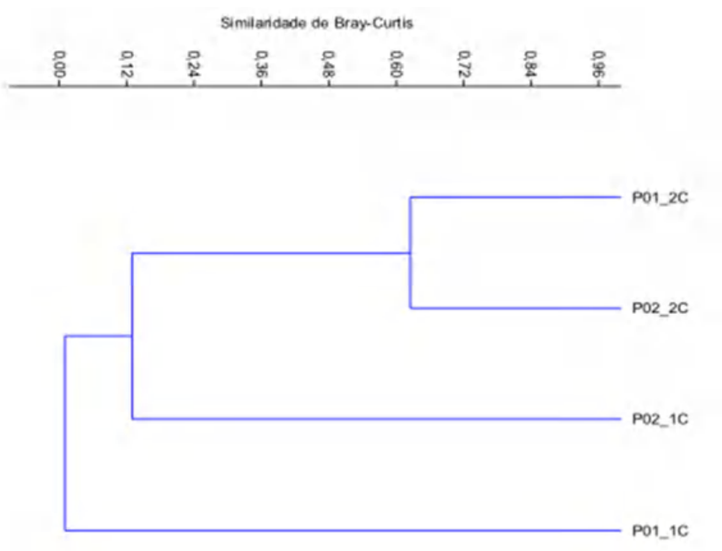


Figure 460 – Similarity of benthic invertebrates in Paraguay River - 1stC (Oct/2019) and 2ndC (Mar/20).

Coefficient = 0,9961,

BMWP Index

The result of the BMWP index for the section of the river Paraguay analysed is shown in the following figure, where the two sample points, in the two campaigns, were classified as poor quality, since the maximum value found was only 14 (P02, 1st campaign). Point P01 received in both campaigns a lower score than P02, which is consistent with the results recorded for richness, which was also lower in this place.

It should be considered that this index is not adapted to the watercourses of the large flood basins and that the water quality measured during the campaigns was good for most of the parameters measured. Therefore, the index may not reflect water quality itself.

In a comprehensive review of benthic invertebrate communities in the Paraguay River basin, Wantzen et al. In general, organisms capable of colonizing the Paraguay River on a large scale have short life cycles and strategic characteristics that allow them to quickly recolonize habitats that change from dry to flooded in a short period of time. According to the authors, as a reservoir basin, the Paraguay River tends to select filtering and collecting organisms from its substrate, such as bivalve molluscs, chironomideal larvae and oligo-lethal anelids. Therefore, it is considered that, despite the low richness and low BMWP, the communities recorded in this study are typical of the region in which they are inserted.

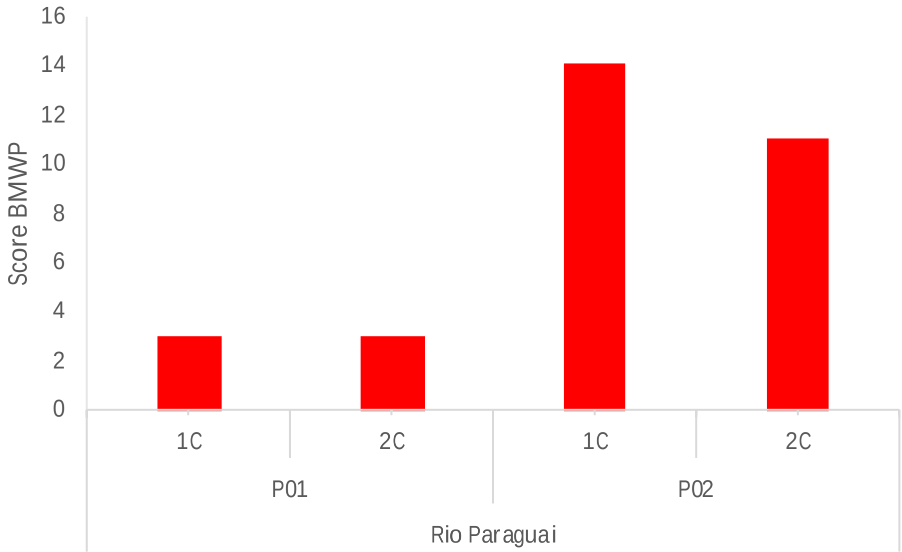


Figure 461 – BMWP Index in Paraguay River - 1stC (Oct/2019) and 2nd C (Mar/20).

Principal Component Analysis

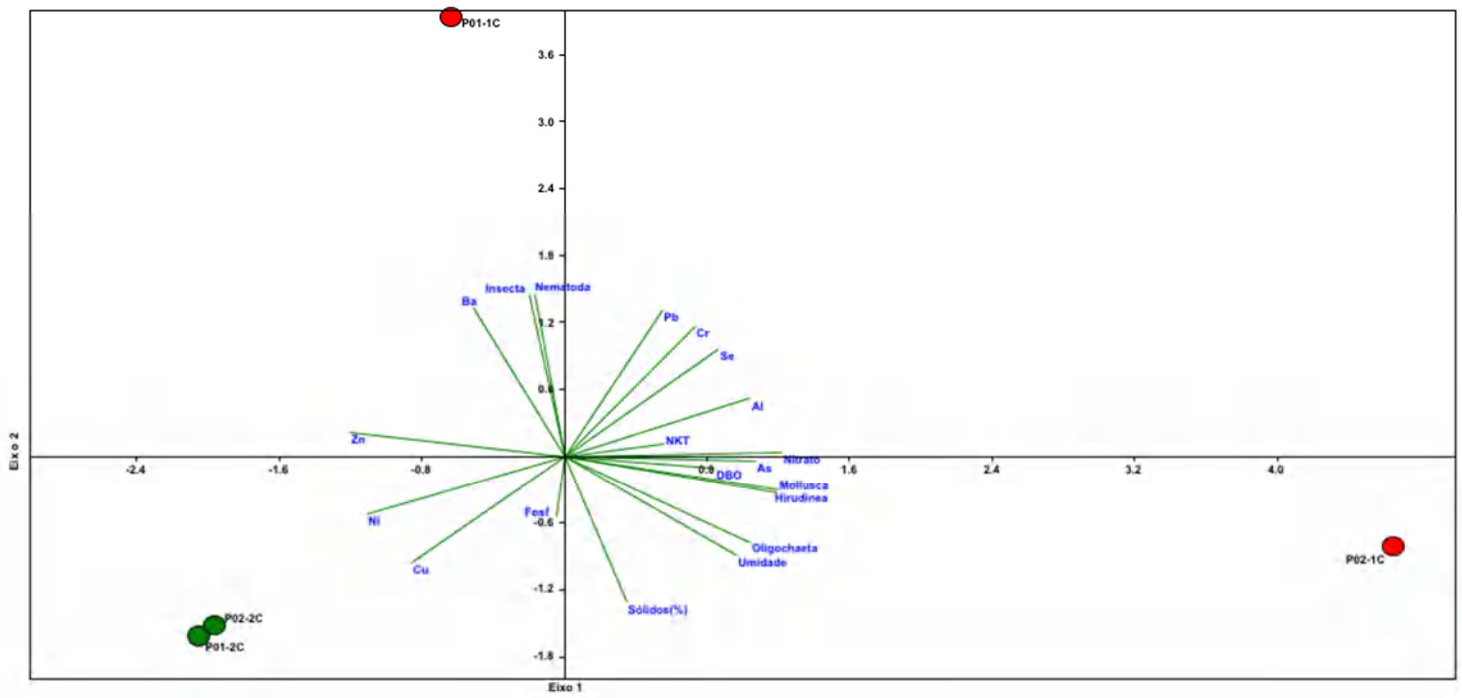
The PCA (Principal Component Analysis) analysis was conducted to investigate the relationships between the benthic invertebrate community and sediment characteristics, as shown in the figure below.

The first two axes of the PCA explain 85% of the data distribution. Axis 1 showed a positive correlation with nitrate, aluminum, arsenic, nickel, Oligochaeta, Hirudinea and Mollusca densities; and negative with variable nickel and zinc concentrations. The second axis showed a positive correlation with the concentrations of barium and lead and with the densities of Insecta and Nematoda; and negative with the percentage of solids.

Corroborating the results found in the similarity analysis, the PCA grouped the samples collected in the March 2020 campaign and showed that in the October 2019 campaign the results were differentiated between the sampling points.

Molluscs (bivalve L. fortunei) and annelids tended to present higher densities in environments whose sediments had the highest percentages of solids, higher BOD, as well as higher concentrations of nitrate and some metals, while insects (family Chironomidae) and nematodes (which only appeared at point P01 in the 1st campaign) presented the opposite trend. It should be pointed out that the PCA is an exploratory analysis and does not take the form of a hypothesis test, nor is it possible to establish a direct cause-and-effect relationship between such variables.

Figure 462 – Principal Component Analysis among Benthic Invertebrate Communities and Sediment Characteristics - 1stC (Oct/2019) and 2ndC (Mar/20).



Leyenda: Al - Aluminium, As - Arsenic, Pb - Plomo, Ni - Nickel, Cu-Copper, Zn= Zinc. Ba= Bario, Se = Selenium, Cr = Chromium, NKT = Total Kjeldahl Nitrogen.

Final considerations

The assessment of the phytoplankton community resulted in the registration of 71 taxons in the Paraguay River, taking into account the integrated data from the two campaigns held in October 2019 and March 2020, during the rainy season. The greatest richness was attributed to the diatoms Bacillariophyceae, followed by Cyanophyceae and Chlorophyceae, groups that are common components of plankton in continental aquatic ecosystems.

Among the taxons inventoried, bacillariophyceae diatoms Diadesmis sp., Gyrosigma sp. and Nitzschia sp., the conscinodiscophic diatom Aulacoseira granulata, the cyanobacterium Phormidium sp. and a taxon of the class Cryptophyceae occurred at all collection points in both campaigns, suggesting a greater adaptability of these taxons to local environmental conditions.

Quantitative analysis showed that phytoplankton density differed substantially between seasons, with the highest values associated with the October 2019 collection, mainly due to the contribution of Cryptophyceae, including algae Cryptomonas sp, considered opportunistic. In the second season (March 2020), the diatoms Coscinodiscophyceae were more numerically representative.

Cell densities of cyanobacteria were low in the two segments sampled in the Paraguay River, which is a positive aspect, considering that this group includes taxons that produce cyanobacteria, which can cause damage to aquatic biota and water quality when present in large quantities.

In the first season, phytoplankton diversity remained low, reflecting the high abundance of Cryptophyceae, and in the next collection there was an increase in this indicator. Bray Curtis' analysis showed a high level of similarity in the two points evaluated in the Paraguay river, in both collections.

The evaluation of benthic invertebrates, in the two campaigns in question, indicated the presence of 11 taxons, with the greatest richness attributed to immature forms of aquatic insects (class Insecta), with emphasis on diptera of the family Chironomidae.

The subclass Oligochaeta, as well as the family Chironomidae was present in all samples, a behavior considered common in continental lotic environments. Among the family Chironomidae, representatives of the subfamily Chironominae were more frequent, being present at both sampling points.

In general, the taxon sampled in these two campaigns are considered to have a wide range of tolerance to variations in their natural habitats and to decline in water quality. The presence of the Limnoperna fortunei, in the Paraguay river, downstream of the future PARACEL pulp mill (P02), should be highlighted as an invasive species, coming from Asia and accidentally introduced into South America by the ballast water of merchant ships.

In quantitative terms, the highest densities were obtained at point P01, in the first campaign, mainly due to the contribution of larvae from the family Chironomidae. At P02 the dominance of the bivalve L. fortunei was found in the first season and of Chironomidae in the later sampling.

Diversity and equitability in the Paraguay river were low at P01 in the first season, due to the high abundance of the family Chironomidae.

The similarity assessment pointed out similarities between the samples obtained in March 2020 (2nd season) and a greater differentiation between the samples obtained in October 2019 (1st season), reflecting the dominance behavior mentioned above.

In summary, in general, the benthic community found is in accordance with that already recorded by other authors in studies conducted in the region, with high frequency and abundance of the family Chironomidae and the Oligochaeta rings. The hydrodynamic regime and flood seem to be the main structuring factors of the community's environment, although there is not yet a complete hydrological cycle to confirm these behaviours.

9.2.3 Protected Areas

Protected Wild Areas

The legal framework for natural resource conservation within protected areas in Paraguay was established by Law 352 on Protected Wildlife Areas ("Areas Silvestres Protegidas" - ASP in Spanish), approved in 1994, which created the National System of Protected Wildlife Areas of Paraguay (SINASIP) (Sienra et al., 2004).

In 2000, in response to a specific need to implement the subsystem of the private forest areas, three resolutions were enforced: Resolution 49, approving the methodology for the elaboration of Management Plans for Wildlife Areas protected by SINASIP; Resolution n.73, authorizing the National Registry of Protected Wildlife Areas of Paraguay; and Resolution 79, establishing the procedure for the legal creation of private domain protected areas (Sienra et al., 2004).

That same year, Law 1561 created the National Environmental System and the Secretariat of State for the Environment (SEAM), entities whose function or objective is the formulation of policies, coordination, supervision and execution of environmental actions and plans, programs and projects within the framework of the National Development Plan and related to the preservation, conservation, recomposition and management of natural resources (Sienra et al., 2004). According to SINASIP, Paraguay's protected wildlife areas have three management categories:

Fully protection

National parks: Those natural areas with ecosystems that contain outstanding geomorphological features, as well as species representative of a natural region and that under protection are destined for research, education and tourism in nature.

Natural Monuments: Those areas that contain unique natural or cultural characteristics or features of outstanding cultural value and that under protection are intended for scientific research and recreation when conditions permit.

Flexible use

Wildlife Refuge: These are those preferably natural areas intended for the conservation of species and ecosystems through active management.

Protected landscapes: Those natural areas intended for the protection of land and water landscapes and recreation.

Reserves of Managed Resources: These are areas that make it possible to combine the conservation of biological diversity with the sustainable use of ecosystems and their components.

Biosphere Reserve: They are those areas that allow the constitution of a flexible use unit and allow the harmonious coexistence of different modalities of use and conservation, which include other categories of management inside its limits.

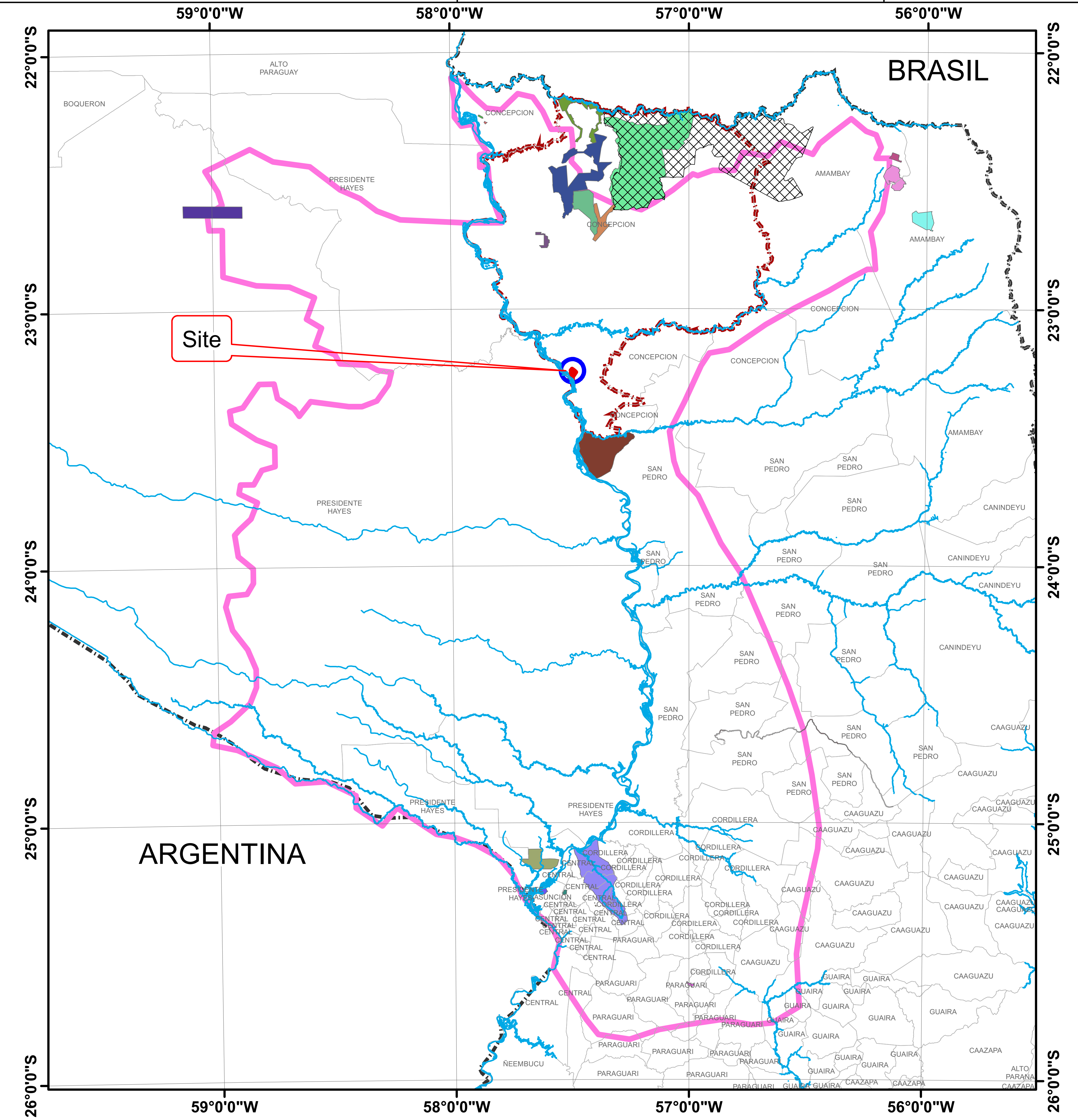
According to the Map of Protected Wildlife Areas in Paraguay (SINASIP/SEAM, 2007; DASP/DGPCB/SEAM, 2011) the country has 68 protected units, i.e. 27% of its territory is under some category of protection. In the department of Concepción, the protected areas are divided into the following categories:

Categories (SINASIP*)		**Law**	**Area (ha)**
National Parks	National Park Serranía de San Luís	Decree 20,712	103,018
	National Park Serranía de San Luís	Decree 17,740	10,273
Private natural reserves	Natural Reserve Cerrados del Tagatiya	Decree 7,791	5,700
	Natural Reserve Tagatiya mi	Decree 10,396	33,789
Biosphere Reserves	Biosphere Reserve of the Cerrado del Río Apa**	Decree 14e431	267,836

Source: * SINASIP: "Sistema Nacional de Áreas Silvestres Protegidas del Paraguay", National System of Protected Wildlife Areas of Paraguay (2007); ** biosphere Reserve del Cerrado del Río Apa is inserted both in Departament of Concepción and Amambay (SEAM, DGECC, 2010).

In addition to the protected areas mentioned above in the study conducted by the World Database on Protected Areas (WDPA, 2017), the Department of Concepción has two other private natural reserves: Guayacán I, II and III and Arrecife. Although the department of Concepción has approximately 300,000 hectares of protected wildlife areas, both public and private, i.e. just over 15% of the total area of its territory, these are concentrated in the northern portion of the department as shown below, so there will be no interference in the protected areas due to the implementation of the PARACEL pulp mill.

Figure 463 – Map of Protected Areas.



Sistema de Coordenadas: SIRGAS 2000 - Geo
Proyección: UTM - Transversa de Mercator
Datum: SIRGAS 2000

FUENTE: Informe Nacional
"Áreas Silvestres Protegidas del Paraguay" - 2007

Subtitle

- DAA
- DIA
- IIA
- Concepción Paraguay_2002_municipios
- Paraguay_2002_rios_principales

Subtitle

UC's

- Arrecife
- Arroyo Blanco
- Banco San Miguel y Bahía de Asunción
- Bosque Yvyraty
- Caverna Kamba Hopo
- Cerrado del Río Apa
- Cerrados del Tagatiya
- Cerro Chorori
- Cerro Cora
- Cerro Koi
- Cerro Morado Caverna Ycua Pai
- Cuenca del Arroyo Tacuary Chopy Sayju
- Estero Milagro
- Estrella
- Guayacan I II III
- Humedales del Bajo Chaco
- Jukyty Guasú
- Lago Ypacarai
- Laguna Teniente Rojas Silva
- Paso Bravo
- Refugio Bilólogico Tati Yupi
- Serrania San Luis
- Tagatiya-mi
- Tapiracuai
- Tres Cerros-santa caverna-14 de Julio y Santa Caverna
- Zona Nacional de Reserva Cerro Lambare
- Ñu Guazu

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PARACEL PÖYRY

TÍTULO DEL MAPA: Protected Areas Map	
TÍTULO DEL PROYECTO: BIOTIC ENVIRONMENT - IIA	
PROCESO DE LICENCIA: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT	
TIPO DE LICENCIA: ENVIRONMENT PROCESS PERMIT	
UBICACIÓN: CONCEPCIÓN-PY	UGHRI: CIH8 Aquidaban y CIH18 Rio Pilcomayo

ESCALA:	REVISIÓN:	RESPONSABLE TÉCNICO:	CRBio Nº:
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Ramsar Convention

The Convention on Wetlands is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources. The Convention was adopted in the Iranian city of Ramsar in 1971 and entered into force in 1975. Since then, almost 90% of the UN member states, from all geographic regions of the world, have agreed to become "Contracting Parties", and it was ratified by Paraguay by Law 350/94 of February 2 (Dominguez, 2015).

This convention gives member countries the responsibility to develop and implement a plan to promote the conservation of wetlands included in the list of international importance and beyond the wise use of all wetlands in their territory. In this sense, it certifies the creation of nature reserves with the corresponding measures for their custody. In addition, the signatories are charged with promoting research and the exchange of data and publications related to wetlands and their fauna and flora (RAMSAR 2006 apud Domínguez, 2015).

Paraguay currently has 6 sites designated as Wetlands of International Importance (Ramsar sites), covering an area of 785,970 hectares (https://www.ramsar.org/wetland/paraguay):

Negro River (Ramsar nº. 729)

Located at 19°52'S and 58°34'W, on the border between Bolivia and Brazil, with a surface area of 370,000 ha it represents a river system of lakes and course located in an ecotone resulting from the confluence of three biogeographic provinces with a representative fauna.

Chaco Lodge Lagoon (Ramsar nº. 1330)

Located in Presidente Hayes, at 22°17'S and 59°18'W, it is a private reserve with 2,500 hectares of surface area. The Chaco Lodge is a salt water lake with marked level fluctuations, surrounded by xerophilic forests and bushes and halophilic vegetation, frequented by many species of birds.

Teniente Rojas Silva Lagoon (Ramsar nº. 1390)

Located in Boquerón at 22°38'S and 59°03'W, it is a private reserve with 8,470 ha of surface area. It occupies part of the basin of the South Yakaré stream in the Paraguayan Chaco, and this lake alternates between fresh and salt water conditions.

Tifunque (Ramsar nº. 730)

Located in Presidente Hayes, at coordinates 24°15'S and 59°30'W, it is a National Park with a surface area of 280,000 ha, which includes an alluvial plain along the Pilcomayo River, flooded most of the year and characterized by patches of forest, extensive grouped lakes and palm tree savannahs.

Estero Milagro (Ramsar nº. 731)

Located in San Pedro at 23°34'S and 57°22'W, it is a National Park with a surface area of 25,000 ha. The area is characterized by natural pastures, low forests, savannahs and gallery forests, swamps, small marshes and a great diversity of plant species. The site provides an important aquatic habitat for migratory birds and other animals associated with aquatic environments, as well as a habitat for the survival of several rare species and threatened plant species.

Ypoá Lake (Ramsar nº. 728)

Located in Paraguari, Ñeembucú, Central in the coordinates 26°30'S and 57°33'W, it is a National Park with 100.000 ha of surface. It is an area of extensive, shallow, grouped lakes (esterales) with mats of floating vegetation, some of which support small trees and fauna. The marshes are interspersed with wooded islands, savannas, rocky areas and streams. This site provides excellent habitat for wildlife and is one of the most important aquatic environments in Paraguay, important for several endangered species, migratory birds and five threatened plant species.

Although Paraguay has the six Wetlands of International Importance mentioned above, no Ramsar areas have been identified in the project's areas of influence.

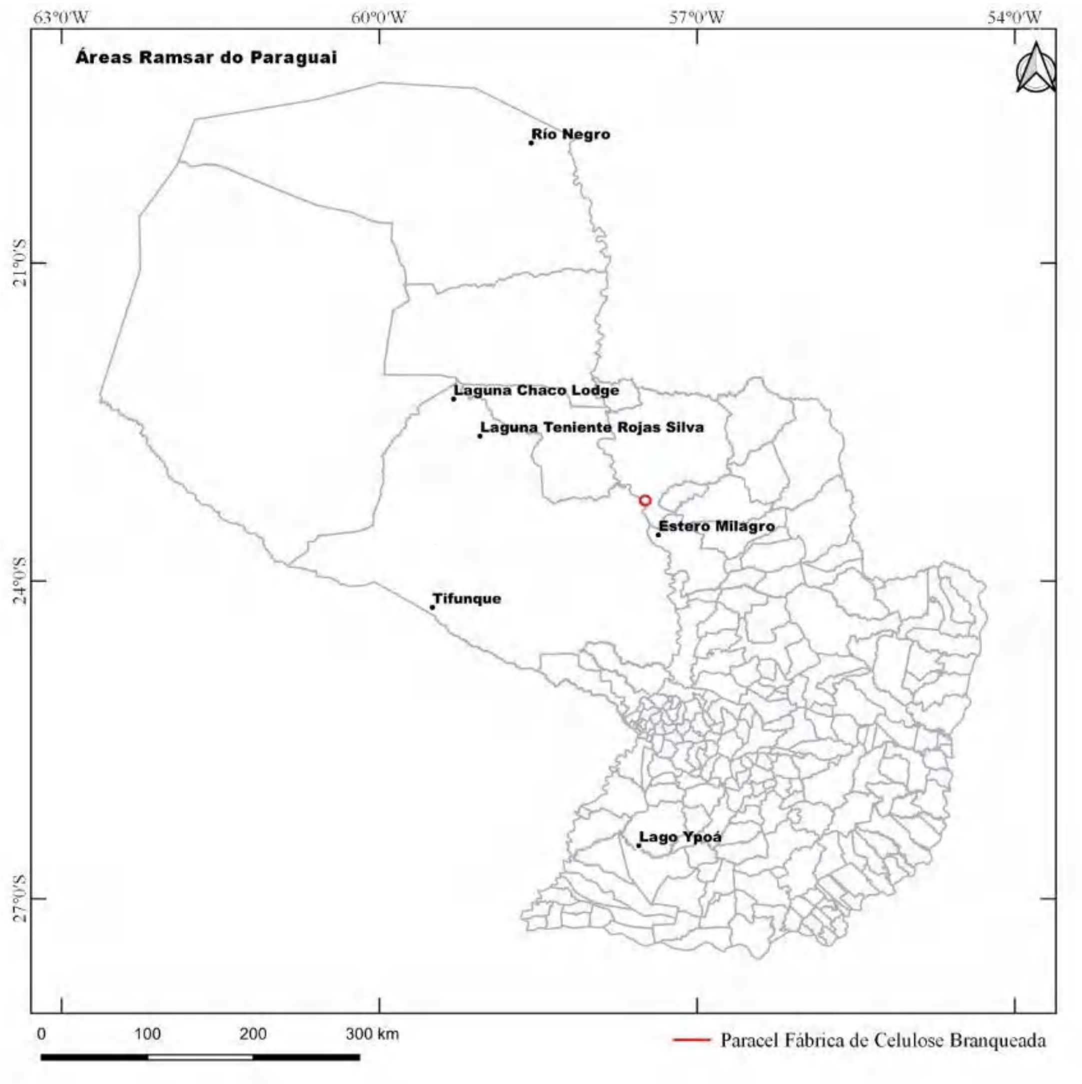

Figure 464 – Map of Ramsar areas in Paraguay. Source: Ramsar Sites Information Service (Available at: https://rsis.ramsar.org/).

Priority Conservation Areas

According to MADES/DGPCB (2019), information from the studies: Priority Areas for Conservation in the Eastern Region of Paraguay by the Centro de Datos para la Conservación - CDC (1990) and the Project "Priority Areas for Conservation in Five Ecoregions of South America", Project GEF/1010-00-14, was used to define priority conservation sites.

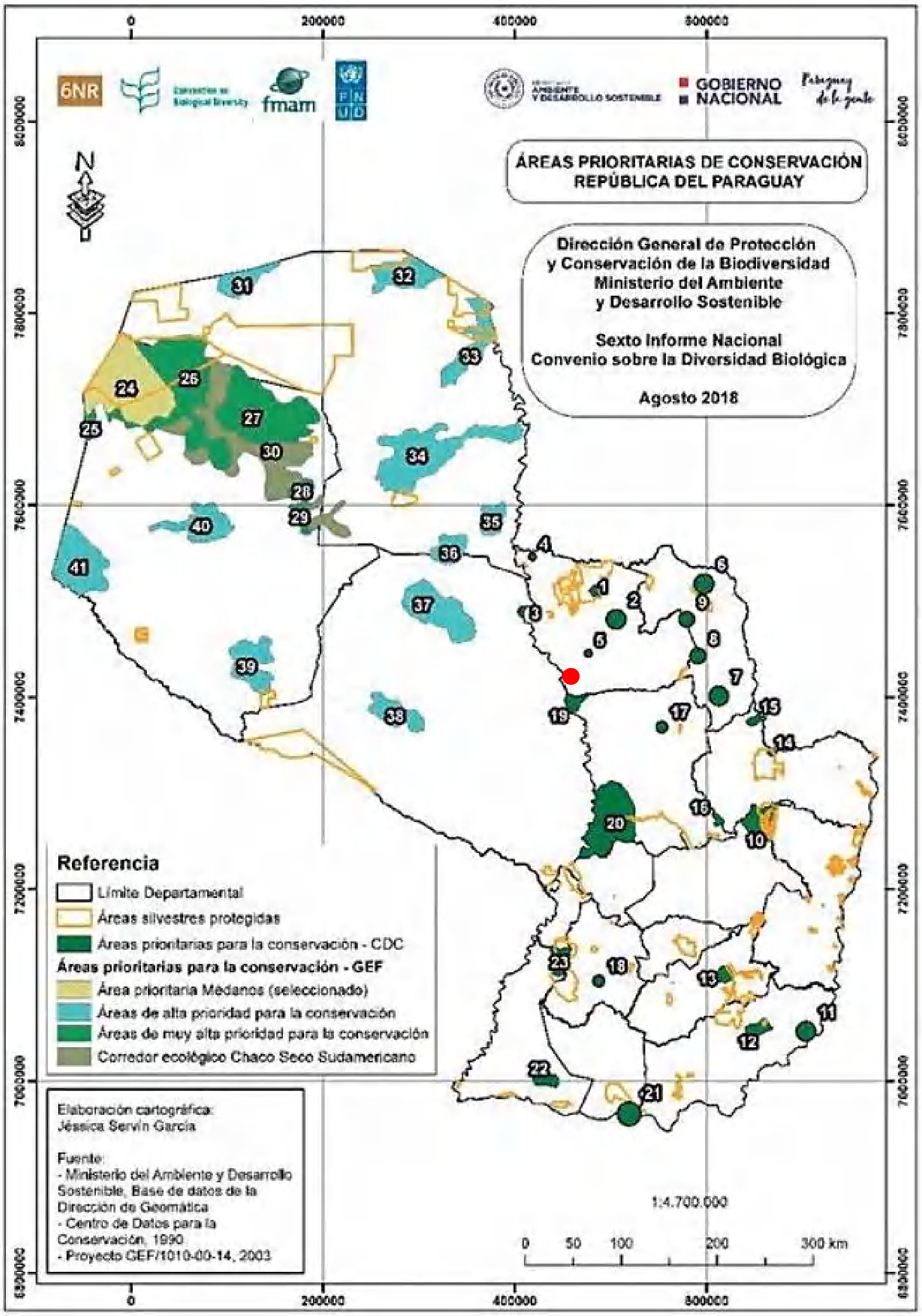

Figure 465 – Map of Priority Conservation Areas (2018). Source: MADES/DGPCB (2019). In red is the location of the PARACEL pulp mill.

Many of the priority areas for conservation identified in the above-mentioned studies overlap with existing protected wildlife areas - ASPs, however, in the eastern region 23 priority areas were identified that had the following characteristics: they were threatened, represented perhaps the last remaining characteristic in a virgin state of the representative ecosystems of each ecoregion, and needed more detailed scientific research. Of these 23 areas, the first five in order of priority are Mbaracayú, Bosque Arary, Cerro Guazú, Serranía San Luis and Serranía San Rafael.

In the western region, 18 priority areas were identified, which were subdivided into high and very high priority areas for conservation and two areas corresponding to the Médanos and the Chaco ecological corridor of South America. This classification took into account ecological and landscape criteria, combined with anthropogenic pressure factors and existing protected areas, and was carried out by means of a GAP analysis, which according to the CBD (Convention on Biological Diversity) is an evaluation of the degree to which a system of protected areas meets the protection objectives established by a nation or region to represent its biological diversity. High priority conservation areas have high diversity, endemism and globally important energy resources distributed over a large part of the proposed territory, as well as a high representation of highly threatened taxons and species.

The high conservation priority areas are important because of the concentration of threatened species according to IUCN, biological diversity, scenic beauty and the presence of migratory birds on Appendices I and II of the Convention on Migratory Species.

Although 41 priority conservation areas have been identified in Paraguay, these are not in the areas of influence of the PARACEL pulp mill.

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

Pöyry Tecnologia Ltda.
Av. Alfredo Egídio de Souza Aranha, 100
Bloco B - 7° andar
04726-170 São Paulo - SP
BRASIL
Tel. +55 11 3472 6955
Fax +55 11 3472 6980
E-mail: contato.br@poyry.com

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Página 1

PARACEL

Pulp Mill, River Port, Transmission Line and Electrical Substation in Concepción – Paraguay

VOLUME II – BOOK III - ENVIRONMENTAL DIAGNOSIS OF THE SOCIO-ECONOMIC ENVIRONMENT

Content	9	ENVIRONMENTAL DIAGNOSIS
Annex	I	Social Study – Mill Component

Distribution	
PARACEL	E
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Orig.	05/08/20 – hbo	05/08/20 – bvv	05/08/20 – hfw	05/08/20 – hfw	For information
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b	31/07/21 – hbo/msh	31/07/21 – bvv	31/07/21 – hfw	31/07/21 – hfw	For information

CONTENT

9 ENVIRONMENTAL DIAGNOSIS 7
9.3 Socioeconomic environment 7
9.3.1 Presentation 7
9.3.2 Project description and influence areas 14
9.3.3 Social Environment Studies Method 18
9.3.4 Characterization of the project's areas of influence 21
9.3.5 Survey of social perception 164

Annex I Social Study – Mill Component

FIGURE LIST

Figure 1 – Areas of influence for social environment studies 17
Figure 2 – Projected rural-urban population by department in 2020, according to projections for 2012 23
Figure 3 – Location of the indigenous communities and PARACEL project (pulp mill in red, TL and mill access road in purple and farms in blue). 26
Figure 4 – Age and gender distribution according to 2017 projected data. Department of Concepción 32
Figure 5 – Age and gender distribution according to 2017 projected data. Department of San Pedro 32
Figure 6 – Age and gender distribution according to 2017 projected data. Department of Amambay 32
Figure 7 – Net migration rate, projection by department 39
Figure 8 – Evolution of the number of intentional homicides per hundred thousand inhabitants in the departments 63
Figure 9 – Property crime rate per 100,000 inhabitants in the departments 64
Figure 10 – National Road Network 66
Figure 11 – National Routes in the IIA 67
Figure 12 – Road network in the department of Concepción 68
Figure 13 – Description of road works and their coordinates in the department of Concepción 69
Figure 14 –Belén district Map 85
Figure 15 – Photo of route of access to the city 86
Figure 16 – City of Belen: representation of indigenous culture 86
Figure 17 –Loreto district Map 87
Figure 18 – Access to Loreto 88
Figure 19 –Loreto City 89
Figure 20 –Horqueta district Map 90
Figure 21 – Photograph of Horqueta 91
Figure 22 –Concepción district Map 92
Figure 23 – Bridge “Nanawa”, on the Paraguay River, city of Concepción 94
Figure 24 – System of relations and the degree of interdependence 95
Figure 25 – Chart of dimensions in hectares of the microterritories of Concepción 96
Figure 26 – Microterritories identified 98
Figure 27 – Reference photographs 105
Figure 28 – Geographic location of institutions and sites of interest 106
Figure 29 – Photograph taken in the micro territory: Saladillo on waste disposal 109
Figure 30 – Main Access roads 111
Figure 31 – Photographs of micro territories in the rainy season 111
Figure 32 – Photographs of different places in the DIA 112
Figure 33 – Social issues 119
Figure 34 – Economic issues 119
Figure 35 – Logging collectors - Callejón San Ramón 122
Figure 36 – Cattle farming 122
Figure 37 – Micro territory Curuzu Ñu 122
Figure 38 – Micro territory Colonia Coronel Mongelós 122
Figure 39 – Micro territory Co’ê Porâ 123

Figure 40 – Micro territory Pirity Mongelós 123
Figure 41 – Limits of Directly Affected Area (DAA) 125
Figure 42 – Entrance by Piquete Cue 126
Figure 43 – Access roads to the community 127
Figure 44 – Access roads to community 128
Figure 45 – Common houses in the DAA 129
Figure 46 – Ranches in the area 136
Figure 47 – Ranches in the area 136
Figure 48 – Ranch in the area 136
Figure 49 – Map of DAA 138
Figure 50 – Reference areas categorized and presented in spotted layer formats 139
Figure 51 – Heritage grids present in the city of Concepción with hierarchical symbols 145
Figure 52 – Location of historical buildings, within the old town of Concepción, in relation to Paracel mill 148
Figure 53 – Mapping of historical buildings, within the old town of Concepción, connection to the Paraguay River 148
Figure 54 – Photography: Cuartel de la Villa Real de Concepcion -1886 149
Figure 55 – Photograph: Current museum front. 2020 150
Figure 56 – Museum's internal gallery 150
Figure 57 – Municipal Museum of the Cuartel de la Villa Real 150
Figure 58 – Old sector cemetery - Villa Real de la Concepción 151
Figure 59 – Dwelling - typology 151
Figure 60 – Satellite image of the city of Belen - heritage survey 152
Figure 61 – Side facing of the church of Belen (Lat. 23°28'21.19 "S Long 57°15'43.84 "W) 153
Figure 62 – Back facing of the church of Belen (Lat. 23°28'21.19 "S Long 57°15'43.84 "W). 153
Figure 63 – Colonial house with front gallery. Padre Sanchez Avenue e/Uruguay. Belen 153
Figure 64 – Corner house with frontage type cover (Lat 23°28'12.57 "S Long 57°15'45.89 "W) 153
Figure 65 – Colonial house with front gallery with details of Jesuit style columns (Lat. 23°28'10.18 "S Long 57°15'49.90 "W) 153
Figure 66 – Colonial house with front gallery with details of Jesuit style columns (Lat. 23°28'9.72 "S Long 57°15'47.76 "W) 153
Figure 67 – Tropic of Capricorn Monument. Belen, Concepción Latitude 23°26''21''. Tourist point and of relevance for the city. 154
Figure 68 – Satellite image of the city of Horqueta 155
Figure 69 – Vivienda transformed into a corner with a front cover and gables on the cornice Location: Mariscal José Félix Estigarribia, corner of Curupayty. Horqueta. 155
Figure 70 – Vivienda in the corner with a front type cover and gables on the roof top and balcony. Location: Mariscal José Félix Estigarribia e/Curupayty. Horqueta. 155
Figure 71 – Map of the city of Loreto – heritage survey 156
Figure 72 – Vivienda - Corner house with front "tapa" type 156
Figure 73 – Colonial style house with front terrace (-23 16 37 -57 19 38) 156
Figure 74 – Monolith "María Auxiliadora" in the main street 159
Figure 75 – Geo processing of field survey areas 165
Figure 76 – Location of the collection process 166
Figure 77 – Assessment of the positive aspects 175
Figure 78 – Priorities for a major development 178
Figure 79 – Results of interviews about social issues 179
Figure 80 – Results of interviews about economic issues 179

TABLE LIST

Table 1 – National and international legal framework related to PARACEL's project 9
Table 2 – Environmental and Social Sustainability Standards and Performance Guidelines from IFC 11
Table 3 – Equator principles 12
Table 4 – Total population projection by sex, according to department. Year 2017 23
Table 5 – Population Evolution (Projection 2017) 24
Table 6 – Population density 24
Table 7 – Main demographic indicators, by department. Year 2017 30
Table 8 – Indicators of Table 7 31
Table 9 – Households, legal and current tenure, years 2017 and 2018 33
Table 10 – Home water sources (%), years 2017 and 2018 33
Table 11 – Solid waste and wastewater disposal (%), years 2017 and 2018 34
Table 12 – Main fuel used for cooking (%), years 2017 and 2018 35
Table 13 – Ownership of long-term goods (%), years 2017 and 2018 35
Table 14 – Información sobre líneas de pobreza al 2017 36
Table 15 – Total and Extreme Poverty by Department (Year 2017) 37
Table 16 – Average and distribution of monthly per capita income of the population, by monthly income quintiles (2017) 37
Table 17 – Homes with UBN, by department and district 38
Table 18 – Population aged 10 years and over migrating by department of residence, according to place of occupation, 2012 39
Table 19 – Main labor market indicators 43
Table 20 – Employed population, by sector of occupation 44
Table 21 – Occupied people according to years of study, by sex, in the IIA (2017) 45
Table 22 – Average labor income (years 2016 and 2017) 46
Table 23 – Average labor income, by department and sex (in thousands of guaraníes) 47
Table 24 – Land according to its use in number of properties, by department in 2008 48
Table 25 – Land according to its number in terms of surface area, by department as of 2008 . 48
Table 26 – Farms according to soil management and conservation, by department as of 2008 49
Table 27 – Forest plantations (Eucalyptus and Pine), by department in 2008 49
Table 28 – Total economic units. Secondary and Tertiary sectors, by department. Year 2011. 50
Table 29 – Evolution of the conceptual economy in the last 50 years 51
Table 30 – Number of water systems and connections according to provider, by department . 52
Table 31 – Average years of study of the population aged 15-29, by department and gender – Year 2018 54
Table 32 – Main education indicators of the population of Concepción (% and absolute value) 55
Table 33 – Students enrolled in high school, by department and gender (year 2015) 56
Table 34 – Students enrolled in high school by emphasis, according to department and zone (year 2015) 56
Table 35 – Universities, district and careers offered (original names) 57
Table 36 – Careers accredited by ANEAES, department of Concepción 58
Table 37 – Enrolled in Concepción – Year 2017 59
Table 38 – Number of graduates in Concepción according to university, faculty, career years 2013 to 2016 59

Table 39 – Total population, by department, gender and health status (%) Year 2018 60
Table 40 – Main health indicators of the population of Concepción per year in % and absolute value o 61
Table 41 – Rate of intentional homicides per hundred thousand inhabitants, by department, years 2010-2017 63
Table 42 – Property offences, by department, years 2010-2017 63
Table 43 – Road network by department by type 66
Table 44 – Bridges and roads being improved in the IIA 69
Table 45 – Current infrastructure works in the project's DIA (2019) 70
Table 46 – Land transport companies from and to Concepción 71
Table 47 – Number of authorized vehicles by type, according to department (2017) 72
Table 48 – Population of 10 years old or elder by gender, according to internet use (%) 72
Table 49 – Population of 10 years old or elder who used the Internet by gender, according to place of access (%) 72
Table 50 – Number of broadcasting stations and TV services, according to department. Year 2017 73
Table 51 – Broadcast FM radio stations - department of Concepción 74
Table 52 – Broadcasts radio stations AM – department of Concepción 74
Table 53 – TV Broadcasting Services – department of Concepción 74
Table 54 – Local digital media in DIA 75
Table 55 – Facilities/installations, rooms and beds in DIA, by district 76
Table 56 – Public institutions with a presence in the municipalities (original titles in Spanish) 77
Table 57 – Citizen participation instances, with the participation of State representatives 78
Table 58 – Land according to its use in number of properties, by department as of 2008 79
Table 59 – Land according to its number in terms of surface area, by department as of 2008 . 80
Table 60 – Land distribution by district, department of Concepción 81
Table 61 – Public colonies formed between 1891 y 2010 81
Table 62 – Resorts in the department of Concepción 83
Table 63 – Additional information about the Belen District 85
Table 64 – Additional information about the district of Loreto 87
Table 65 – Other information about the District of Horqueta 90
Table 66 – Other information about the District of Concepción 92
Table 67 – Summary description of identified microterritories 99
Table 68 – Register of recreational spaces 104
Table 69 – Total population of microterritories in the district of Concepción 107
Table 70 – Number of lodgings 2 108
Table 71 – Treatment of Solid Waste 109
Table 72 – Sanitary landfill or drainage system 110
Table 73 – Use of technologies 112
Table 74 – Health services 113
Table 75 – Educational institutions 115
Table 76 – Prioritization of social problems in the micro territories of the district of Concepción 118
Table 77 – Main economic activities 120
Table 78 – Time of establishment in the structure 128
Table 79 – Number of people per house 130
Table 80 – Number of people per age group 130
Table 81 – water distribution to population 131
Table 82 – Summary matrix of Piquete Cue homes and their characteristics 133

Table 83 – Assessment and impacts on the evaluated cultural heritage 140
Table 84 – Selection and assessment criteria for the study of architectural cultural heritage 143
Table 85 – List of relevant material heritage of the city of Concepción 146
Table 86 – List of relevant immaterial heritage in the DIA 157
Table 87 – List of relevant "patron" holidays.. 158
Table 88 – Relevant natural heritage list: Protected areas and reserves in the project area/DIA 160
Table 89 – Listing of typical food items surveyed with local testimonies (in Spanish to preserve the integrity).. 162
Table 90 – Techniques used in the intervention.. 167
Table 91 – Main economic activities of population... 169
Table 92 – Aspects mentioned by the population as positive.. 170
Table 93 – Problems identified by the families surveyed 170
Table 94 – Priority issues selected by the Piquete Cue (ADA) census takers 171
Table 95 – Recreational and cultural activities mostly mentioned 171
Table 96 – Media... 172
Table 97 – Economic Activities.. 173
Table 98 – Recreational Activities... 174
Table 99 – Main positive aspects mentioned about living in the area...................................... 176
Table 100 – Results about issues needed for development 177
Table 101 – Results of surveys, community interviews, institutional interviews and census... 181
Table 102 – Results of surveys, community interviews, institutional interviews and census... 181
Table 103 – Results of surveys, community interviews, institutional interviews and census... 182
Table 104 – Result of inquiries.. 182
Table 105 – Results of community and institutional interviews, census and inquiry responses 183

9 ENVIRONMENTAL DIAGNOSIS

9.3 Socioeconomic environment

This section presents the content of the "Social Study Report", developed within the framework of the Environmental and Social Impact Assessment (ESIA).

It is emphasized that a "Cultural Heritage" report was prepared by the external consultant Lic. Enrique Bragayrac, a cultural heritage specialist and team, from which the main information for this document was extracted.

For the purposes of the IPRS, and considering the requirements of the indigenous population, a specific study has been developed independently of the social studies, the "Preliminary Study on Indigenous Communities in the Departments of Concepción and San Pedro", prepared by the principal consultant Urbano Palacio and specialists contracted by PARACEL, from which the main information for this document was also extracted.

9.3.1 Presentation

This document was prepared on the basis of a report by a team of external specialists led by Caren Kremer and corresponds to the results of the studies of the social component, developed within the framework of the ESIA PARACEL project for the construction and operation of a pulp mill in the department of Concepción, Paraguay.

This report is developed according to the following sections:

- Description of the project and the areas of influence, which contains a brief description of the project and the implications of its implementation, the proposed phases, including the estimated periods of execution and the results to be achieved, in terms of income generation, technological innovation, possible partnerships, among others. Likewise, the selection criteria for the project's areas of influence: Area Directly Affected (DAA), Direct Influence Area (DIA) and Indirect Influence Area (IIA).
- Methodology for the elaboration of the social studies, presenting in detail the work done by the team responsible for the elaboration of this material, in its different chapters as baseline and support studies, evaluation and analysis of impacts, measures and proposed programs. It also describes the process of collecting information in the field, the techniques used, the processing and analysis system, among others.
- Social characterization of the project's areas of influence. This section describes the economic, social and cultural aspects of the IIA and DIA, including variables such as land tenure, income, gender, among others. Initially, a general presentation is made of each area (departmental, district and local) and then its situation in relation to demography, economy, employment, access to basic services, etc.
- The survey of social perception is one of the main components of the baseline, since it contains information, especially qualitative information regarding the perception of the resident population in the DAA and the DIA, in two major categories :

- o Socioeconomic characteristics of the area in which they reside; and
- o The installation of the pulp mill in the department of Concepción.

Finally, in the annexes section, information related to information collection tools, verification sources resulting from field work and specific studies is presented.

9.3.1.1 Objectives and scope of the studies of the social component

The main objective of the social studies carried out within the framework of the ESIA is to develop a social baseline of the project's area of influence that will make it possible to evaluate the impacts of the social environment and consequently develop mitigation measures and social management programs.

An important part of the social studies was devoted to surveying the population's perception of the area of influence in relation to its community and the project, as well as identifying key actors at the institutional and community level, and the communities living in the area closest to the plant.

Taking into account the importance of social management in a project of this magnitude, permanent two-way social work was proposed from the outset, that is, the development of actions that would make it possible, on the one hand, to collect first-hand information that was as accurate as possible for the purposes of the project and the ESIA, and on the other, to provide communities with information of interest from the outset, generating participatory spaces so that the population would be involved from the project design stage.

9.3.1.2 Related International and National Regulatory Framework

The following are the main laws, norms and principles that have been considered for the development of social studies. PARACEL's sustainability policy takes into account the best international practices, which guide the socio-environmental management of the project.

The national and international regulatory framework cited below has been considered in the different stages of the social studies, from the definition of the areas of influence to the criteria for impact evaluation and program development.

National level

Within the framework of the socio-environmental processes of the projects, both public and private, specific studies are carried out within the framework of Law 294/93 on Environmental Impact Assessment, and its Regulatory Decrees No. 453/13 and 954/13, which establish the Environmental Management Plan (EMP) or the Environmental and Social Management Plans (ESMP) that will govern the undertaking in its different stages, i.e. during design, construction and subsequent operation.

International level

Related international legislation, such as the Equator Principles, the International Finance Corporation's (IFC) Environmental and Social Sustainability Performance Standards that guarantee the implementation of socially responsible projects linked to rigorous environmental management practices, the Sustainable Development Goals (SDAs), the World Bank's Environmental, Health and Safety Guidelines, and ILO Convention No. 169, ratified by Law No. 234/93, among others.

Table 1 presents the legal instruments and principles that govern the project, with emphasis on social aspects.

Table 1 – National and international legal framework related to PARACEL's project

Matter	Law
NATIONAL CONSTITUTION	▪ Main rule of the Paraguayan State. It establishes the principles of the organization and administration of the country, guaranteeing the protection of fundamental rights. It establishes the principles that define the right to quality of life (Article 6), the right to a healthy environment (Article 7), among others.
Major International Treaties and Conventions	▪ Law No. 1231/1986. Approving and ratifying the Convention concerning the Protection of the World Cultural and Natural Heritage. ▪ Law No. 2885/2006. Approving the Convention on the Protection of the Archaeological, Historical and Artistic Heritage of the American Nations (San Salvador Convention). ▪ Law No. 2886/2006. Approves the Convention on the Protection of the Underwater Cultural Heritage and Annex. ▪ Instruments derived from the commitment to climate change (National Strategy for Adaptation to the CC, National Strategy for Mitigation of the CC, National Plan of Adaptation to the CC). ▪ Law No. 234/93. Which approves the Convention No. 169 on Indigenous and Tribal Peoples in Independent Countries, adopted during the 76th. International Labor Conference held in Geneva on 7 June 1989.
Environmental Impact Assessment	▪ Law No. 294/1993. Environmental Impact Assessment. ▪ Law No. 345/1993. Amending Article 5 of Law No. 294/93 on Environmental Impact Assessment.
Institutional framework with emphasis on environmental, social and territorial issues	▪ Law No. 1561/2000. Creates the National System of the Environment, the National Council of the Environment and the Secretariat of the Environment. ▪ Law N° 6123/2018. It elevates the Secretariat of the Environment to the rank of Ministry and changes its name to the Ministry of the Environment and Sustainable Development. ▪ Law N° 436/1994. Departmental Organic Charter. ▪ Law N° 3966/2010. Municipal Organic Law. ▪ National Environmental Policy - PAN. ▪ Law No. 1183/1985 Civil Code

Matter	Law
	▪ Ordinances of the Municipalities of the area of influence. ▪ Resolutions issued by the MADES
Health, Hygiene and Safety	▪ Law No. 836/80 Health Code ▪ Law No. 213/93 Labor Code ▪ Decree No. 14.390/1992. General Technical Regulations on Safety, Hygiene and Medicine at Work
Social, Cultural and Heritage	▪ Law No. 3051/2005 "National Culture". ▪ Law No. 5621/2016 on the Protection of Cultural Heritage. ▪ Law No. 904/1981 "Statute of Indigenous Communities". ▪ Law No. 946/1982 on the Protection of Heritage Assets. ▪ Law No. 352/1994 on Protected Areas. ▪ Law No. 4228 /2010 By which the National Park Serrania San Luis is declared a Protected Wildlife Area under public domain, within the department of Concepcion. ▪ Law No. 4577 on Natural Monuments (Santa Elena, Kamba Hopo Cavern, Tres Cerros, among others.) ▪ Decree N° 1039/2018 "By which the Protocol for the Process of Consultation and Free, Prior and Informed Consent with the Indigenous Peoples living in Paraguay is approved".
Other related regulations	▪ Laws governing the management of solid waste (Law No. 3956/2009), water resources (Law No. 3239/2007), air quality (Law No. 5211/2014), noise pollution (Law No. 1100/1997), others.

The following is a detailed presentation of the Principles and International Performance Standards that have guided the development of the baseline and the studies of the social component within the framework of the development of the ESIA.

Table 2 – Environmental and Social Sustainability Standards and Performance Guidelines from IFC

Performance standards	Description
1. Assessment and management of environmental and social risks and impacts	In order to develop a good management system during the different stages of the project, a comprehensive evaluation is required to identify impacts, risks and opportunities at the environmental and social levels. This requires the inclusion of stakeholders as part of participatory processes, as well as the dissemination of relevant information about the project.
2. Work and working conditions	This principle is based on recognizing and guaranteeing the basic rights of workers by promoting fair, healthy and safe working conditions. Promoting non-discrimination, equality, protection of workers including the category of vulnerable workers such as children, migrants or contract workers.
3. Resource efficiency and pollution prevention	Increased industrial activity and urbanization can lead to increased levels of pollution. Therefore, this principle describes the approach of the project to avoid or minimize the impacts generated on human health and the environment; integrating technologies and practices for pollution prevention and control.
4. Community health and safety	The principle stipulates the need to anticipate and avoid impacts and risks on the health and safety of communities affected by project activities.
5. Land acquisition and involuntary resettlement	The acquisition of land for project purposes may result in: physical displacement (relocation or loss of housing) and/or economic displacement (loss of access to resources to generate income or livelihood) of individuals or communities. The objective is to avoid physical or economic displacement or to minimize impacts through appropriate measures that are governed by general requirements stipulated in the regulations such as: compensation, community participation, complaints mechanism, among others.
6. Conservation of biodiversity and sustainable management of living natural resources	It aims at the protection and conservation of biodiversity; the sustainable management of natural resources by adopting conservation and protection practices.
7. Indigenous Peoples	To ensure that the development process ensures and promotes full respect for the human rights and dignity of indigenous peoples
8. Cultural Heritage	This principle seeks to protect cultural heritage from the adverse impacts of project activities and to support its conservation by recognizing its importance for current and future generations.

Source: Prepared by the external consultant Lic. Caren Kremer and team based on the documents examined

Table 3 – Equator principles

Principles	**Description**
Review and categorization	The adhering financial institution (EPFI) categorizes the project based on risk levels and environmental and social impacts of the project.
Environmental and Social Assessment	Refers to assessment processes to address relevant environmental and social risks and impacts of the project; incorporate measures to minimize, mitigate and compensate for adverse impacts in an appropriate manner
Applicable Environmental and Social Standards	The evaluation process should address compliance with the laws, regulations and permits of the host country and should demonstrate the overall compliance of the project with applicable standards.
Environmental and social management system and EP action plan	Projects must have an adequate environmental and social management system. An Environmental and Social Management Plan must be developed.
Stakeholder Engagement	The effective and systematic participation of stakeholders must be guaranteed through informed consultation and participation processes in the different phases of the project.
Complaints and Claims Mechanism	A system must be in place to receive and facilitate the resolution of concerns and problems related to the environmental and social performance of the Project.
Independent Review	A review by an external environmental and social consultant is needed to evaluate compliance with the principles.
Contractual Commitments	All projects must comply with current host country documentation, regulations, environmental and social permits.
Independent Monitoring and Reporting	Monitoring information must be verified by a qualified external expert
Reporting and transparency	In addition to the reporting requirements of Principle 5, at least a summary of the Environmental and Social Impact Assessment should be ensured; public reporting of GHG emission levels.

Source: Prepared by the external consultant Lic. Caren Kremer and team based on the material examined.

9.3.1.3 Human Rights

In Paraguay, the General Directorate of Human Rights (in Spanish, *Dirección General de Derechos Humanos* - DGDH) is in charge of coordinating, articulating, formulating and executing all those actions that make it possible to provide permanent institutionality to the promotion, defense and realization of Human Rights through the commitment of the authorities, other public officials and non-governmental organizations. The DGDH reports to the Vice-Ministry of Justice.

In the DGDH there is a general directorate and 4 specialized directorates (Public Policies, International Affairs, Human Rights Protection in the Penitentiary System and Historical Memory and Reparation).

The Human Rights action in Paraguay are guided by National Human Rights Plan

Among the main areas worked in the DGDH are:

1. The coordination of the Human Rights Network of the Executive Branch, a body that promotes the permanent and sustainable institutionalization of Human Rights throughout the country, through the formulation and articulation of policies, plans and programs coming from this branch of the State. In this sense, the MJT faces a series of actions for the strengthening of Human Rights and the fulfillment of the commitments assumed in the matter. One of its main goals is the implementation of the National Human Rights Plan and the continuation of the process of elaboration of the Human Rights Indicators.
2. The construction of Human Rights Indicators, i.e., a methodological system of measurement absolutely necessary to evaluate the implementation of national efforts in this area, based on information that allows assessing and measuring the progress, impact and specific results of the actions adopted and policies implemented.
3. The follow-up of international recommendations and sentences through the Inter-institutional Commission for the fulfillment of International Sentences and Recommendations (CICSI), which is coordinated by the MJT and chaired by the Vice-Presidency of the Republic.
4. The coordination of tasks with the National Team for the investigation, search and full identification of detained-disappeared and extrajudicially executed persons, during the period 1954-1989-(ENABI), formed by different institutions.
5. Monitoring of the National Penitentiary System, carried out through prevention and follow-up visits of a thematic or comprehensive nature, consisting of periodic visits to detention centers under the Ministry of Justice and Labor, interviews with detainees and those responsible for such centers, analysis and orientation of complaints made by detainees and/or family members, drafting of notes, reports and recommendations related to conditions of deprivation of liberty, among others.

<u>Human Rights by PARACEL</u>

According to HSE Guidelines, PARACEL is committed to developing its activity in a safe, environmentally correct and socially responsible manner, generating value and creating opportunities for society and the country. Human rights is embedded in one of the guiding principles: “Equal opportunities and promotion of non-discrimination based on gender, religion, ethnicity, race, sexual orientation, social status or any other, within the framework of full respect for human rights.", and in one of the pillars on which the company's values are structured: "Sustainability, create value by protecting the environment, people and their culture. At PARACEL, sustainability is a fundamental value since it encompasses all the axes of corporate social responsibility, such as: institutional governance, human rights, fair operating practices, labor practices, consumers, the environment and the community."

Code of Ethics guides the actions of PARACEL and its stakeholders through declarations of principles and values, moral and ethical foundations of a universal nature, in order to establish relationships based on trust, transparency and mutual benefit. PARACEL support the principles of the United Nations Global Compact, basing our fundamental values on respect for human rights, labor rights, the environment and the fight against corruption. Human Rights is one of the Ethical Principles: "The directors and employees of Paracel must treat all people with respect and dignity, promoting diversity, promoting equal opportunities for all and an ethical culture in accordance with the conventions and recommendations of the International Labor Organization (ILO). Paracel wants and expects the same conduct on the part of the stakeholders with which Paracel has relationships." In addition, Directors and employees must ensure that Paracel does not use illegal child labor in its operations. The minimum age for work is determined by national legislation. Young people under the age of 18 should not be employed to perform any work that, by its nature or the circumstances in which it is performed, may harm their physical, mental or moral health, school performance, safety or spirit, or that must be performed underground or under water. Also, Directors and employees will refrain from violating human rights. They should not incur or benefit from the use of forced or compulsory labor. All employment is voluntary (under an employment contract) and employees are free to terminate their hiring or leave their job in accordance with the law.

Human Rights topic is also embedded in the Social Management Program, Communication Plan, Stakeholder Engagement Plan, Internal Management Program for Land Affection and risks by External Agents, Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations, Corporate Security Management Manual, Supplier Code of Conduct and PARACEL's polices (Recruitment and Selection, Equal Opportunity and Non-Discrimination and Linkage with Indigenous Peoples).

9.3.2 Project description and influence areas

9.3.2.1 Project synthesis

PARACEL, a Paraguayan company with national and foreign investment, is planning to build and operate a pulp mill on the left riverside of Paraguay River, approximately 15 km north of the city of Concepción, in the department of the same name.

The plant (industrial component of the Project) will be designed based on the best available technologies and managed according to certified systems; both from the productive and the environmental point of view.

The raw material, made up of Eucalyptus sp. wood, will come from our own plantations, with certified forestation, located almost entirely in the department of Concepción (forestry component of the Project), although during the first years of operation a supply from Mato Grosso do Sul (Brazil) and, in a smaller fraction, from the north of Argentina is foreseen.

The estimated times for each component are:

- Study phase: For the study phase (engineering, forestry, environmental, social, among others) initiated in 2019, it is expected to last approximately 2 years.
- Planting phase: 5 - 7 years.
- Construction phase: 2 - 3 years.

It is estimated that the project will generate direct quality jobs: around 8,000 at the peak of the construction phase, and 1,200 during operation. In addition, the generation of indirect jobs is projected to be between 10,000 and 30,000, with the venture being a potential for boosting the local and national economy. Having as a priority the absorption of local labor, the company will seek to create partnerships with local and national educational institutions, to stimulate training and qualification according to the required profiles.

To protect the environment, the project will be governed by national regulations (water and effluent quality standards, zero deforestation, among others). With the highest international standards, which require permanent monitoring of environmental impacts, and public dissemination of the results.

9.3.2.2 Criteria for defining the areas of influence

The following criteria were taken into account for the delimitation of the areas of influence in the framework of social studies:

- IFC Performance Standard No. 1, on the delimitation of the project's area of influence, [1]
- The phases of the project (design, construction and operation), its components (industrial and forestry[2]), possible impacts and
- The social and cultural aspects studied

From the analysis of these aspects and the initial recognition of the area, three areas of influence of the project were established, for which a particular methodology of work with the resident population has been defined, taking into account the different aspects studied about them.

- The three areas were named as follows:
- Indirect Influence Area (IIA);
- Direct Influence Area (DIA); and
- Directly Affected Areas (DAA).

1 The area possibly affected by: (i) the project and by activities and facilities directly owned or operated by the client (including through contractors) and which are components of the project; (ii) impacts of unplanned but predictable events caused by the project, which may occur later or elsewhere; or (iii) indirect impacts of the project on biodiversity or on the ecosystem services on which affected communities depend for their livelihoods. Related facilities, which are facilities not funded as part of the project, that would not have been built or expanded in the absence of the project, and without which the project would not be viable. The cumulative impacts (resulting from the incremental impact) on areas or resources used or directly affected by the project, produced by other existing, planned or reasonably defined constructions at the time of the risk and impact identification process. Performance Standard 1 assessment and management of environmental and social risks and impacts. IFC.2012. P.9.

2 Although the characterization does not include the development of the baseline and impact assessment for the forestry component, it will be taken into account in the framework of the proposed social work.

9.3.2.3 Description of the project's influence areas

The scope of the areas of influence is described below:

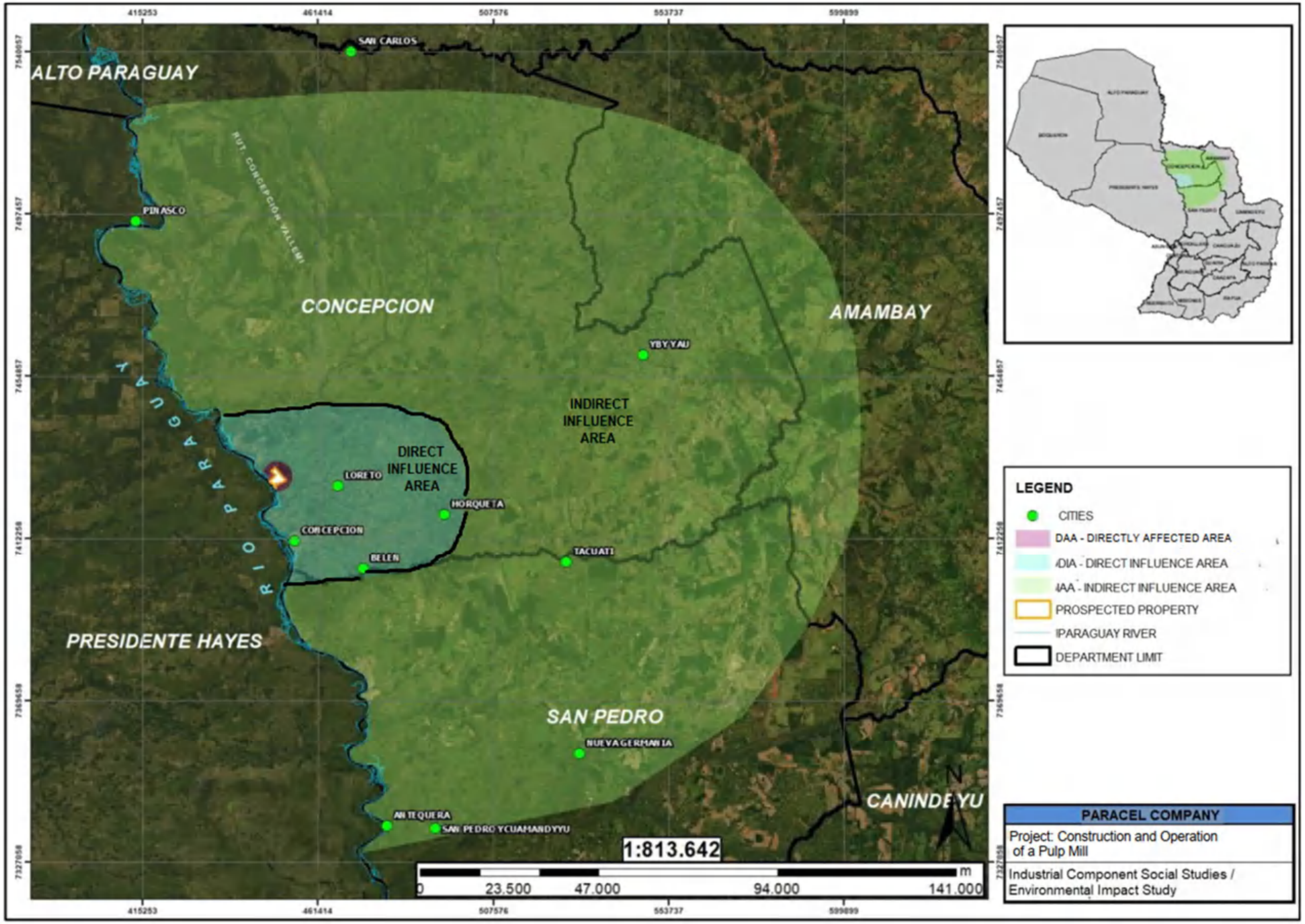
Indirect Influence Area (IIA): Includes the three northern departments of the country: Concepción, San Pedro and Amambay; which were taken into account since they could represent, given their proximity, areas of possible migratory flows, especially in the context of the construction stage.

Direct Influence Area (DIA): The district of Concepción (belonging to the department of the same name) was integrated to the project's direct influence area, as it is the closest urban area and the most populated one to the project, which is also important because it is the department's capital. Especially, within this district, it was initially considered an area of approximately 5 km around the area prospected for the construction of the mill. Regarding the transmission line right of way, is considered 15 meters for the cable side and 10 meters for the other side. The impacts of port, wood transport and accommodation camps on the Direct Influence Area were also considered, although they are not included in the map.In this area, 18 localities were identified as being interconnected by local roads. In view of this aspect, it was decided to extend the initial range to a 13 km radius around the prospect area. Also included were the districts near the prospect area, such as Belén (54 km), Horqueta (66 km) and Loreto (26 km)[3].

Directly Affected Area (DAA): This area included the social units (properties, building infrastructure, housing, etc.) located in the immediate surroundings of the area prospected for the installation of the plant, settled within a radius of 1 km.

[3] Road distances.

Figure 1 – Areas of influence for social environment studies



The figure below shows the location of the mill and all of the associated facilities, including the locations of the worker accommodations.

Figure - Location of the Industrial Mill and relevant related activities

9.3.3 Social Environment Studies Method

For the elaboration of the social studies referring to the industrial component of the project, the following actions have been developed:

- **Creation of an interdisciplinary team** of professionals and social technicians in charge of carrying out the necessary process for the elaboration of the studies. The collection, processing and analysis of information was carried out according to the different study topics developed in each section.
- **Survey and analysis of information** obtained through secondary and primary sources, including the use of different selected techniques, which has allowed, in the case of field work, access to the perception of the inhabitants regarding the socioeconomic characteristics of their community and the implementation of the project in those areas.
- **Identification and direct communication** with key actors in the areas involved in the project, departmental, municipal and community references, in

order to have their participation and involvement during all stages of the work carried out.

9.3.3.1 Methodological framework

Considering the objectives of the elaboration of this document, a methodological scheme of work was defined based on the steps described below:

- **Review of Secondary Sources:** In order to access information regarding the socioeconomic characteristics of the project's areas of influence, including their cultural heritage; and for the elaboration of the impact assessment carried out, it was necessary to review and analyze relevant documentation such as censuses, statistical databases, development plans, specific studies, land use plans, periodic reports from public institutions, regional research, reports from local programs for socioeconomic development, among others.
- It was considered information from the departmental and district level, however, there were difficulties in accessing official data on the local level, so we turned to information generated through field work, including consultations made to reference bodies such as the Government of Concepción, municipalities involved and other public institutions in the area.
- Both national and international regulations, mentioned above, have been the basis of guidance for the development of the various sections that make up this document.
- **Access to information via primary sources/field work**: Several activities were carried out to collect information in the field, through the application of pre-designed tools in order to obtain the necessary data for each study and to provide information to the population involved. These will be described in detail in item 9.3.3.2.
- **Processing of collected data:** Once collected, the information has been processed in order to generate a unique database, taking into account each technique used, so that it is available for the following actions to be developed within the project.

9.3.3.2 Field information reporting

As mentioned above, for social work in general and in particular for field surveys, the importance of carrying out a constant two-way process was proposed, developing actions that made it possible, on the one hand, to collect information from the first source, as accurately as possible and necessary for the purposes of the project and the ESIA, and on the other hand, to provide information of interest to the communities from the beginning, generating participatory spaces so that the population is involved from the design stage of the project.
Through this work, baseline studies have been developed, contributing with information (especially qualitative) regarding the population living in the areas involved in the project.

The field survey was structured taking into account the different zones of influence of the project, which has also required the use of different data collection techniques (qualitative and quantitative). The steps taken during the data collection process are described below:

- Direct observation: Initially, a reconnaissance tour in situ was carried out and important aspects of the zones were recorded for the final delimitation of the project's areas of influence; in addition, the first contacts were made with key actors in the departmental capital.
- Resident population in the Directly Affected Area (DAA), the units closest to the plant's area, with whom the following activities were carried out:
  - ✓ Socioeconomic census with the application of a previously designed census card, to families identified in the community of Piquete Cue, located near the entrance to the prospected area of installation of the Plant; and
  - ✓ Semi-structured interviews with owners and managers of mostly livestock establishments (estancias) located in that area.
- Resident population in the Direct Influence Area (DIA) with whom survey activities were carried out, taking into account the district (Concepción, Horqueta; Loreto and Belén) and local level involving 18 localities or micro-territories, located in the access roads to the plant area, carrying out the following activities:
  - ✓ Interviews with institutional actors in coordination with focal points of the municipalities and the Government of Concepción, in addition to other references with whom we had contact during the field work;
  - ✓ Community interviews, which initially involved the identification of key informants, which made it possible to involve representatives of community organizations, women's committees, members of water and sanitation boards, educators, pantry workers and former residents, among others.
- Participatory workshop with institutional actors from the city of Concepción, including representatives from public and educational institutions, the private sector, civil society organizations and other key actors in the area;
- Focus groups with representatives of community organizations, producers, neighborhood committees, water and sanitation boards, educational institutions, among others. These were implemented by areas that bring together several localities, in addition to communities in the districts of Loreto, Horqueta and Belén;
- Perception surveys in strategic points of agglutination of people such as supermarkets; educational supervisions; public hospitals; private sanatoriums and pharmacies; transport and tourism houses; hotels; small, medium and large shops; churches; squares; etc. In the urban area of the districts involved in the project, taking into account profiles such as: university students; shopkeepers and users of shops; people who frequent religious, organizational and recreational spaces; teachers; directors of educational institutions; staff in white; among others.

Finally, it is important to consider the following points related to the working methodology:

- Tools were designed to collect information with special emphasis on identifying the socio-economic characteristics of each zone and the existing capacities and/or needs from the viewpoint of the actors involved.
- The survey of the population's perception of the socioeconomic characteristics of their community and of the installation of the plant was carried out in a transversal manner, to all the people involved in each of the activities, so that the necessary inputs are available to carry out the corresponding monitoring during other stages of the project.
- The work of field surveys (primary sources) was considered a priority since it provided valuable information for the development of the studies that make up this document, especially the sections of characterization of the districts and localities of the DIA in the absence of specific data related to these.

9.3.4 Characterization of the project's areas of influence

9.3.4.1 Indirect Influence Area (IIA)

Taking into account the information available from official sources, this socioeconomic characterization contains data related to the three departments involved in the IIA (Concepción, San Pedro and Amambay), with emphasis on Concepción. Likewise, with reference to the four districts of the IYD, this section presents complementary quantitative data that was available. As explained in item 9.3.3. Methodology for the elaboration of the social studies; for the characterization of the DAI, and due to the lack of official data at the district level, the information has been complemented with the survey work carried out in each of the districts, which is presented in item 9.3.4.2.

The information is presented in subchapters by topic of interest, grouped by department and district (where available). Taking into account the diversity of data sources and the differences in the periods for which the information was available A comparative analysis between departments was integrated where possible.

With regard to statistical data, the following should be mentioned:

- Preference was given to the use of the most recent publications and databases provided by the General Directorate of Statistics, Surveys and Censuses (DGEEC);
- Although certain information could only be obtained from the different Censuses carried out: National Census (2012), Agricultural Census (2008), Economic Census (2011), a valuable amount of information could be gathered from the Permanent Household Survey 2017 (and previous ones);
- For uniformity of criteria, population projections and related data were used for the year 2017;
- In December 2019, the DGEEC presented departmental results from the Permanent Household Survey (EPHC) 2017 and 2018, a publication that presents average annual estimates at the departmental level. Where possible, these data were incorporated. However, given the change in methodology, it was not always possible to perform a comparative analysis.

9.3.4.1.1 Departmental Overview

The department of Concepción is located in the north of the Eastern Region. To the north, it borders the Apa River, to the south the department of San Pedro, to the west the Paraguay River and to the east the department of Amambay. Numerous rivers and streams run through it; and the main river communication route is the Paraguay river.

The department has a surface of 18,051 km^2 and occupies the second place in the region in terms of area. According to data from 2017, the current population amounts to 244,071 inhabitants of which 48.58% are women, with a population density of 13.51 people per square kilometer. In this department the population is young, with a large majority under 35 years old (72%); and with an average of 7.61 years of education. Concepción is divided into twelve districts: Concepción, Belén, Horqueta, Loreto, San Carlos del Apa, San Lázaro, Yby Yaú, Azotey, Sargento José Félix López, San Alfredo, Paso Barreto and Arroyito; and the city of Concepción is the capital of the department.

Although the main economic activity historically was extensive agriculture and livestock, in recent years, large companies have been installed such as meatpacking plants and cement plants, with the latest technology. Likewise, important service providing companies have been developed; and, in the district of Azotey there is a milk processing plant (Lácteos Norte) that has developed the milk basin in the districts of Azotey, Tacuati, Yby Yaú and Horqueta. These companies generated new sources of work for qualified and unqualified people, and boosted economic growth in the department.

The department of San Pedro borders on Concepción to the south and has an area of 20,002 km^2. Its population reaches 419,629 inhabitants (data projection 2017) and has a population density of 21 inhabitants/km^2. Slightly more than half of the population is male and predominantly young: 70% of the inhabitants are under 35 years old; with an average of 7.21 years of education. The main economic activity is agriculture and livestock. The department is divided into 21 districts: Antequera, Capiibary, Choré, General Aquino, General Resquín, Guayaibi, Itacurubí del Rosario, Liberación, Lima, Nueva Germania, San Estanislao, San Pablo, San Pedro, Santa Rosa del Aguaray, San Vicente, Tacuatí, Unión, 25 de Diciembre, Yataity del Norte, Yrybycuá and Villa del Rosario. The departmental capital is the city of San Pedro del Ykuamandiyú.

The department of Amambay borders to the west with Concepción. It has an area of 12,933 km^2, its population is 164,462 inhabitants (2017 data) and the population density is 12.7 inhabitants/km^2. In this department, there are almost equal numbers of men and women and most of the population is under 35 years old (68%); and with an average of 8.48 years of education. The department is divided into five districts: Pedro Juan Caballero, Bella Vista, Capitán Bado, Zanja Pyta and Karapai; the capital is Pedro Juan Caballero.

9.3.4.1.2 Demographic dimension

As follows, there are statistical information related to the population of the Indirect Influence Area and their evolution, age and gender distribution, households, housing, poverty levels, among others. It also includes data related to the migration patterns that occurred in the departments, with emphasis on the department of Concepción. Where available, data are also presented for the districts of the Direct Influence Area.

9.3.4.1.2.1 Population

According to data from the General Directorate of Statistics, Surveys and Census (DGEEC), the total population of the department of Concepción is 244,071 inhabitants (projection 2017); this represents 3.5% of the total population of Paraguay (6,953,646 inhabitants, projection 2017). It is the ninth most populated department in the country, while San Pedro is in sixth place and Amambay is in thirteenth place.

Table 4 – Total population projection by sex, according to department. Year 2017

	Concepción	San Pedro	Amambay	Total IIA
Men	125.490	219.509	82.173	427.172
Women	118.581	200.119	82.289	400.989
Total (both sexes)	244.071	419.629	164.462	828.162
% Total population of Paraguay	3,5%	6,03%	2,37%	11,91%

Source: DGEEC. Anuario Estadístico del Paraguay, 2017.

Women account for 48.58 per cent of the inhabitants of Concepción, while in San Pedro less than half the population is women (47.39 per cent) and in Amambay approximately half are women (50.77 per cent). The total population of the three IIA departments is 828,162, which is estimated to represent 11.91% of the country's population, of which 400,989 are women (48.41%).

With respect to the population living in rural and urban areas, Figure 2 presents estimates made for each department [4].

Table 5 presents data from Population Projection, revision 2015, in the three departments of the Indirect Influence Area, and also for the districts studied. An estimate of the IIA population projection has also been made.

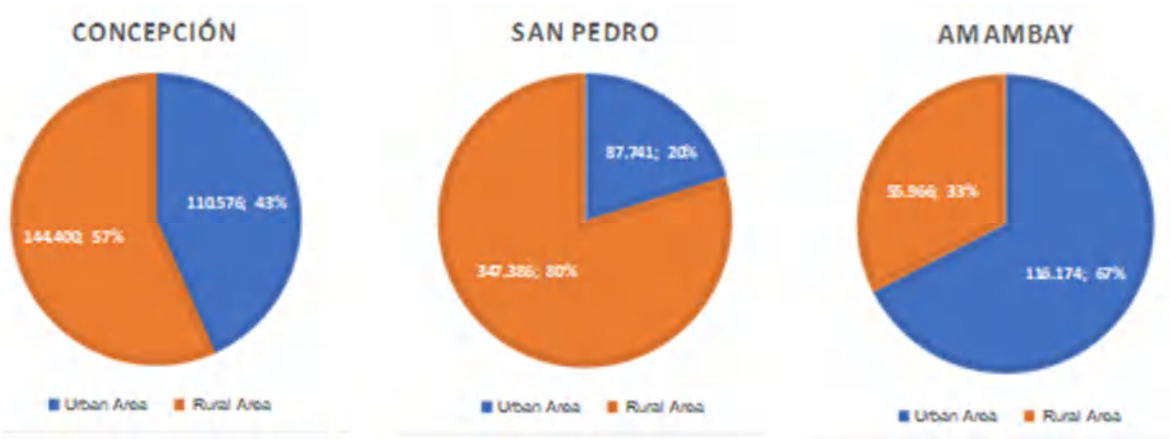


Figure 2 – Projected rural-urban population by department in 2020, according to projections for 2012 [5].
Source: Elaboración en base a datos proporcionados por STP/DGEEC. February 2020

[4] For the estimates, according to the methodology indicated by the DGEEC, data from a report specifically prepared by that institution were used; for each department, the population projected for the year 2020 was used and the proportions according to observations of the 2012 National Census were applied.
[5] Source: STP/DGEEC. Paraguay. Population projection by sex and age, by department, 2000-2025. Revision 2015 and STP/DGEEC. National Population and Housing Census 2012.

Table 5 – Population Evolution (Projection 2017)

Department/District	2015	2016	2017	2018	2019	2020
Total IIA	805.603	816.868	828.161	839.499	850.887	862.272
Concepción	236.959	240.495	244.071	247.675	251.314	254.976
Concepción	80.622	81.917	83.226	84.545	85.876	87.215
Belén	12.223	12.418	12.615	12.814	13.014	13.215
Horqueta	59.374	60.031	60.691	61.349	62.008	62.664
Loreto	18.419	18.514	18.608	18.701	18.791	18.879
San Pedro	409.381	414.503	419.629	424.774	429.957	435.126
Amambay	159.263	161.869	164.462	167.050	169.615	172.169

Source : DGEEC. Paraguay. National Population Projection. Revision 2015. Prepared by the external consultant Lic. Caren Kremer and team.

In terms of population density, the department of Concepción has a density of 13.5 inhabitants per km^2, while San Pedro has 21 and Amambay 12.7. On average, then, one can estimate a population density of 16.2 inhabitants per km^2 in the Area of Indirect Influence. Table 6 summarizes these data.

Table 6 – Population density

	Concepción	San Pedro	Amambay	Total IIA
Surface (km^2)	18.051	20.002	12.933	50.986
Total Population (Projection 2017)	244.071	419.629	164.462	828.162
Population Density (inhabitants/km2)	13,5	21,0	12,7	16,2

Source: DGEEC. Statistical Yearbook of Paraguay, 2017. Prepared by the external consultant Lic. Caren Kremer and team.

9.3.4.1.2.2 Indigenous Population

For the purposes of the ESIA and considering the requirements of the indigenous population, a specific study has been developed independently of the social studies, prepared by specialists hired by PARACEL. The complete report produced by the Natan Foundation is presented in the ESIA Forestry, social baseline chapter.

It is important to highlight that there are indigenous population communities within the area of influence of the pulp mill, the details of these communities are included in the ESIA Forestry.

Administration and Self-Determination

Indigenous peoples or ethnic groups are distributed in indigenous communities, that is, the organizational component of the ethnic is reduced to communities and each community is autonomous and autarkic to define its own statutes and rules (Law 904/81, Official Gazette of the Republic of Paraguay). One of the main cultural characteristics that have resulted from the autonomy of indigenous communities is that they are "closed", this means that they maintain social distance with those people who are not members of their communities.

The community is a territorial entity that, within the departmental territorial order, is endowed with a communal territory, legislative autonomy and executive powers, as well as the power to administer itself through its own representatives (Law 904/81, Official Gazette of the Republic of Paraguay). The communities function as "micro-states" with the right to self-determination, recognizing their right to choose their political administration and the actions they will take to achieve their well-being and economic, social and cultural development.

In short, the times and processes related to the relationship with indigenous peoples do not respond to the conventional logic of community intervention, but to their own traditions and customs.

Language families of Paraguay

Before the incursion and occupation of the Paraguayan lands by the Spanish colonizers, the people that inhabited them had a diverse and complex ethnic-cultural composition; the region was populated by various ethnic groups, belonging to various linguistic groups, with their own languages and different cultural traits, the most important being Paĩ Tavyterã, the Avá Guaraní and the Mbyá Guaraní. For historical reasons, today we can also find some families and population groups of the indigenous people of the Chaco.

Right to Consultation and Free, Prior and Informed Consent

Indigenous communities have the right to participate actively and collectively in those projects that may affect their territories, culture and livelihoods. Projects, whether of public or private origin, have the obligation to consult, inform and dialogue with indigenous communities in all phases of project execution, from the preliminary study to the completion or closure of the project.

For this project, it was ensured the technical specifications of the Performance Standard 7 Indigenous Peoples were followed. This rule postulates that the indigenous communities identified within the DIA (direct influence area) are vulnerable groups who live in a socio-economic situation that does not allow them to defend their rights and interests. Therefore, all the necessary steps required by this standard were taken to identify any adverse impacts that, as a consequence of project activities, could threaten their integrity, identity, culture, and livelihoods; as well as for the survey of information and relationship respecting the free consent of the communities, which was prior and informed; baseline analysis; and for the development of management plans that benefit the development and participation of indigenous communities.

It is also important to note that IFC Performance Standard 7, as a guideline, is in line with the Paraguayan legal framework and establishes respect for the rights of indigenous peoples, as well as international conventions that contribute to respect the rights of indigenous peoples and promote their sustainability, such as the United Nations Declaration on the Rights of Indigenous Peoples and the International Convention on the Elimination of All Forms of Racial Discrimination, among others.

Prior is the right of the community to know in advance when they will be consulted, before decisions that could affect them are made.

Informed is the right of the community to know in completeness and truthfulness all the information related to the project, including things that could benefit and harm them, giving them the information in an appropriate language that allows them to fully understand it.

The dialogue with the indigenous communities in instances of meeting and consultation, were carried out with the objective of finding out if each community provides its broad support to the project, that is, the support of the main groups of each community that are representative of the voice of the other members who agree with the project and want it to be carried out.

Taking into account the areas linked to the project, the communities identified are presented below, with the exception of the district of Loreto where, according to the source consulted, there is no presence of indigenous people. Of the total indigenous population living in these areas, 9.5 per cent (381 persons) reside in urban areas, in the district of Concepción, and 90.5 per cent (3,617 persons) in rural areas, including Concepción, Belén and Horqueta.

The project identified the following indigenous communities: Redención, Jeguahaty, Vy'a Renda, Takuarendyju, Takuarita, Sati - Pai Renda Chiru Poty, Guyra Ñe'engatu Amba, Mberyvo Jeguarymi, Yvyty Rovi Cerro Poi and Apyka Jegua. They will be discussed at Socio-Economic Forestry ESIA in more detail.

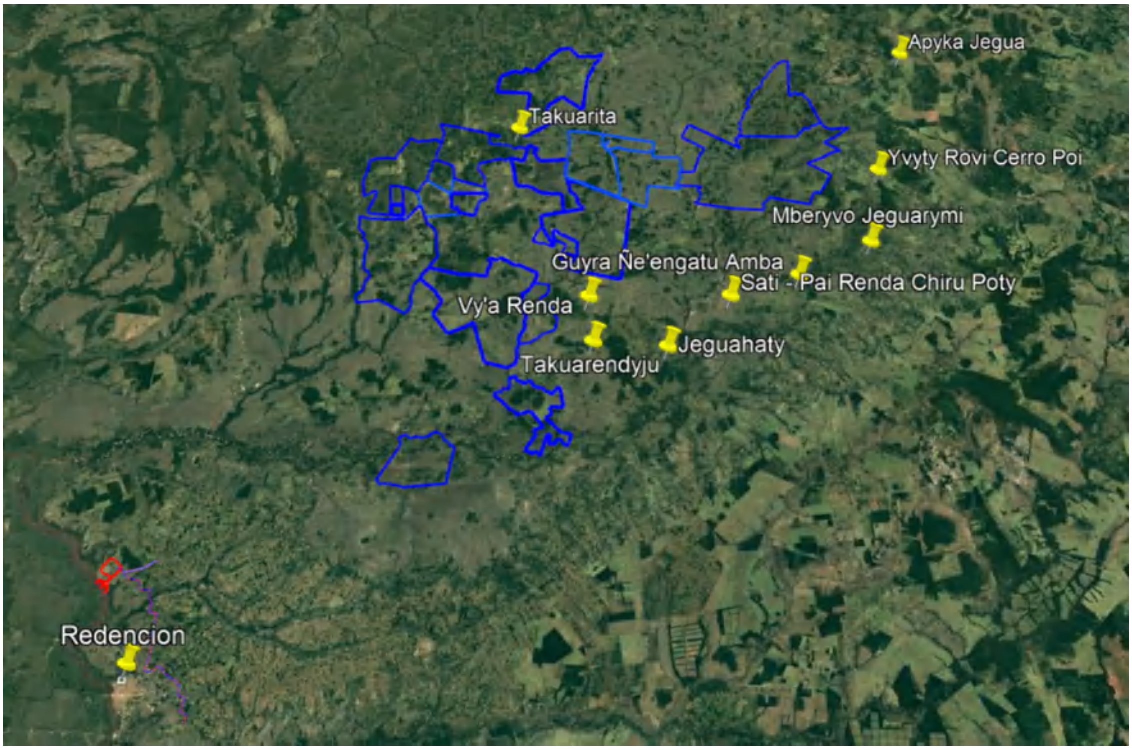


Figure 3 – Location of the indigenous communities and PARACEL project (pulp mill in red, TL and mill access road in purple and farms in blue).

Summary of the baseline of the Redención indigenous community

The families that belong to the indigenous community of Redención, the nearest from the pulp mill, mainly carry out informal work activities such as selling gambling tickets on the streets of Concepción or doing masonry work; they do not carry out activities to take advantage of ecosystem services, such as harvesting, fishing, or agriculture. The community's water supply comes from an artesian well.

Community members report that they live in conditions of poverty, hopelessness and social rejection. Living in the city gives them access to public services, such as health centers, educational centers, professional technical centers, legal institutions and the national police.

Although inclement weather temporarily affects their living conditions, especially the flooding of the stream due to rain, it does not seem to determine their well-being and quality of life.

In the Redención community, the form of social organization is established by three main institutions: the assembly, the political leader, and the spiritual leader, who collaborate to guide their community towards development and sustainability.

Throughout the consultation and diagnostic process, the community leader showed interest and support for the project; a high level of participation in the planning and execution of meetings and interviews facilitated the establishment of an atmosphere of enthusiasm and cooperation.

The people of the community stated that their original culture is being displaced by the predominant western culture, acquiring practices typical of the people of the city, such as the celebration of festivals and the Christian religion. Among the negative aspects that affect the integrity of community members, some interviewees mentioned drug addiction, delinquency, alcoholism, and prostitution.

Indigenous Peoples Plan

The baseline is the main tool for the evaluation and analysis of the impacts that will occur in the indigenous communities related to the PARACEL project, serving as a starting point for the development of the Indigenous Peoples Plan, as well as to guide the development of strategies and programs focused primarily on avoiding, minimizing, mitigating and compensating the identified socio-environmental impacts.

The strategies, programs and actions resulting from this plan are especially relevant for the indigenous communities identified because there are vulnerable groups that are highly dependent on some type of assistance to enhance their development.

The dialogue and work activities done in partnership with the indigenous communities should always seek horizontal relationships, emphasizing the strengths and all kind of resources that families have, in order to contribute to the improvement of their living conditions and increase their level of well-being.

The purpose of the programs presented below is to avoid, prevent, mitigate or compensate for negative impacts and enhance positive impacts.

The Indigenous Peoples Plan (PPI) is linked to PARACEL's Social Management Plan and Environmental Management Plan; this plan is designed for the 10 indigenous communities analyzed in this study, one of them located in the urban area in the district of Concepción and the homonymous city called Redención and 9 rural indigenous communities distributed in the departments of Concepción and Amambay, called Jeguahaty, Vy'a Renda, Takuarendyju, Takuarita, Sati, Guyra Ñe'engatu Amba, Mberyvo, Yvyty Rovi and Apyka Jegua.

The objectives of the PPI are:

- Ensure full respect for the rights of indigenous peoples and carry out activities established by current legislation and international regulations.
- Establish a participatory, healthy and predictable relationship framework with indigenous communities.
- Strengthen support for indigenous communities with the project.
- Promote local and community development.
- Influence PARACEL's stakeholders for the improvement of the relationship practices with indigenous communities.
- Generate a successful experience of social management with indigenous communities in the country in order to inspire future work related to local and foreign investment projects of similar characteristics.

The selection of these communities within the AID was made under the following criteria:

- Location of the PARACEL project; Distance from PARACEL undertakings; Watercourses of the Aquidabán Basin; Common access roads between the communities and the undertakings; Protected wilderness areas (PWA) bordering PARACEL properties; Social indicators; and Traditions and customs.

- The AID is in accordance with Paraguay's current legal framework, the international regulations ratified by the Paraguayan government and the frameworks that guide this report, using as guidelines the Equator Principles, the IFC Performance Standards and the World Bank's Operational Policy for Indigenous Peoples. Likewise, all the design, execution and evaluation of the activities contemplated in this program or that may result as a product of some of the strategies presented here, must be framed strictly within the respect for the self-determination model of each community.

- The implementation of the PPI is the responsibility of PARACEL's Communication and Social Sustainability Management, which should work towards the commitment and cooperation of other areas of the company that are linked to the indigenous issues analyzed in this report. The PPI must be integrated into the other management plans of the company and also incorporated into the PARACEL Socio-Environmental System.

- Collaboration with other company departments and stakeholders is essential for the success of this plan. To this purpose, it is recommended that no effort be spared to achieve a clear understanding and awareness of the importance of working responsibly, systematically and permanently on the programs and actions described in this PPI, essentially in those areas and groups in which their actions may directly affect the respect for the rights of indigenous peoples.

- Throughout the implementation process of the PPI and in accordance with Decree No. 1039/18, PARACEL is responsible for maintaining fluid, clear and complete communication with indigenous communities about actions involving their physical integrity, cultural identity, use of ecosystem services, livelihoods, heritage, territories and any elements that are part of their traditional way of life, as well as to carry out free, prior and informed consultations, in all cases when necessary.

- For the PPI, as for all other management plans, it is recommended to supervise and audit external organizations to ensure the proper and timely implementation of this plan, including documentation of the activities carried out and verification of participation with broad support from the communities.
- The execution of the PPI will be the responsibility of the Socio-Environmental Committee formed to execute the Social Management Plan, who may assume responsibility for carrying out the programs and activities or may delegate their execution to external and competent organizations.
- The Socio-Environmental Committee is responsible for establishing the dates, frequency of meetings, work spaces and activities, while in conversation with the indigenous communities and attending institutions, as well as representing the company before local government organizations.
- Some of the stipulated measures in this PPI are mandatory to ensure full respect for the rights of indigenous peoples from the pre-construction phase of the project, so they should be implemented as soon as possible and continue throughout the life of the project; other activities should be implemented during the operation phase. As stipulated in INDI's regulations, this organization will act as supervisor and guarantor of the indigenous peoples' rights, therefore, the Socio-Environmental Committee and/or the organization in charge of implementing this plan must coordinate actions in collaboration with this government institution, especially those stipulated in the Law, such as Decree 1039/18.
- The following is the PPI designed to be added to the management plans of the Industrial and Forestry components mentioned in the Social Studies and which are especially focused on rural indigenous communities. For the urban indigenous community of Redención, it is proposed (in addition to their participation in the PPI programs), to include them in the management plans designed for the Industrial Component presented in the Social Studies, because they reside in the urban area and their socio-demographic characteristics and means of subsistence are more similar to an urban vulnerable group than to a vulnerable group of a rural indigenous community, since they have practices that are typical of the predominant culture in the country. According to what was found during fieldwork, they celebrate 15th birthday parties, work informally in the city, and engage in banditry. In addition, population at risk of drug addiction, prostitution, domestic violence, among others, was found.

9.3.4.1.2.3 Gender Context

The project plans to employ 90% of women in forest nurseries, thus contributing to reducing the existing gender gap in employment opportunities. The jobs related to the nurseries will be around 150, including more than 80% of unskilled profiles that will be trained by the project. In this sense, it is expected that most of the jobs may be held by local women, considering that the technical/professional qualification of labor in the area is low, with the additional advantage that the nurseries operate throughout the cycle of the project.

In the DIA districts, women make up an average of 47.97% of the population. As for the Bella Vista Norte district of the Amambay department, also part of the DIA, 49.44% of the population are women. According to the data collected in the field in the localities of these districts close to/neighboring the forest plantations (with emphasis on Paso Barreto, Loreto and Jhuguá Guazú). Women are mainly engaged in household chores, the farm, handicrafts, the raising of small animals, the sale of dairy products and their derivatives, trade, decoration, rentals, gastronomy, hairdressing, dressmaking, among other activities and/or they migrate in search of job opportunities, both to Asunción and its metropolitan area; the departmental capitals of the IIA as well as abroad. Regarding training aimed at productive employment for women, the lack of opportunities was mentioned. It was also mentioned that unequal practices still persist, assigning women to household tasks and to men productive tasks that generate income.

In this context of lack of opportunities for women, the project's human resources policy will contribute to offering employment opportunities that currently do not exist in the DIA, from which women from the IIA or other areas of the country could also benefit.

9.3.4.1.2.4 Main demographic indicators

In this section, the main demographic indicators related to the three IIA departments are presented. The data used were collected in publications of the General Directorate of Statistics and Censuses and correspond to the year 2017.

Table 7 – Main demographic indicators, by department. Year 2017

Indicator	Concepción	San Pedro	Amambay
Global Fertility Rate	3,02	2,97	2,62
Birth Rate (per thousand)	24,7	23,38	22,31
Mortality Rate (per thousand)	5,31	5,53	5,36
Life Expectancy at Birth	74,12	73,73	73,76
Men	71,3	70,88	70,91
Women	77,09	76,72	76,76
Sex Reason	105,8	109,7	99,9
Median Age	22,5	23,2	24,3
Total dependency ratio	66,9	64,5	59,3
Dependency ratio children	57,6	55	50,7
Dependency ratio older adults	9,3	9,5	8,6
Ageing index	16,2	17,2	17
Percentage of female population of reproductive age	49,7	49,9	52,5

Percentage of male population of household age	27,6	26,2	25,9
Index of availability of care for the elderly	26,2	24,3	20,9

The definitions provided by the DGEEC[6] for the indicators contained in the table above are transcribed below.

Table 8 – Indicators of Table 7

Gender reason	It is the ratio of men to women, expressed as the number of men per 100 women.
Median age	Age indicating exactly when half of the population is older and the other half younger.
Age-dependency ratio	It is the ratio of people in the age group on which they generally depend (people under 15 and over 64 years old) and people in the economically productive age group (between 15 and 64 years old)
Ageing index	It relates the older population (65 years and older) to the younger population (0-15 years), indicating the number of older adults per 100 children. This indicator clearly shows how the ageing of the population is progressing in line with the two previous indicators.
Percentage of male population of household age	It is a rough indicator of the demand for housing
Index of availability of care for the elderly	Ratio between adults over 80, most of whom have lost their autonomy, and the female population between 50 and 64, which would correspond approximately to their daughters. This measure roughly indicates the number of elderly people per 100 potential me-care providers.

Source: DGEEC.

In the department of Concepción, the age and gender distribution are presented as illustrated in Figure 6.

The age and gender distribution of the departments of San Pedro and Amambay can be seen in the following Figures 7 and 8[7]:

In the three departments, the population is eminently young: in Concepción 72% of the total population is under 35 years old, while in San Pedro and Amambay the figures are 70% and 68% respectively.

[6] DGEEC. Paraguay, Proyección de la Población por Sexo y Edad, según Departamento, 2000-2025. Revisión 2015.
[7] DGEEC. Paraguay, Population Projection by Sex and Age, by Department, 2000-2025. Review 2015.

Figure 4 – Age and gender distribution according to 2017 projected data. Department of Concepción [8]

Source: DGEEC. Prepared by the external consultant Lic. Caren Kremer and team.

Figure 5 – Age and gender distribution according to 2017 projected data. Department of San Pedro

Source: DGEEC. Prepared by the external consultant Lic. Caren Kremer and team.

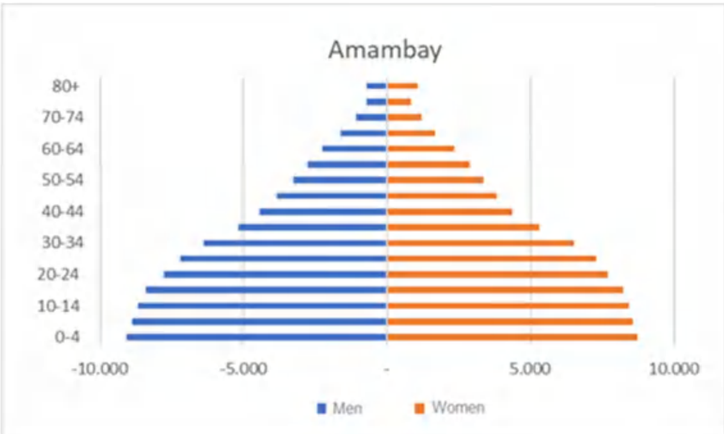


Figure 6 – Age and gender distribution according to 2017 projected data. Department of Amambay

Source: DGEEC. Prepared by the external consultant Lic. Caren Kremer and team.

[8] DGEEC. Paraguay, Population Projection by Sex and Age, by Department, 2000-2025. Review 2015.

9.3.4.1.2.5 Households, accommodation

Throughout this section, we present data taken from the Permanent Household Survey, year 2017 (Encuesta Permanente de Hogares, in Spanish); complemented with the data included in the Permanent Household Survey, years 2017-2018. Due to differences in the methodology of each Survey, the data may not be comparable at this time, but will serve as a baseline for comparisons with future surveys.

In the department of Concepción, there are 60,157 households (EPH 2017); while in San Pedro, there are 103,024 households (EPH 2017); and in Amambay 43,100 households (EPH, 2017). In the data contained in table 9, it may be observed that a large percentage of the households in the three departments are owned or are in the process of purchasing in installments, and have electricity.

In both Concepción and San Pedro, in 2017, the highest percentage of water in the dwellings came from SENASA or the local Sanitation Board, while in Amambay, most of the households obtained water from a community network, as shown in Table 10.

Table 9 – Households, legal and current tenure, years 2017 and 2018

	Concepción		San Pedro		Amambay	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
Total Households (Number)	**60.157**	**62.476**	**103.024**	**109.443**	**43.100**	**44.719**
Legal ownership (%)						
- own or paying in installment	83,65	85,7	86,25	87,6	73,86	68,6
- on loan	11,33	8,1	10,91	9	13,08	12,1
- rented	(*)		(*)	3,5	13,06	19,3
Electric current rating (%)	97,79	98,6	99,24	99,4	98,54	98,4

Source: DGGEC. Prepared by the external consultant Lic. Caren Kremer and team based on DGEEC data (1) DGEEC. EPH 2017 data. (2) DGEEC. EPHC 2017-2018 data. (*) Sample deficiency, less than 30 cases.

Table 10 – Home water sources (%), years 2017 and 2018

Water sources (%)	Concepción		San Pedro		Amambay	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
- SENASA/“Junta de Saneamiento”	48,79	29,6	58,29	69	8,13	10,8
- Public System	27,85	37,7	25,76	16,9	33,57	32,3
- ESSAP	11,28	18,8	(*)	2,8	17,89	20,8
- Water well	(*)		(*)	3,4	10,9	8,9
- pumped or no-pumped wells	9,88	7,9			18,36	14,3
- Others (3)	(*)		6,09	7,8	8,33	3,6

Source: DGGEC. Prepared by the external consultant Lic. Caren Kremer and team based on DGEEC data
(1) DGEEC. EPH 2017 data. (2) DGEEC. EPHC 2017-2018 data
(*) Sample deficiency, less than 30 cases.
(3) Others: includes spring or source, floodplain, river or stream.

In terms of solid waste disposal, the vast majority of households use burning in Concepción and San Pedro, and public/private collection services in Amambay. It is worth mentioning that one third of the population of Concepción has access to garbage collection services.

Similarly, for the disposal of wastewater (sewage), only 6.55% of households have access to the sanitary sewerage network (cloaca) in Concepción (1.03% in San Pedro and 4.14% in Amambay).

Almost 30% of households use a cesspit with a septic chamber, and a similar percentage use a cesspit without a septic chamber in Concepción and San Pedro, while in Amambay these percentages rise to more than 40% in both cases. In addition, a very important percentage of households (35.47% in Concepción, 37.38% in San Pedro) still use common latrines with or without a roof or door, ventilated dry pit latrines or surface soil, stream, river and others. While in Amambay this percentage drops to 8.23%. The corresponding data are found in Table 11.

Table 11 – Solid waste and wastewater disposal (%), years 2017 and 2018

Solid Waste and Wastewater Disposal (%)	Concepción		San Pedro		Amambay	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
Solid Waste Disposal (%)						
- Incineration	61,44	52,3	75,7	72,2	29,84	30,5
- Public/Private Collection	30,32	33,1	8,18	13,4	63,12	62,8
- Shoot in a hole			12,73	11		
- Others (3)	8,24	14,6	(*)	3,3	7,05	6,7
Sewage Disposal (%)						
- Sanitary sewage network (sewer)	6,55	6,8	1,03	2,2	4,14	6,1
- Septic tank and cesspit	29,8	35,8	29,08	34,4	46,39	47
- Cesspool without septic tank	27,81	23,5	31,38	25	41,24	35,2
- Common toilet without roof or door	27,79	25,7	26,93	29	4,57	9,9
- Common dry pit toilet (with slab, roof, walls and doors)	6,01	6,4	8,79	7	2,63	1,1
- Ventilated dry pit latrine (common with vent)	1,29	0,3	1,26		1,03	
- Land surface, open hole, ditch, stream, river.	0,38	1,4	0,40	1		0,4

Source: DGGEC. Prepared by the external consultant Lic. Caren Kremer and team based on DGEEC data
(1) DGEEC. EPH 2017 data
(2) DGEEC. EPHC 2017-2018 data
(*) Sample deficiency, less than 30 cases.
(3) Others: includes Landfill, hole, yard, waste, ditch or street, farm.

In households in Concepción, the most widely used fuel for cooking continues to be wood (46.49%), followed by gas (31.87%), coal (9.57%) and electricity (8.69%), as in San Pedro. However, in Amambay, the statistical data indicate a strong predominance of gas use, as can be seen in Table 12.

Table 12 – Main fuel used for cooking (%), years 2017 and 2018

Main fuel used for cooking (%)	Concepción		San Pedro		Amambay	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
- Firewood	46,49	44,2	59,76	55,3	12,76	83,1
- Gas	31,87	38,7	21,31	23	82,74	11,2
- Coal	9,57	6,5	8,07	5,6	(*)	(*)
- Electricity	8,69	9	9,31	13,8	(*)	(*)
- No cooking	(*)		(*)		(*)	(*)

Source: DGGEC. Prepared by the external consultant Lic. Caren Kremer and team based on DGEEC data
(1) DGEEC. EPH 2017 data
(2) DGEEC. EPHC 2017-2018 data
(*) Sample deficiency, less than 30 cases.

Regarding existing durable goods in households, in the three departments it can be observed that the same five types of goods have higher percentages of ownership; and the ownership of mobile phones is higher. In second place is the possession of motorcycles in Concepción, while households in San Pedro and Amambay give preference to the possession of electrical appliances (refrigerators, televisions and washing machines), as can be seen in Table 13.

Table 13 – Ownership of long-term goods (%), years 2017 and 2018

Ownership of long-term goods (%)	Concepción		San Pedro		Amambay	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
- Mobile phone	96,63	95,9	95,97	96,2	98,46	96,5
- Motorcycle	86,58	82,2	71,88	76,2	74,57	74,1
- Refrigerator	83,25	85	84,69	86,9	92,41	90,3
- Television	81,24	86,8	79,98	81,1	89,39	86,9
- Washing machine	69,57	76,1	71,62	76,7	83,07	82,7

Source: DGGEC. Prepared by the external consultant Lic. Caren Kremer and team based on DGEEC data
(1) DGEEC. EPH 2017 data
(2) DGEEC. EPHC 2017-2018 data

9.3.4.1.2.6 Poverty, Income Distribution, Unsatisfied Basic Needs (UBN)

Poverty

In Paraguay, the method used to measure poverty is the Poverty Line method. Among other indicators, the DGEEC makes calculations to estimate the incidence of total poverty and extreme poverty (percentage of poor and extremely poor), defined as "the proportion of the population with an income below the total poverty and extreme poverty lines".[9] That is, it measures the percentage of people in a situation of Total Poverty [10] and in extreme poverty [11]. Considering the cultural and consumption characteristics of the population in urban and rural areas, Total Poverty Line and Extreme Poverty Line values are calculated for urban and rural areas.

For the year 2017, the values of the poverty lines are as follows [12]:

Table 14 – Información sobre líneas de pobreza al 2017

	Urban Area (Gs.)	Rural Area (Gs)
Total Poverty Line (TPL)	664.297	473.601
Extreme Poverty Line (EPL)	256.881	234.592

Source: DGEEC. Permanent Household Survey 2017.

As can be seen in the data from the Permanent Household Survey 13, 43.97% of the population of Concepción is in a situation of poverty, that is, around 107,097 people have a per capita income lower than the cost of a basic consumption basket (LPT). Of these people, 15,911 (6.53 per cent) have a monthly per capita income below the cost of a minimum food consumption basket, i.e. they are unable to cover the cost of the minimum amount of food. In San Pedro, the percentage of total poverty is similar to that of Concepción; however, the percentage of people in extreme poverty is higher. Amambay is the department with the lowest poverty rates in the IIA, and this result is aligned with the other indicators contained in other sections of this report. Table 15 summarizes the main data obtained.

[9] DGEEC. Main Poverty and Income Distribution Results. EPH 2017. Marzo 2018.
[10] The percentage of inhabitants in a situation of poverty is calculated by comparing the per capita income with the cost of the basic consumption basket (Total Poverty Line), considering in addition to food other non-food expenses such as: housing, education, health, transportation, communication, entertainment, etc. (DGEEC. Summary of the Estimation of the Poverty Lines).
[11] The percentage of inhabitants living in extreme poverty is determined by comparing the per capita income of households with the cost of the basic food basket or Extreme Poverty Line (DGEEC. Summary of the Estimation of the Poverty Lines).
[12] DGEEC. Main Results of Poverty and Income Distribution EPH 2017. March 2018.
[13] DGEEC. Permanent Household Survey 2017.

Table 15 – Total and Extreme Poverty by Department (Year 2017)

Department	Total Population (1)	Total Poor Population (2)		Extreme Poor Population	
		Absolute (number)	Relative (%)	Absolute (number)	Relative (%)
Concepción	243.560	107.097	43,97	15.911	6,53
San Pedro	418.851	182.567	43,59	33.894	8,09
Amambay	164.254	25.026	15,24	5.390	3,28

Source: DGEEC. Permanent Household Survey 2017.
(1) Does not include domestic employees without retirement.
(2) Includes extreme and non-extreme poor

Income distribution

According to available data, in 2017, the average per capita income in Concepción was approximately Gs. 896.026[14], which is 8.7% less than that of San Pedro and 41.47% less than that of Amambay. In the three IIA departments, the richest quintile is over 50% of the population. There is a marked inequality in both per capita income in each department and between quintiles. For example, in Concepción, the poorest 20% earn 11.74% of what the richest 20% earn, a ratio similar to that of Amambay (11.50); while in San Pedro, the ratio drops to 8.55%. However, when comparing absolute values in that same quintile, the average income in Concepción is almost 40% lower than in Amambay and 7.45% higher than in San Pedro. The data collected can be seen in Table 16.

Table 16 – Average and distribution of monthly per capita income of the population, by monthly income quintiles (2017)

Quintiles of per capita income	Concepción		San Pedro		Amambay	
	Average (Gs)	Percentage Distribution	Average (Gs)	Percentage Distribution	Average (Gs)	Percentage Distribution
Total	896.026	100	981.516	100	1.530.906	100
poorest 20%	265.696	5,93	245.836	4,97	440.099	5,71
next 20%	433.258	9,67	397.922	8,16	754.516	9,9
next 20%	605.317	13,43	550.863	11,29	1.069.846	13,93
next 20%	911.518	20,48	832.589	16,86	1.553.616	20,34
20% wealthier	2.262.201	50,5	2.876.140	58,72	3.824.094	50,12

Source: DGEEC. Permanent Household Survey 2017. Prepared by the external consultant Lic. Caren Kremer and team

[14] DGEEC. Newsletter - Main Results of Poverty and Income Distribution EPH 2017. Concepción.

Unsatisfied Basic Needs (UBN)

According to data from the 2012 Census, in Concepción, more than half of the households (56.2%) have at least one UBN. In the three departments the highest percentage is in access to health infrastructure, as is also the case, if we compare, with the total (country). It should be mentioned that all percentages are higher than those recorded at the country level (except access to livelihood capacity in Amambay), indicating that the departments and districts are in a worse position than the national average.

As for the districts studied for DIA, Concepción has the lowest percentages in each indicator surveyed, denoting better access overall compared to other districts, while Loreto has the highest percentage of households with at least one UBN, in addition to the highest percentages in each type of UBN, except access to education. Table 17 presents data for the 3 departments and 4 districts.

Table 17 – Homes with UBN, by department and district

Department and District	Total houses	Households with Unsatisfied Basic Needs (UBN) (%)				
		At least 1 UBN				
Total (country)	**1.232.496**	**43,0**	**Total (country)**	**1.232.496**	**43,0**	**Total (country)**
Concepción	**42.638**	**56,2**	**Concepción**	**42.638**	**56,2**	**Concepción**
Concepción	14.973	46,6	Concepción	14.973	46,6	Concepción
Belén	2.165	57,9	Belén	2.165	57,9	Belén
Horqueta	10.784	59,4	Horqueta	10.784	59,4	Horqueta
Loreto	3.317	60,0	Loreto	3.317	60,0	Loreto
San Pedro	**78.742**	**57,6**	**San Pedro**	**78.742**	**57,6**	**San Pedro**
Amambay	**27.047**	**48,3**	**Amambay**	**27.047**	**48,3**	**Amambay**

Source: DGEEC. Triptych Unsatisfied Basic Needs (UBN) 2012. Paraguay based on STP-DGEEC. National Population and Housing Census 2012.

9.3.4.1.2.7 Migration

Like other countries, in Paraguay there are significant difficulties in determining migration, and even more so in predicting it. This situation is compounded by the lack of internal migration statistics at the interdepartmental level[15]. Considering these limitations, in this section, we have used the Population Projection data published by the DGEEC, where data are presented that allow for their analysis.

Migration may be defined as "permanent or semi-permanent transfer of persons and families between geopolitical units, with the consequent change of residence"[16].

15 DGEEC-STP. PARAGUAY. POPULATION FORECAST BY SEX AND AGE, BY DEPARTMENT. 2000-2025. REVIEW 2015

16 DGEEC. Migración Pendular en el Paraguay, 2012 (original title).

In Paraguay, for the years 2001 to 2024, migration rates are negative in all departments, except in the Central Department, where there is a high rate of immigration. These data suggest a significant migratory movement from the interior of the country to the cities surrounding the capital.

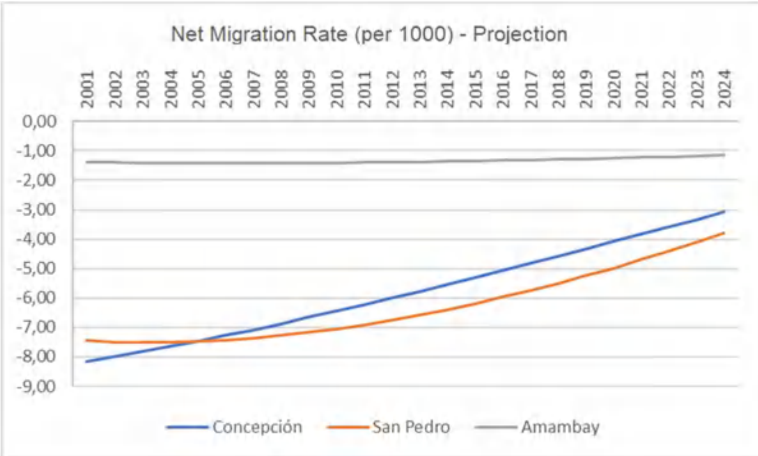


Figure 7 – Net migration rate, projection by department

Source: Prepared by the external consultant Lic. Caren Kremer and team based on Population Projection (DGEEC).

Figure 9 presents the Net Migration Rate for the years 2001-2024 for the three IIA departments. As can be seen, in Concepción and San Pedro, the net rates are negative (emigration) with a tendency to decrease. In Amambay, although they are also negative, the trend remains relatively stable.

According to Pereira, in his text "Departmento de Concepción. Wealth and Social Inequality", based on official data from the 2002 Population and Housing Census, 40% of people migrated to the central department, 16% to Asunción and 12% to the department of Amambay. It also reports that during this period "emigration from the department of Concepción has a woman's face. Fifty-seven out of every 100 migrants... were women”[17]. This statement may still be valid as of 2017, however, no data have been found.

Fluctuating Migration

Pendular migration is migration "of a periodic nature and does not result in a change of residence".[18] This refers to persons who regularly move to another country, department or even district for work purposes. In this section, data will be used on the population aged 10 years old and over, employed in the same department, but in a different district, a different department, another country or no fixed district from the one in which they reside, according to data from the 2012 Census.

Table 18 – Population aged 10 years and over migrating by department of residence, according to place of occupation, 2012

[17] Pereira, Hugo. *“Departamento de Concepción. Riqueza y desigualdad social*”. Available in:https://revistascientificas.una.py/index.php/RE/article/view/714

[18] DGEEC. Migración Pendular en el Paraguay, 2012 (original title).

Workplace	Residence Department		
	Concepción	San Pedro	Amambay
Asunción	113	272	29
Concepción	666	118	69
San Pedro	133	1.020	16
Amambay	261	110	131
Cordillera	5	18	0
Guairá	0	25	5
Caaguazú	13	73	1
Caazapá	3	6	2
Itapúa	3	7	0
Misiones	2	6	0
Paraguarí	1	8	0
Alto Paraná	23	83	9
Central	43	121	4
Ñeembucú	3	4	0
Canindeyú	2	101	6
Presidente Hayes	401	168	5
Boquerón	659	114	6
Alto Paraguay	357	60	9
Another country	104	122	2.346
Has no fixed district	346	441	148
Total Pendular migrant population	**3.139**	**2.875**	**2.786**

Source: DGGEC. Pendular Migration in Paraguay. Prepared by the external consultant Lic. Caren Kremer and team.

As can be seen in Table 18, a large part of the pendular migration from Concepción and San Pedro occurs as intra-departmental migration: 21.2% and 35.5% respectively, indicating that while a significant number of people move outside their area of residence to work, the vast majority do so relatively close by and remain in the same department.

It should also be noted that a very significant proportion of Concepción's workers in the Chaco: 45 per cent in the three departments of Chaco[19], with easy access via the Nanawa bridge linking the Western and Eastern regions, which is not reported in San Pedro department. With respect to Amambay, 84.2% of the pendulum migrant population moves to another country (probably Brazil due to the geographical location of the

[19] On the contrary, the total number of people who migrate from the Chaco to Concepción on a temporary basis to work is low, being 101 people, which represents 1.57% of the total number of Chacoans with pendular migration.

department) and the lowest percentage of people moves to Concepción (4.7%) although no significant numbers of interdepartmental pendulum migration are recorded.

Going a little deeper into the analysis, and based on the data included in other sections of this document, it is possible to observe that the industrial sector in San Pedro is better paid than the industrial sector in Concepción. For this reason, it is likely that the migratory flow is of untrained labor and probably also from the primary sector.

Based on the information presented in this document, the migratory flow from Amambay to Concepción is unlikely, considering that the department of Amambay presents much better ratios than the other two departments of the IIA, so the flow could be unlikely.

9.3.4.1.3 Employment

In the first part of this section, the main statistical data related to the Working Age Population (WAP), Economically Active Population (EAP), Unemployment, Underemployment and others are presented. Where available, data disaggregated by sex was included.

In the second part, information is presented on employment formality in the 3 departments of the IIA, and on average labor income.

9.3.4.1.3.1 Overview of main labor market indicators

For the three departments, wherever possible, data and information have been compiled and total values have been calculated. The data used were extracted from reports prepared by the DGEEC, according to data from the Permanent Household Survey (Year 2017).

Table 19 systematizes the main labor market indicators, and Table 20 provides data on the employed population, according to different segmentation criteria.

In Concepción, there is a Working Age Population (WAP) of 186,627 people (53.53% are women), of which 58.33% are Economically Active (108,860 people, of which 41.33% are women). The activity rate in the department is 58.33 per cent, which is lower than the national activity rate (63.09 per cent)[20]. For women, an activity rate of 45.04 per cent was recorded, while for men this figure reached 73.64 per cent, in line with the nationally recorded rates of 50.91 per cent and 75.24 per cent respectively.

The figures recorded for the other two departments are close to the national figures. In San Pedro, the activity rate was 63.11 per cent (47.33 per cent for women and 77.63 per cent for men). In Amambay, it was 64.03 per cent (54.07 per cent for women and 74.55 per cent for men).

In 2017, the open unemployment rate in Concepción was 6.66% and in Amambay 5.48%. In other words, some 7,247 people in Concepción and another 4,490 in Amambay were unemployed [21]. The unemployment rate in the country was 5.20%, which is lower than any of the above.

The Permanent Household Survey also measures the number of "people who worked less than 30 hours a week and wish to work more hours and are available to do so".[22], i.e. underemployment due to insufficient working time (or visible underemployment) In Concepción, the rate of visible underemployment reached 8.25% (13.55% of women),

[20] DGEEC. Main Employment indicators. Permanent Household Survey 2017.
[21] DGEEC. EPH 2017. Sin datos para San Pedro.
[22] DGEEC. Main Employment indicators. Permanent Household Survey 2017.

while in San Pedro it was 6.41% (10.8% of women) and in Amambay it was 5.63% (10.27% of women). It should be mentioned that the country's visible underemployment rate is 5.43 per cent, lower than those recorded in the three departments.

With regard to employment by economic sector, 47% of the economically active population of Concepción is dedicated to activities in the tertiary sector (commerce and services), a sector that absorbs two thirds of the female and one third of the male workforce; while the primary sector occupies 36.2% of the EAP and the secondary sector 16.63%. A similar situation exists in Amambay where 70% of the EAP works in the tertiary sector, which occupies 88% of the female EAP and 57% of the male EAP. In San Pedro, however, the vast majority of EAPs work in the primary sector (56.35%), which occupies 60% of the male population and 49% of the female population.

Table 19 – Main labor market indicators

	Concepción			San Pedro			Amambay			Total		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
Total Population	244.097	114.152	129.945	419.617	220.754	198.863	164.483	80.975	83.508	828.197	415.881	412.316
Working Age Population (WAP)	186.627	86.734	99.893	330.995	172.399	158.596	127.915	62.230	65.685	645.537	321.363	324.174
Economically Active Population (EAP)	108.860	63.869	44.991	208.902	133.841	75.061	81.908	46.391	35.517	399.670	244.101	155.569
Economically Inactive Population (EIP)	77.767	22.865	54.902	122.093	38.558	83.535	46.007	15.839	30.168	245.867	77.262	168.605
Population occupied	101.613	59.780	41.833	203.463	131.579	71.884	77.418	44.197	33.221	382.494	235.556	146.938
Open Unemployment	7.247	(*)	(*)	(*)	(*)	(*)	4.490	(*)	(*)			
Underemployed population due to insufficient working time (visible underemployment)	8.981	(*)	6.097	13.398	5.292	8.106	4.611	(*)	3.646	26.990	S/D	S/D

Source: DGEEC, Permanent Household Survey - Year 2017. Prepared by the external consultant Lic. Caren Kremer and team
(*) Sample deficiency, less than 30 cases.

Table 20 – Employed population, by sector of occupation

	Concepción			San Pedro			Amambay		
	Total	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**	**Men**	**Women**
Employed by Economic Sector (%) (1)	101.613	59.780	41.833	203.463	131.579	71.884	77.418	44.197	33.221
Primary	36,2	41,78	28,22	56,35	60,48	48,8	11,27	17,13	(*)
Secondary	16,63	24,5	(*)	11,55	14,72	(*)	18,74	26,12	(*)
Tertiary	47,17	33,72	66,39	32,1	24,79	45,46	69,98	56,76	87,58
Occupied by Category of Occupation (%)	101.613	59.780	41.833	203.463	131.579	71.884	77.418	44.197	33.221
Employee / public worker	8,37	(*)	11,12	6,38	5,7	7,62	7,82	(*)	10,35
Employee / private worker	27,42	36,61	14,28	18,26	23,01	9,56	43,93	55,13	29,02
Employer	5,07	(*)	(*)	3,28	(*)	(*)	7,07	9,72	(*)
Self-employed person	38,92	40,19	37,11	44,32	46,97	39,46	25,96	22,84	30,11
Unpaid family worker	13,03	9,8	17,64	24,86	19,8	34,12	6,09	6,08	(*)
Domestic employee	7,19	(*)	16,86	2,9	(*)	(*)	9,14	(*)	20,88
Employed by Company Size (%)	101.613	59.780	41.833	203.463	131.579	71.884	77.418	44.197	33.221
Alone	27,57	25,88	29,98	27,06	26,59	27,94	19,88	16,27	24,68
2 to 5 people	42,97	49,34	33,87	54,28	55,36	52,3	36,26	44,91	24,75
6 to 10 people	7,21	8,66	(*)	15,28	17,05	12,04	9,39	11,38	(*)
More than 10 people	14,2	14,91	13,18				23,18	24,48	21,45
Domestic employee	7,19	(*)	16,86	2,9	(*)	(*)	9,14	(*)	20,88
Doesn't know	0,87	0,78	0,98	0,47	0,6	0,24	2,03	2,64	1,21
Occupied according to Years of Study (%)	101.613	59.780	41.833	203.463	131.579	71.884	77.418	44.197	33.221
No Instruction (2)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
From 1 to 6	42,04	41,38	43	50,35	48,69	53,4	34,36	37,91	29,63
From 7 to 12	38,47	43,33	31,53	34,97	39,72	26,27	41,25	42,14	40,07
From 13 to 18	16,97	12,28	23,67	12,31	9,73	17,02	22,58	18,06	28,59
Not available							0,14	- -	0,32

Source: DGEEC, Permanent Household Survey - Year 2017. Prepared by the external consultant Lic. Caren Kremer and team

(1) Primary Sector: Includes Agriculture, Livestock, Hunting and Fishing Secondary Sector: Includes Manufacturing Industries, Construction, Mines and Quarries. Tertiary Sector: Includes Electricity and Water, Commerce, Financial Establishments, Communal and Personal Services.

(2) Includes: Pre-Primary (*) Sample deficiency, less than 30 cases

In the three departments, the largest proportion of people working is in MSMEs/Establishments with 1 to 5 employees (Concepción: 70.54%; San Pedro: 81.34%; Amambay: 45.14%). On the other hand, analyzing the data provided by occupation category, it is possible to conclude that both in Concepción and San Pedro, the population works mainly independently (Concepción: 57.02%; San Pedro: 72.46%) while in Amambay most of the population works as an employee of private companies (43.93%) compared to 39.12% of independent workers.

Employment formality

One of the main criteria for defining formality or informality in the employment of wage-earners is registration and contributions to a retirement system. In Paraguay, although there are various types of retirement schemes depending on the business sector, the main mandatory retirement system for salaried workers in a dependent employment situation is the Social Security Institute.

In 2017, just over a third of the employed wage earners in the three departments were registered and contributed to a retirement system: 13,969 people in the department of Concepción contributed to a retirement system, or 38.41% of the employed wage earners; in San Pedro, there were 19,171 contributors (38.24%) while in Amambay there were 14,167 (35.36%).

In addition, taking into account that, in general, people who were able to complete higher levels of education have better access to better-paid jobs with a greater degree of formality, one indicator to consider is the employed population that is employed according to years of study. Table 21 provides data in this regard:

Table 21 – Occupied people according to years of study, by sex, in the IIA (2017)

	Concepción			San Pedro			Amambay		
	Total	**Men**	**Women**	**Total**	**Men**	**Women**	**Total**	**Men**	**Women**
Occupied according to years of study (%)	101.613	59.780	41.833	203.463	131.579	71.884	77.418	44.197	33.221
No instructions (1)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
From 1 to 6	42,04	41,38	43,00	50,35	48,69	53,40	34,36	37,91	29,63
From 7 to 12	38,47	43,33	31,53	34,97	39,72	26,27	41,25	42,14	40,07
From 13 to 18	16,97	12,28	23,67	12,31	9,73	17,02	22,58	18,06	28,59
Not available							0,14	- -	0,32

Source: DGEEC, Permanent Household Survey - Year 2017. Prepared by the external consultant Lic. Caren Kremer and team.
(1) Pre-primary
(*) Sample deficiency, less than 30 cases

In table 21, it can be seen that, in Concepción, the majority of the working population has a maximum of six years of studies (i.e. 42.04% have primary education), a smaller percentage (38.47%) has secondary studies, and only 16.97% have tertiary studies (7,340 men and 9,900 women). In San Pedro, approximately half of the EAP has a primary education, while almost 35 per cent has a secondary education and only 12 per cent has a tertiary education. In Amambay, the majority have secondary studies (41.25% compared to 34.36% with primary studies); and there is also a higher percentage of EAP with tertiary studies (22.58%). It should be noted that in all three departments, more women (as a percentage) have completed tertiary studies.

Current Legal Minimum Salary

In recent years, the legal minimum wage has been gradually increased. From March 2014 to November 2016 it was Gs. 1,824,055; on that date it increased to Gs. 1,964,507 and in July 2017 it increased to 2,041,123. Finally, in July 2018, it increased to Gs. 2,112,562, until the conclusion of this study.

Average Employment Income

As can be seen in the data from the Permanent Survey of Homes, until 2016, the department with the lowest overall average labor income was San Pedro. While the department with the best average income was Amambay, corresponding to the number of years of study of the population. In 2017, the average labor income was reduced by almost 14% in Concepción, placing this department in last place. It is worth mentioning that in 2017, the average labor income was higher than the minimum legal wage in force only in the department of Amambay.

Table 22 shows the average monthly income (in thousands of guaraníes) in the main occupation of the population aged 15 and over per year, by department and sex, for 2017 and 2018.

Table 22 – Average labor income (years 2016 and 2017)

	Concepción		San Pedro		Amambay	
	2016	2017	2016	2017	2016	2017
Average labor income (in thousands of guaraníes) of the main occupation (1)	1.763	1.518	1.537	1.747	2.580	2.422
Average labor income (in thousands of guaraníes) of the population of Q1 (1) and Q2 (1)	738	704	494	665	1.110	1.350
Average labor income (in thousands of guaraníes) of the population of Q1 (1)	562	497	389	512	887	1.082
Average labor income (in thousands of guaraníes) of the population of Q2 (1)	853	865	579	795	1.264	1.554

Source: DGEEC. Permanent Household Survey 2016-2017
(1) Corresponds to the regular monthly income of those employed in the main occupation at constant prices 2017

As can be seen, the average income is significantly higher in Amambay, when we compare data from the three departments. Moreover, in all three departments, there is a significant wage gap between women and men. In Concepción, women earn 25% less than men, on average, while the gap is 15% in San Pedro and 22% in Amambay.

Table 23 – Average labor income, by department and sex (in thousands of guaraníes)

Department	2017	2018
Concepción		
Total	1.511	1.735
Men	1.682	1.920
Women	1.259	1.439
San Pedro		
Total	1.506	1.885
Men	1.594	1.977
Women	1.317	1.672
Amambay		
Total	2.249	2.346
Men	2.466	2.581
Women	1.932	2.016

Source: DGEEC. Annual Departmental Results EPHC 2017-2018

9.3.4.1.4 Economy

By way of introduction, an attempt was made to present comparative information on the different economic sectors: primary, secondary and tertiary for the three departments. However, it was only possible to do so for the Secondary (Industry) and Tertiary (Commerce and Services) sectors due to the type of data available[23].

Accordingly, the first section presents data related to the Primary Sector and then data from the Secondary and Tertiary sectors of the IIA. Finally, an analysis of the evolution of the economy in the department of Concepción is presented.

9.3.4.1.4.1 Primary Sector

In all the three departments, 68,047 properties are registered with a total area of 4,575,725[24] hectares dedicated to the sector. The surface dedicated to livestock reaches 2,935,287 hectares (65.2% of the total), while the one used for agriculture is 527,512 hectares (11.5%), and the surface with natural forests and cultivated forests is 734,741 hectares (16.1%).

Comparing the data corresponding to the three departments, there is a greater number of farms in the department of San Pedro, which shows the greater occurrence of small agricultural farms, more agricultural than livestock, as can be seen in Table 24.

[23] In other words, we only have data from the primary sector for 2008 (collected by the 2008 National Agricultural Census, with some annual projections using sampling techniques in non-continuous years), and from the other 2 sectors for 2011 (collected by the 2011 National Economic Census, applied by the DGEEC, was unique in its class so the data presented corresponds to an observation). The provision of projections from a single observation lacks statistical robustness, since its preparation is carried out through indirect methods, using series of other observations or determinations taken periodically or regularly over time, such as the Permanent Household Survey (EPH), the Consumer Price Index (CPI), among others.

[24] DGEEC. Agricultural Census

Table 24 – Land according to its use in number of properties, by department in 2008

Department	Number of farms with land	Farms with Permanent Temporary Crops and Vegetables	Farms with natural or cultivated pasture	Properties with natural woods or forest plantation	Farms with fallow and resting land	Farms with land for other uses
Concepción	17.377	15.285	10.071	6.414	7.485	15.583
San Pedro	45.875	42.889	23.866	18.468	24.154	40.784
Amambay	4.795	3.969	2.726	2.454	1.745	3.261
Total, Estimated IIA	68.047	62.143	36.663	27.336	33.384	59.628

Source: National Agricultural Census 2008. Prepared by the external consultant Lic. Caren Kremer and team

On the other hand, the department of Concepción is the one that devotes a notoriously higher percentage of its area to livestock activity in relation to agriculture, compared to the other departments of the IIA.

With a total of[25] farms covering an area of 1,619,416 hectares where the farm management by a single producer reaches 16,809 farms, associated producers 431 farms, companies or societies legitimately constituted 115, the State 4 and others not defined 8.

The cultivated area is 464,267 hectares, the composition of the labor force is dominated by the national one with 16,512 national producers and the international labor force is dominated by the Brazilian one with 261, and only 36 of other nationalities.

The education of agricultural producers in the department of Concepción is distributed among 1,108 producers with no educational training at all; 5,066 with basic school training (from 1st to 3rd year); 7,668 with basic school training (from 4th to 6th year); 1,422 with basic school training (from 7th to 9th year); 1,058 with secondary school training and 173 with a technical bachelor's degree, while 404 are those with non-university higher education.

Table 25 – Land according to its number in terms of surface area, by department as of 2008

Department	Total surface (ha)	Area with permanent temporary crops and vegetables	Area with natural and cultivated pasture	Area with natural forests and cultivated forests	Fallow and resting surface	Surface area under other uses
Concepción	1.619.416	71.431	1.218.911	233.300	50.394	4.538
San Pedro	1.739.232	321.156	909.500	276.656	81.091	150.828
Amambay	1.217.077	134.925	806.876	224.785	28.567	21.924
Total, Estimated IIA	4.575.725	527.512	2.935.287	734.741	160.052	177.290

Source: National Agricultural Census 2008. Prepared by the external consultant Lic. Caren Kremer and team.

[25] DGEEC. Agricultural Census

As shown in table 26, with respect to soil management and conservation, San Pedro presents a clear leadership in conservationist techniques, which could be connected to its link with international cooperation development programs, since this department has historically shown high levels of poverty and inequality.

Table 26 – Farms according to soil management and conservation, by department as of 2008

Department	Number of farms with soil management	Management and soil conservation					
		Contour farming	Crop rotation	Green manure	Plots with certification of organic production	Direct sowing	Others
Concepción	10.390	232	9.176	178	273	596	1.196
San Pedro	28.598	998	23.592	297	393	3,669	3.792
Amambay	1.715	307	1.123	10	39	740	241

Source: National Agricultural Census 2008

As for the existing forest plantations in the three departments, it is also possible to see a clear leadership of the department of San Pedro in terms of the number of trees. However, Amambay presents a smaller number of farms containing more trees per unit of area. The department of Concepción presents a lower efficiency among the three, per unit of area. This could be due to less efficient, or less aggressive, planting and management techniques. The corresponding information is included in Table 27.

Table 27 – Forest plantations (Eucalyptus and Pine), by department in 2008

Departme nt	Compact forest plantation		Eucalyptus plantation			Pinus plantation		
	Total surface	Number of farms	Surface cultivated	Total surface	Number of farms	Surface cultivated	Total surface	Number of farms
Concepción	1.451	4.209	573	1.269	2.254.095	19	60	113.387
San Pedro	2.994	11.022	740	4.431	6.315.778	29	332	556.676
Amambay	222	6.716	87	3.126	5.986.820	6	7	12.787

Source: National Agricultural Census 2008

9.3.4.1.4.2 Secondary and tertiary Sectors

The following data is presented for the Secondary and Tertiary sectors of the Project's IIA departments, seeking to measure part of the economic activity in the area. The data used were extracted from the 2011 Economic Census, which did not include the primary sector.

In Concepción, there are 5,242 economic units that employ 13,682 people (44.55% are women) and generate income of Gs. 1.444.284.575.000. San Pedro presents data of high similarity with Concepción, while there is a lesser coincidence with Amambay, where all the registered data are of greater magnitude; for example, the income that reaches Gs. 5.112.545.870.000. This is due to the exposure of the department of Amambay to

Brazil, where trade with the neighboring country is one of the highest in the country after Alto Paraná.

In fact, the Trade sub-sector is the most developed of the three sub-sectors in the IIA, occupies the largest number of Economic Units and people, and generates the largest amount of income. The following table 28 presents a summary of the Secondary and Tertiary sectors of the three departments of the Project's Indirect Influence Area.

Table 28 – Total economic units. Secondary and Tertiary sectors, by department. Year 2011

Department and sector of economic activity	Economic units	Busy personnel			Total Payments	Expenditure on purchases of goods and services	Income from the supply of goods and services
		Total	Men	Women	(In thousands of Gs)	(In thousands of Gs)	(In thousands of Gs)
Concepción	**5.242**	**13.682**	**7.586**	**6.096**	**88.154.610**	**1.079.862.460**	**1.444.284.575**
Industry	572	1.877	1.604	273	12.397.928	109.362.370	151.834.489
Commerce	3.032	7.136	3.757	3.379	39.053.593	857.146.675	1.069.238.665
Services	1.638	4.669	2.225	2.444	36.703.089	113.353.416	223.211.421
San Pedro	**5.448**	**13.801**	**7.786**	**6.015**	**89.635.307**	**1.151.030.240**	**1.530.882.702**
Industry	493	1.641	1.385	256	15.239.236	92.135.588	131.524.254
Commerce	3.416	7.481	3.986	3.495	44.082.621	934.217.439	1.207.312.984
Services	1.539	4.679	2.415	2.264	30.313.450	124.677.213	192.045.463
Amambay	**6.249**	**18.502**	**11.071**	**7.431**	**188.575.177**	**4.236.320.036**	**5.112.542.870**
Industry	540	1,869	1,504	365	24.544.937	148.327.137	214.828.806
Commerce	3.868	10.663	6.310	4.353	100.170.416	3.721.163.117	4.347.214.366
Services	1.841	5.970	3.257	2.713	63.859.823	366.829.782	550.499.699

Fuente: DGEEC. Censo Económico del Paraguay, 2011

9.3.4.1.4.3 Evolution of the economic-productive and service activity in the department of Concepción

The economic and productive activity in the department of Concepción, in general, has been increasing in the last 50 years.

There are no available and detailed time series to carry out a consistent and evolutionary analysis in a punctual way, however, it is possible to analyze aggregated data such as those shown in table 29, including macro trends at a regional level.

In Table 29, the decrease in the EAP can be seen, which is due to the interdepartmental migration that occurs towards the Chaco, as well as towards the capital Asunción and the Metropolitan Area. This also affects the EAP of the primary sector as can be seen in the corresponding section of the same table.

The EPH data for 2015 show an unemployment rate for Concepción of about 16%, which is inconsistent with the results in table 29, which has the same institution as its source. This is mainly due to the modification of methodologies in the determination of the percentages of occupation that occurred in the same year.

Table 29 – Evolution of the conceptual economy in the last 50 years

Years	1.962	1.972	1982	1,992	2,002	2.012	2.017
Population of Concepción	**85,690**	**108,130**	**133,977**	**167,289**	**179,450**	**226,585**	**244,070**
Economically Inactive Population	61,397	77,783	95,191	121,058	121,843	129,833	135,210
Economically Active Population (EAP)	24,293	30,347	38,786	46,231	57,607	96,752	108,86
Economically Active Population (%)	28	28	29	28	32	43	45
Occupancy rate	87	97	96	98	98	99	93
EAP per sector							
Primary	14,456	18,467	24,675	27,189	25,805	38,984	39,19
Secondary	3,873	4,419	4,901	6,477	9,195	17,442	17,418
Tertiary	5,18	5,986	6,791	11,046	21,932	40,325	51,164
Other	784	1,475	2,419	1,519	675	s.d.	1,089

Source: Elaborated by extern consultantLic. Caren Kremer and team with DGEEC Data Base.

9.3.4.1.5 Services

This section presents content related to the availability of services in the Project IIA. The information is organized by type of service to which the population has access: basic services, education, vocational and technical training, health, security and justice, infrastructure and accessibility, means of transport, information and communication technologies (ICTs), media, financial services, housing, state presence.

9.3.4.1.5.1 Basic services

Considering that in item 9.3.4.1.2.4. Households and housing, details of the use of basic services in households were presented, this section complements the information with data related to the service and the providers.

Overall, a significant percentage of the IIA population has access to two basic services: electricity and improved water. In terms of improved sanitation, the percentages of access are much lower, as they are throughout the country. With respect to waste collection, service is registered in some municipalities and a relatively small proportion of the population has access to this.

Electric power

The electricity provider is the National Electricity Administration (ANDE), which has national coverage and provides electricity to 99.92% of the population (2017 data). The company's coverage in the IIA is high, reaching 97.79% of households in Concepción, 99.24% in San Pedro and 98.54 in Amambay (2017 data) .

In order to benefit the population, depending on the use the client will make of the electricity, the company establishes requirements and differentiated rates. The categories of use (consumption) available are the following[26]:

– Household consumption group (residential)
– Industrial consumer group
– Consumption group others: low and medium voltage
– High and Very High Voltage consumption group
– Governmental Consumer Group
– Differential Consumption Group
– Electric Lighting Service

Improved water

According to the sectoral study conducted by the Pan American Health Organization [27], In 2010, the Ente Regulador de Servicios Sanitarios (ERSSAN) had the following number of providers registered in the Project's IIA:

Table 30 – Number of water systems and connections according to provider, by department

	ESSAP		Sanitary Boards *(Juntas de Saneamiento)*		Neighborhood Commissions		Private Operating Institutions		Others	
Dpto.	**N° of systems**	**N° of connections**	**N° of systems**	**N° of connections**	**N° of systems**	**N° of connections**	**N° of systems**	**N° of connections**	**N° of systems**	**N° of connections**
Concepción	1	5.183	127	11.104	65	3.628	2	1.056	1	100
San Pedro	1	1.311	261	32.196	64	4.376	1	100	0	0
Amambay	1	6.630	13	3.034	35	8.876	3	457	0	0

Source: MOPC-OPS/OMS

At present, it is possible to provide details on the following:

a) a) National Environmental Sanitation Service - SENASA: It is the main supplier of improved water in the three departments according to 2017 data[28].

[26] Details of fees and requirements can be found in the following documents: ANDE. Fare Document N. 21; and ANDE. Resolution N. 42.847/19 "By which the definitions and general conditions of Fare Document N. 21 are modified".
[27] MOPC-OPS/OMS. Update of the Paraguayan Water and Sanitation Sector Analysis. 2010.
[28] Source: DGEEC. Permanent Household Survey period 2003-2004-2015-2016-2017.

In 2017, the SENASA office in Concepción had registered 81 artesian wells in the districts of Concepción, Loreto, Belén, Paso Barreto, José Félix López, San Alfredo, San Lázaro and San Carlos del Apa that had been built from 1993 to 2014 by the same institution or several others such as DINCAP, FONPLATA, Gobernación de Concepción, Lions Club, Office of the First Lady, IBRD, JICA and Sembrando Oportunidades. These wells had 8,904 users. Of the wells, 17.3% had chlorine treatment, the same percentage had systems that were not working and 65.4% had no system for chlorine treatment. 53% is managed by a Sanitation Board (which has legal status); and 47% is managed by Neighborhood Commissions. The number of users per well is variable, from 20 to 1,800 beneficiaries connected to the network. According to data provided by the office manager, these numbers have varied very little in the last two years (Justino Blanco, personal interview, 2020).

b) Paraguayan Sanitary Services Company - ESSAP: It is the second most important provider in the department of Concepción and reaches 11.28% of households in Concepción. It has two water treatment plants in the IIA [29]:

   – *Treatment Plant of Concepción:* Located in the area north of the departmental capital, it draws water from the Paraguay River and then distributes it to the city. It has a production capacity of 25,920 m3, to serve 31,245 inhabitants.

   – *Treatment Plant f Pedro Juan Caballero:* The production is 800 m3 of drinking water, which is distributed to about 6,500 users.

c) Private service: Supplies 8.33% of households in Amambay (EPH, 2017), less than 1% in San Pedro, and not registered in Concepción.

d) (d) Other sources: They include artesian well, well with or without pump, spring or river or stream, all in much lower percentage of use by the population of Concepción and San Pedro; while almost 30% of the population of Amambay obtains water from artesian wells and/or wells (EPH, 2017).

Sanitary Landfill

There is sanitary sewage service in the city of Concepción, provided by ESSAP; and it reaches some 3,742 users, approximately 23% of the population of the departmental capital. In May 2018, ESSAP presented the Preliminary Environmental Impact Report for the adaptation of the system, whose data are reproduced in this section[30].

The system has an estimated flow of 5,760 m3/d, which is much less than 1% of the natural flow of the river. It includes a network of pipes of approximately 48,020 m in length that collects the wastewater with the support of two pumping stations located in the center of the city of Concepción; and then discharges it underwater (through a final emissary of 150 m in length) to the Paraguay River 10 m from the bank. The discharge point is located about 600m south of the ESSAP raw water intake for the Water Treatment Plant. Its geographical coordinates in UTM are: 21K 453777; 7410868.

[29] www.essap.gov.py. Consultado el 05/02/2020
[30] ESSAP. Relatorio de Impacto Ambiental Preliminar. Emprendimiento "Adecuación Ambiental del Sistema de Alcantarillado Sanitario de la Ciudad de Concepción – ESSAP S.A.". Mayo, 2018.

On the other hand, MOPC is planning the construction of Wastewater Collection and Treatment Systems and Improvement of the Drinking Water System for the City of Horqueta[31], with effluent collection network and pumping station, within the framework of the Sanitation and Drinking Water Program for the Chaco and Intermediate Cities of the Eastern Region of Paraguay. The plant would be located within the city of Horqueta, and would benefit the city's urban population estimated at 13,222 inhabitants per year 2,016[32].

Garbage collection

In Paraguay, garbage collection is the responsibility of the municipalities.

In the Municipality of Concepción, garbage collection is a service provided by the Municipality that reaches 8,500 taxpayers (data 2016, Abc). For disposal, it has a landfill on a 22-hectare site located at kilometer 9 of Route PY05 "Gral. Bernardino Caballero". As indicated on the website of the Municipality of Concepción[33].

With respect to the other municipalities in the Area of Direct Influence, Belén does not have a garbage collection system, so most of the population proceeds to burn and others bury [34]. In Loreto, according to a publication by MSPYBS-CIRD[35], Only some houses in the urban area have access to the service provided by the Municipality and in rural areas, burning is used. Finally, in Horqueta, there is a collection service provided by the Municipality, but only a part of the houses in the urban area have access to it, while almost 90% of the houses resort to burning and a few others bury[36].

9.3.4.1.5.2 Education

In this section, statistical data related to the Project IIA population in terms of education (school, middle and university level) and number of institutions in the DIA districts are presented. With respect to universities, considering that several are located in more than one district, consolidated information is provided.

According to data from the DGEEC, the young population of the IIA (in general) has an average of more than 9.4 years of education. In Concepción, the average is 10 years and 10.8 years of study for women, the highest in the IIA. Table 31 presents information for each department and by age group.

Table 31 – Average years of study of the population aged 15-29, by department and gender – Year 2018

Department, gender and age group	Concepción		San Pedro		Amambay	
	Men	Women	Men	Women	Men	Women
Total	**10,0**	**10,8**	**9,4**	**9,9**	**10,0**	**10,2**
15 to 19	8,9	9,2	8,7	8,9	8,8	8,8
20 to 24	10,9	11,8	10,4	9,8	10,3	10,7

[31] MOPC Dirección de Planificación Vial. Resumen de Obras del MOPC en Concepción, San Pedro y Amambay. Agosto 2018-Diciembre2019.
[32] HYDEA-AESA-HIDROCONTROL Consortium Environmental Impact Assessment. "Construction of the Sanitary Sewage System and Effluent Treatment Plant in the City of Horqueta". Sanitation and Drinking Water Program for the Chaco and Intermediate Cities of the Eastern Region of Paraguay - MOPC. Loan Agreement 2589/BL-PR and GRT/WS-12928/PR. December 2017.
[33] https://www.municipalidadconcepcion.gov.py/ Consulted on February 5th, 2020
[34] MSPBS-CIRD. Plan Local de Salud. Belén. Period 2014-2016.
[35] MSPBS-CIRD. Plan Local de Salud. Loreto Period 2014-2016.
[36] MSPBS-CIRD. Plan Local de Salud. Horqueta. Period 2014-2016.

25 to 29	10,3	11,2	9,6	11	10,9	10,9

Source: DGEEC. EPHC 2017-2018

As indicated in DGEEC publications, the vast majority of the school-age population in the Department of Concepción attends an educational center (97.18% in 2017), with a gradual increase in both percentage terms and average years of study. The percentage of the population attending in 2017 is 97.18 per cent for children up to 14 years old; and, the average number of years of study for the population aged 10 and over is 7,61.

Table 32 – Main education indicators of the population of Concepción (% and absolute value)

	2003	2004	2015	2016	2017
Average years of study of the population 10 years and older	6,34	6,47	7,53	7,6	7,61
Assistance population 6-14 years old (%)	89,56	94,87	96,88	95,71	97,18
Assistance population aged 6-14 (absolute value)	44.994	50.466	53.779	52.599	51.736

Source: DGEEC. Encuesta Permanente de Hogares - Period 2003-2004-2015-2016-2017

With reference to the department of San Pedro, a situation with similar characteristics is presented: 88,204 people of school age attended educational centers in 2017; this represents 97.33% of the school population, with an average number of years of study of 7.21 (DGEEC, EPH 2017). In Amambay, although the absolute number of students attending an educational center is much lower (31,889 in 2017), the trend is maintained in percentage terms (97.48%) and the average number of years of study increases to 8.48 (DGEEC, EPH 2017).

Basic School Education

In the Department of Concepción, most of the institutions that offer Basic School Education (BSE) are official (398 institutions) and the private ones are subsidized (32 institutions)[37]. 79% of the institutions are located in rural areas. While 42% of all institutions offer all cycles (first, second and third cycle), the rest offer a combination.

In San Pedro, there are a total of 943 educational institutions that offer BSE; 87.7% of which are in rural areas and the rest in urban areas. Ninety-six percent of the institutions are public, and the rest are divided between private subsidized (2.86%) and private institutions.

In Amambay, 210 institutions offer BSE. 91.9% are public; 5.7% are private and the rest are subsidized private. Although most are located in rural areas (65.7%), the percentage of institutions in urban areas is higher than in Concepción and San Pedro (34%).

High School Education

There are a total of 111 institutions that provide secondary education in the Department of Concepción (data 2015[38]), 39 institutions are located in urban areas and 72 in rural

[37] DGEEC. Anuario Estadístico del Paraguay, 2017, p. 77-79
[38] DGEEC. Anuario Estadístico del Paraguay, 2017, p. 103, 104, 116, 117

areas. Of these, 106 offer the Scientific degree (38 in urban areas and 68 in rural areas); and 22 offer the Technical degree (13 in urban areas and 9 in rural areas).

In San Pedro, there are 49 institutions that offer high school education in urban areas and 222 in rural areas, while in Amambay there are 32 institutions in urban areas and 9 in rural areas.

In the three departments covered by the IIA, the vast majority of students enrolled in the Scientific Baccalaureate and only a smaller percentage enrolled in the Technical Baccalaureate, according to official data from 2015[39] included in Table 33.

Table 33 – Students enrolled in high school, by department and gender (year 2015)

	Scientific Graduation	Technical Graduation	Total
Concepción	**8.011**	**1.323**	**9.334**
Men	3.824	742	4.566
Women	4.187	581	4.768
San Pedro	**12.689**	**2.995**	**15.684**
Men	6.391	1.616	8.007
Women	6.298	1379	7.677
Amambay	**3.832**	**514**	**4.346**
Men	1.778	224	2.002
Women	2.054	290	2.344

Source: Elaborated by extern consult Lic. Caren Kremer and team based on data of DGEEC

As can be seen in table 33, both Concepción and Amambay have a slight majority of female students enrolled (51% and 54% respectively), while in San Pedro the situation is the opposite (49% are female).

Moreover, with respect to the area in which they enrolled, in both the department of Concepción and Amambay most students were enrolled in urban areas. While in San Pedro, almost a third of high school students are in rural areas (see table 34).

Table 34 – Students enrolled in high school by emphasis, according to department and zone (year 2015)*[40]*

	Scientific Graduation	B. on Industrial Technician	B. on Services Technician	B. on Farming Agricultural Technician	Total
Concepción	8.011	153	855	315	9.334
Urban area	4.359	131	713		5.203
Rural area	3.652	22	142	315	4.131
San Pedro	12.689	182	1725	1088	15.684
Urban area	3.826	93	1178	221	5318

[39] DGEEC. Anuario Estadístico del Paraguay, 2017, p. 103, 104, 116, 117
[40] DGEEC. Anuario Estadístico del Paraguay, 2017, p. 99, 100, 113

Rural area	8.863	89	547	867	10.366
Amambay	3.832	0	451	63	4.346
Urban area	3.542		451	50	4.043
Rural area	290			13	303

Source: Elaborated by extern consult Lic. Caren Kremer and team based on data of DGEEC

It is worth mentioning that while most of the students enrolled in the Scientific Baccalaureate (General), the second option of those enrolled was Technical Baccalaureate (emphasis on Services) in the year 2015.

Universities

In the Department of Concepción, there are several public and private university educational offerings, with a large concentration in the department's capital. The majority of the universities offer degrees in the humanities, with a deficit in the exact sciences.

Although there are many courses on offer, the quality of education is still low, and there is a great lack of infrastructure and adequate timetables. This can be seen, considering the low number of degrees accredited by the National Agency for Evaluation and Accreditation of Higher Education (ANEAES, in Spanish) in Table 35, compared to those offered by the various universities, in Table 36.

Table 35 – Universities, district and careers offered (original names)

University	Careers
Facultad de Ciencias Veterinarias UNA/ Subsidiary Concepción	Veterinary
UNC – Universidad Nacional de Concepción (distritos de Concepción, Horqueta, Yby Yaú, Loreto)	Dentistry, Agronomy, Agribusiness Administration, Agricultural Administration, Commercial Engineering, Business Informatics, Public Accounting, Administration, Medicine, Education Sciences, Social Communication, Psychopedagogy, Social Work, Applied Mathematics and Civil Engineering.
Universidad Nacional de Asunción/Facultad de Enfermería y Obstetricia Concepción	Nursing and the Obstetrics
Universidad Católica Nuestra Señora de la Asunción - Campus Concepción	Business Administration, Law, Accounting and
Uninorte/Concepción	Business Administration, Rural Administration, Accounting Sciences,
Universidad San Carlos (Horqueta)	Law, Notary Public, Commercial Engineering, Psychology and
UPAP – Universidad Politécnica y Artística del Paraguay. Concepción Horqueta	Nursing, Midwifery, Law, Education Science, Psychology, Physical Education, Art Education, Accounting, Business Administration, Electronic Engineering, Industrial Engineering, Architecture Kinesiology and Physiotherapy, Medicine, Criminalistics, Criminology, Pharmacy, Nutrition and University Education
UTCD – Universidad Técnica de Comercialización y Desarrollo. Concepción Loreto	Environmental Engineering, Kinesiology and Physiotherapy, Sports Science. Education Sciences, Nutrition, Psychology, International Trade and University Didactics

University	Careers
Horqueta	
UTIC – Universidad Tecnológica Intercontinental Concepción Horqueta	Computer Systems Engineering, Accounting, Administrative Sciences, Education Sciences, Computer Systems Analysis and Nursing
Universidad Autónoma San Sebastián Concepción Horqueta	Agronomy, Physical Education, Education Sciences, Law, Public Notary, Computer Systems Analysis, Production, Business Administration, Agricultural Administration, Accounting, Commercial Engineering, Nursing, Nutrition, Veterinary Medicine, University Didactics and Thesis Tutoring.
Concepción	Nursing/Kinesiology/Physiotherapy, Pharmacy/Radiology/Chemistry and Pharmacy/Clinical Laboratory, Nutrition/Psychology/Obstetrics, Biochemistry
Universidad Privada del Guairá Horqueta Vallemí Yby Yaú	Law, Agronomy and Accounting

Source: Prepared by the external consultant Lic. Caren Kremer and team.

According to ANEAES, the following careers are qualified:

Table 36 – Careers accredited by ANEAES, department of Concepción

University	College	Career
UNC – Universidad Nacional de Concepción	Agricultural Sciences	Agronomic Engineering
	Agricultural Sciences - Horqueta	Agricultural Administration
	Humanities and Educational Sciences	Educational Sciences
	Dentistry	Dentistry
	Health Sciences	Medicine
	Economic and Administrative Sciences	Public Accounting
UNA – Subsidiary Concepción	"Instituto Dr. Andrés Barbero"	Nursing
	College of Veterinary	Veterinary
UCA – Campus Concepción	Accounting, Administrative and Computer Science	Public Accounting
		Business Administration
	Law and Diplomatic Sciences	Law
UTIC – Universidad Tecnológica Intercontinental	Health Sciences - Horqueta Headquarters	Nursing

Source: Elaborado por la consultora externa Lic. Caren Kremer y equipo según datos de la ANEAES, 2019.

In line with the professional orientation (and probable employment) in the department of Concepción, the veterinary career at the UNA received the highest number of students enrolled in 2017, doubling the number of students enrolled in nursing and accounting. The data can be seen in Table 37.

Table 37 – Enrolled in Concepción – Year 2017

University/College	Career	Enrolled	Period of time
UNA - Facultad de Ciencias Veterinarias	Veterinary	440	6 years
UNA - Instituto "Dr. Andrés Barbero"	Nursing	215	5 years
	Obstetrics	97	5 years
UCA – Facultad de Ciencias Jurídicas	Law	172	6 years
UCA - Facultad de Ciencias Contables, Administrativas Y Económicas	Accounting Sciences	213	5 years
	Administrative Sciences	95	5 years
UCA – Facultad de Ciencias de la Educación	Teaching in Higher Education	61	1 year (Specialization)

Source: Elaborado por la consultora externa Lic. Caren Kremer y equipo según datos de la DGEEC, 2017.

Table 38 presents the number of graduates in a range of 4 years.

Table 38 – Number of graduates in Concepción according to university, faculty, career years 2013 to 2016

University/College	Career	Number of graduates			
		2013	2014	2015	2016
UNA - Facultad de Ciencias Veterinarias	Veterinary	58	57	58	63
UNA - Instituto "Dr. Andrés Barbero"	Nursing	24	50	25	60
UCA – Facultad de Ciencias Jurídicas	Obstetrics	n/d	n/d	16	17
UCA - Facultad de Ciencias Contables, Administrativas Y Económicas	Legal Sciences	n/d	n/d	16	15
	Accounting Sciences	n/d	n/d	9	14
UCA – Facultad de Ciencias de la Educación	Administrative Sciences	n/d	n/d	15	17
	Educational Sciences	n/d	n/d	11	15
	Social Work	n/d	n/d	37	33

Source: Prepared by the external consultant Lic. Caren Kremer and team according to DGEEC data, 2017.

Educational institutions in DIA

According to the Municipal Development Plan of each municipality (2016), Concepción has 60 educational institutions in urban areas and 50 in rural areas; Belén has 3 educational institutions in urban areas and 22 in rural areas; and Horqueta has 20 educational institutions in urban areas and 113 in rural areas. In Loreto, the Local Health Plan provides for 9 national schools and 32 basic schools.

In the Department of Concepción, professional training courses are provided by the government through the SINAFOCAL and the SNPP. In 2018, according to its management report, SINAFOCAL gave nine courses on various subjects, benefiting 234 men and 142 women. In the Northern Zone (Concepción, San Pedro, Amambay, Canindeyú) 33 courses were given that year, constituting 7.7% of the total number of courses given in the country.

9.3.4.1.5.3 Health

This section presents statistical data related to the population of the Project's Indirect Influence Area, in order to measure the demand for health services. Next, information related to the services available in the Project's DIA is provided.

In Concepción and San Pedro, in 2018, a little more than 50% of women showed up for a medical consultation, while the average drops to 46.5% in Amambay. With respect to men, the averages remain below 50% in the three IIA departments, with the lowest average in Amambay and the highest in San Pedro.

Table 39 presents data related to the health status of the population in each department, recording whether they presented themselves for at least one medical consultation, either due to illness or accident, during 2018.

Table 39 – Total population, by department, gender and health status (%) Year 2018

Department, gender and health status	Concepción		San Pedro		Amambay	
	Men	Women	Men	Women	Men	Women
Total	**124.338**	**123.357**	**225.411**	**199.370**	**80.534**	**86.478**
Sick/Accident (%)	44,1	51,2	46,6	51,1	39,5	46,5
Healthy (%)	55,9	48,8	53,4	48,9	60,5	53,5

Source: DGEEC. EPHC 2017-2018

According to data from the 2017 statistical yearbook, there were 214 hospital beds in the Department of Concepción. In 2015, 70,842 medical and dental consultations were made at the IPS, and in 2016, a total of 70,477.

In 2018, 1,154 deaths were recorded, of which 17% were due to diseases of the circulatory system; 11.6% were due to tumors; 9.4% to diseases of the respiratory system; 7.9% to various types of accidents; and 7.4% to cerebrovascular diseases. The remaining deaths were for other reasons. 61.3% of the deaths were recorded in persons over 60 years old. According to MSPBS records, in 2017 there were 29 deaths from motorcycle accidents in the Department.

On the other hand, according to data from the DGEEC, only a small proportion of the population of the Department of Concepción has health insurance, either private or from the IPS. Thus, while records indicate a slight increase to 16.52 per cent coverage in 2015, in recent years for which data are available the trend remains at less than 15 per cent of the population. However, the records indicate relatively high percentages of the population who came to consult for illness or accident. Table 40 provides data in this regard.

Table 40 – Main health indicators of the population of Concepción per year in % and absolute value o

	2003	2004	2015	2016	2017
In percentage					
Population with health insurance coverage (1)	12,02	13,94	16,52	14,2	14,72
Access to health (2)	63,79	53,03	79,5	78,4	71,48
In absolute terms					
Population with health insurance coverage (1)	23.898	28.069	39.146	34.139	35.936
Access to health (2)	15.337	21.299	55.999	82.696	92.788

(1) Includes IPS and other insurance.

(2) Includes the sick or injured population who consulted.

Source: DGEEC. Permanent Household Survey 2003-2004-2015-2016-2017

In the district of Concepción and neighboring areas, the Volunteer Fire Department of Concepción is the entity that helps people who have suffered various types of accidents. However, according to conversations held with the entity's representatives, this type of service could be affected by the lack of budget, since they have difficulty covering the cost of these.

After that is presented the main findings of "Indigenous Component Study: 2nd Phase" elaborated by Natan Foundation, related to health.

In terms of health, alcoholism is a predominant issue at the country level. According to data provided by MSPBS (2016), 50.9% of the population consumes alcoholic beverages and 24% consume it excessively. Harmful alcohol consumption affects both consumer and family health, becoming a social problem that triggers economic damage to society and the state. Although the impact assessment did not identify the existence of alcoholism among indigenous families, it cannot be assumed that it does not exist; therefore, it is a factor that should be added to any health and wellness program directed to these communities, since alcoholism can cause physical and social damage and is a risk factor for other conditions such as violence against women and traffic accidents.

In the field was observed that rural indigenous communities have serious difficulties in accessing health centers to receive quality medical and dental care for reasons such as distance, quality of roads, and lack of vehicles.

Adolescent pregnancy is a common denominator in indigenous communities, especially in rural areas, where pregnant girls and adolescents must give birth to their children in the same communities, putting mothers and their children at risk. According to data collected on the baseline of this birth study, 11% of babies were stillborn or died before their first month of life. 89% of babies are born in their indigenous community and do not have adequate hygiene and health conditions, nor the necessary professional staff to reduce the risk of accidents during childbirth to ensure the well-being of the mother and baby.

Young women reported using natural contraceptive methods based on "yuyos" or native herbs because they have to travel long distances to reach health centers and because of the lack of quality sexual education. However, the rate of children per woman is 3.97 children in the communities within the DIA. In addition, some women report having 9 to 10 or even 12 children, indicating that the contraceptive methods they use have a low level of efficacy. Likewise, the non-use of contraceptive methods such as condoms increases the risk of contracting sexually transmitted diseases (STDs). According to the MSPBS (2016) only 3.76% of indigenous people usually use condoms in their sexual relations.

The high number of children per family and the limited capacity to provide adequate food for all of them has a direct impact on the nutrition of the children and the overcrowding in which many families live, perpetuating the cycle of poverty in which the vast majority of indigenous families find themselves.

it is important to note that the increase in population density in the city of Concepción, the economic growth of the department and the conditions of vulnerability in which many indigenous children and adolescents live, suggest that some of them could be at risk of child sexual exploitation. Britos (2002) found some characteristics related to the profile of children and adolescents at risk of child sexual exploitation, which is: be underage, having at least 4 younger siblings, dropping out of school, difficulty in finding employment, alcohol consumption, tobacco use, and drug use, among others. According to the information gathered in the fieldwork, specifically in the rural sector, the need for security and the high school dropout rate of children and adolescents indicate that many of the underage children are working on the farm from a very early age, which could be accentuated if there is no proper control and monitoring of the hiring practices of PARACEL's suppliers in its value chain.

The care of children and adolescents is a priority for any public or private project, so it is recommended that PARACEL allocate specific efforts to prevent the development of exploitation and abuse of children in all its forms, with emphasis on the prevention, and mitigation of sexual exploitation, human trafficking and labor exploitation.

9.3.4.1.5.4 Safety and justice

This section contains information on security in the Project IIA. It first provides data related to violence and criminality, then details on justice and the institutions involved in the processes. More information about that will be presented later.

The content on crime and victimization in this section was taken from the Atlas of Violence and Insecurity in Paraguay (2018), which collects and analyzes objective data on insecurity from National Police records between 2010 and 2017; and from the National Victimization Survey 2017. Information is collected at the departmental level in some cases, when clarified as such, all other data mentioned correspond to the northern zone comprising Concepción, San Pedro and Amambay.

The rate of intentional homicides recorded per 100,000 inhabitants between 2010 and 2017 in the Department of Concepción was 18.85, while the hidden figure for crimes (the portion of crimes reported by victims in the National Victimization Survey that are not recorded by the institutions responsible) in the northern region is 71.4%. All three departments have declining rates of homicide registration, yet it is the region with the highest homicide rate in the country. Table 41 presents data for the three departments of the IIA, for the period 2010-2017.

Table 41 – Rate of intentional homicides per hundred thousand inhabitants, by department, years 2010-2017

Homicides	2010	2011	2012	2013	2014	2015	2016	2017
Concepción	27,3	25,24	22,64	27,42	20,56	18,99	17,05	18,85
Amambay	85,37	78,1	86,78	78,73	67,03	77,86	82,17	70,53
San Pedro	16,79	16,17	15	13,83	13,11	14,41	13,99	7,63

Source: Atlas of Violence and Insecurity in Paraguay - 2018.

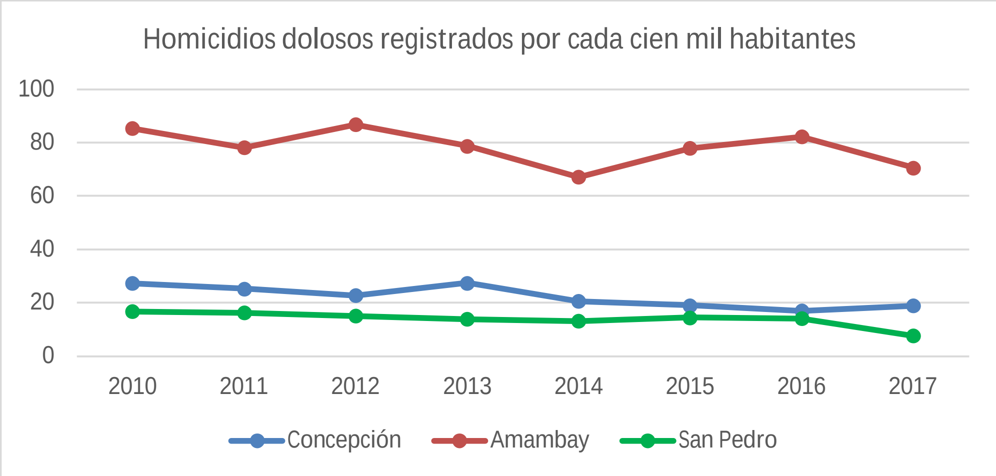


Figure 8 – Evolution of the number of intentional homicides per hundred thousand inhabitants in the departments

Source: Prepared by the external consultant Lic. Caren Kremer and team with data from the Atlas of Violence and Insecurity in Paraguay – 2018.

In terms of property offences, they have declined in all three departments. Compared to 2010, in 2017 Concepción had a 40% decrease, although in 2013 it had a much higher peak than the average for those years. As for Amambay, they decreased by 50% in 2017 compared to 2010; however, in 2011 there was a higher peak. The same situation occurred in the department of San Pedro in relation to the percentage decrease in punishable acts and the peak recorded, as shown in Table 42.

Table 42 – Property offences, by department, years 2010-2017

Property offences	2010	2011	2012	2013	2014	2015	2016	2017
Concepción	141,76	138,28	134,79	171,36	104,09	106,35	118,09	82,76
Amambay	315,94	475	357,45	335,6	265,57	146,93	148,27	165,39
San Pedro	155,63	190,98	130,52	120,05	121,94	135,81	108,56	75,3

Source: Prepared by the external consultant Lic. Caren Kremer and team with data from Altas de la violencia e inseguridad en Paraguay - 2018.

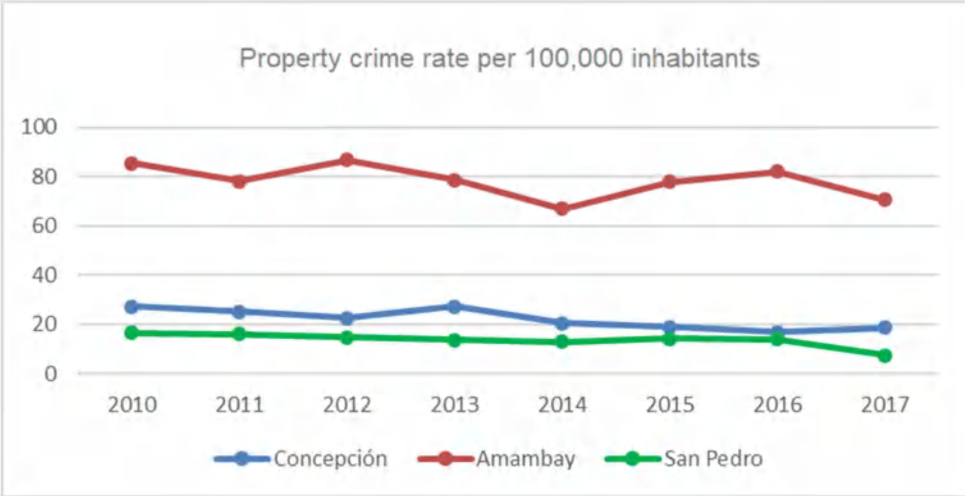


Figure 9 – Property crime rate per 100,000 inhabitants in the departments

Source: Prepared by the external consultant Lic. Caren Kremer and team with data from Altas de la violencia e inseguridad en Paraguay - 2018.

With regard to victimization of the population, in the northern zone (i.e., the three departments of the IIA), 18.2 per cent of the population has been the victim of crimes against the home, with burglary being the most recurrent event. With regard to the victimization of crimes against persons, extortion is the most frequent event with 18%. The highest percentage is observed in the victimization of corruption with 97.3%.

9.3.4.1.5.5 Infrastructure and the accessibility

This section describes the main access routes to the Project's Area of Influence. The information is organized in the following three sections: ports, airports and road infrastructure.

Main ports on the Paraguay River

The Paraguay River is one of the access routes to the Department of Concepción; and to the area prospected for the industrial component of the project. The Local Health Plan of Concepción indicates that the following ports are located along its banks, north of Concepción:

- Concepción Port
- Vallemí Port
- Risso Port: port Calero, produce lime.
- Fonciere Port: It is characterized by an important viewpoint and a large house dating from 1927.
- Max Port: Port “Tres Ollas” (Three Waves). Currently a cattle establishment, in front of Puerto Pinasco.
- Itapucumí Port: Used by the cement and lime factory, in front of Puerto Pinasco.

- Puerto Arrecife: With dangerous reefs during the river's descent, it is ideal for dorado fishing.
- Abente Port: Livestock port of estancias, near the Napegue stream.
- Pagani Port: Today abandoned.
- Negro Port: Used by estancias.
- Algesa Port: Used for loading and unloading of cargo and freight.
- Old Port: Used for embarkation of passengers and minor cargo.
- Itapuá Port: North of Puerto Fonciere, used by caleras.
- Guyrati Port: Used by the lime factory, located about 10 km from the Itacuá Port.

Although the Concepción Municipal Development Plan states that "despite having a port, river traffic has declined compared to its beginnings", a large part of the region's production of limestone products and grains is moved through the ports. Another company that has bet on the waterway is Frigorífico Concepción, which has invested in private ports to facilitate and reduce the cost of transporting livestock. In addition, the Paraguay River and its ports are a means of transport, communication and trade used by the inhabitants of the riverside communities located north of Concepción, which are often isolated by the rains.

Airports

In the Department of Concepción, there are 2 airports with limited infrastructure and which are rarely used:

- Airport "Tte. Cnel. Carmelo Peralta" – City of Concepción
- Airport "Dr. Juan Plate" - San Lázaro.

On the other hand, there are several airstrips located in the IIA, mainly in farming installations.

Road Infrastructure

For more than 50 years, the road network of Paraguay was composed of 12 national routes, the departmental and municipal. In May 2019, the Ministry of Public Works and Communications (MOPC) has classified and restructured the conformation of the National Road Network, increasing the number of national routes to a total of 22, as can be seen in Figure 12.

According to information published by the MOPC[41], the road network in the department of Concepción totals 3,213 km of national, departmental and local roads and routes, 19% of which are paved. In San Pedro, the road network reaches 5,806 km, of which 18% are paved, and in Amambay, there are 2,666 km of road network, of which 12% are paved. These data are provided in Table 43.

[41] Available at: https://www.mopc.gov.py/mopcweb/index.php?cID=769 examined on January 23th 2020.

Figure 10 – National Road Network
Source: MOPC - Road Planning Department

Table 43 – Road network by department by type

Type of road	CONCEPCION		SAN PEDRO		AMAMBAY	
	Paved (km)	No Paved (km)	Paved (km)	No Paved (km)	Paved (km)	No Paved (km)
National	383,73	20,52	583,68	116,97	207,37	134,92
Departmental	97,8	327,51	268,54	193,45	40,03	343,58
Local	134,88	2248,16	199,13	4444,05	62,85	1877,04
Type of road	**3213**		**5806**		**2666**	
% paved	19%		18%		12%	

Source: MOPC - Road Planning Department (data from July 2019)

As can be seen in figure 12, the following three national routes pass through the Project IIA:

Route PY05: From EAST to WEST, with a length of 577 km It begins in the city of Pedro Juan Caballero (Amambay), located on the border with Brazil; it crosses the department of Concepción via the city of Concepción; it crosses the Paraguay River via the Nanawa Bridge and continues in the department of Villa Hayes until it reaches Fortín Pilcomayo, on the border with Argentina.

Route PY22: From South to North, with a length of 424 km. It starts in San Estanislao (San Pedro) in the junction with Route PY03; passes through the cities General Aquino, Villa del Rosario, San Pedro del Ykuamandiyú; enters the department of Concepción by the city of Belén, passes through Concepción, Loreto, San Alfredo and ends in San Lázaro.

Route PY08: From South to North, with a length of 588 km. It starts in Coronel Bogado (Itapua), at the junction with Route PY01, passes through the departments of Caazapá, Guairá, Caaguazú, enters San Pedro through San Estanislao: continues to Yby Yaú in Concepción and then to Bella Vista Norte in Amambay.

Figures 13 and 14 show in more detail the road network of the department of Concepción, indicating the type of paving of the roads and routes.

On the other hand, several routes and local roads link the locations of the Project's IIA, some of which are currently undergoing improvements in the framework of the National Program of Local Roads and Bridges, executed by the MOPC in most of the country's departments. In the IIA, this program proposes interventions to improve bridges and roads according to the summary provided in Table 44 below[42].

Figure 11 – National Routes in the IIA

Fuente: MOPC – Road Planning Department

[42] MOPC/DGSA-BID. Preliminary Environmental Impact Assessment. Local Roads Improvement Program - Eastern Region (PRL-1084). 2015.

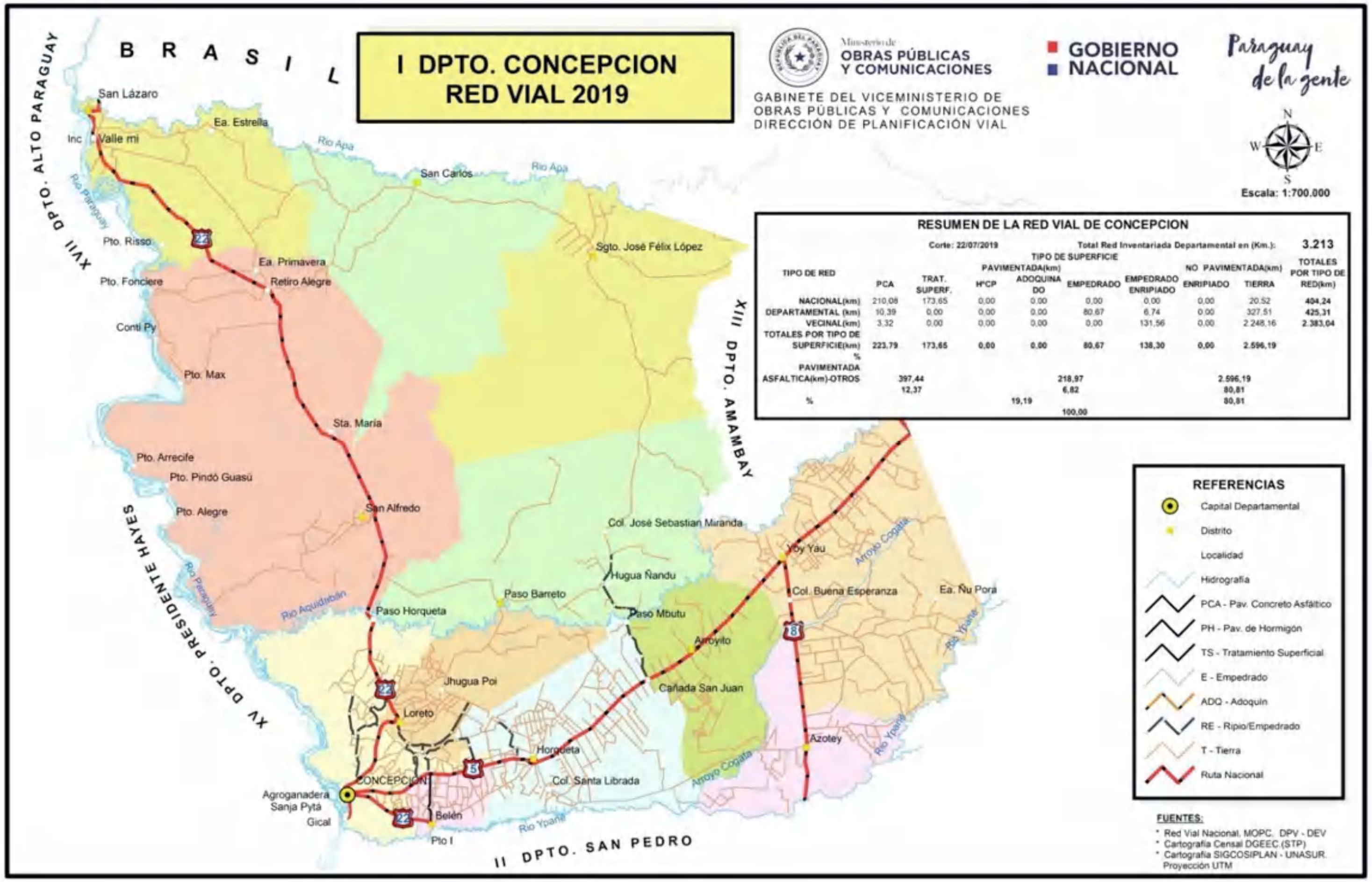


Figure 12 – Road network in the department of Concepción
Fuente: MOPC – Dirección de Planificación Vial

Table 44 – Bridges and roads being improved in the IIA

Department	Bridges		Roads
	Bridges (number)	Longitude (M.L.)	
Concepción	11	119	Concepción
San Pedro	11	200	San Pedro
Amambay	8	86	Amambay

Source: MOPC

Figure 15, extracted from the Preliminary Environmental Impact Study of the Program, shows the works and their location, in the department of Concepción.

With the execution of these works on access roads in the department, it is possible to perceive an increase in road connectivity in the intervention areas, especially in the areas where gravel roads were transformed into asphalt roads. This allows for an increase in traffic, including cargo trucks, and a reduction in transfer times.

With respect to the Project's DIA, more specifically in Concepción, the MOPC is carrying out construction, improvement and maintenance activities of the access roads; in addition to building bridges and water systems in support of the communities. According to information provided by the MOPC's Road Planning Directorate, the main works in progress in the Project's Area of Direct Influence are those detailed in Table 45.

CONCEPCIÓN				
ORIGEN - DESTINO	Largo (m)	Ancho (m)	Tipo	Coordenadas UTM
Paso Barreto-Cruce X	30,0	4,0	PM	21K464281 7456246
RUTA V KM 21 - LAS PALMAS	7,0	3,0	PM	21K471782 7419193
CURUZU ÑU - ROBERTO L. PETIT	6,0	4,0	PM	21K458340 7430807
COSTA PUCU - MBOCAYATY	12,0	3,0	PM	21K459379 7425970
CONCEPCIÓN - MARIA AUXILIADORA	6,0	5,0	PM	21K460058 7412237
RUTA V - CALLE 12 NORTE	5,0	4,0	PM	21K508322 7439014
	6,0	4,0	PM	21K512919 7433374
RUTA V - CALLE 9 NORTE	20,0	3,0	PM	21K508006 7429573
RUTA V - CALLE 20 NORTE	6,0	4,0	PM	21K524506 7444456
	10,0	4,0	PM	21K526683 7441681
YBY YAU - COL. MEDALLA MILAGROSA	11,0	4,0	PM	21K551330 7458412
TOTAL	119,0			

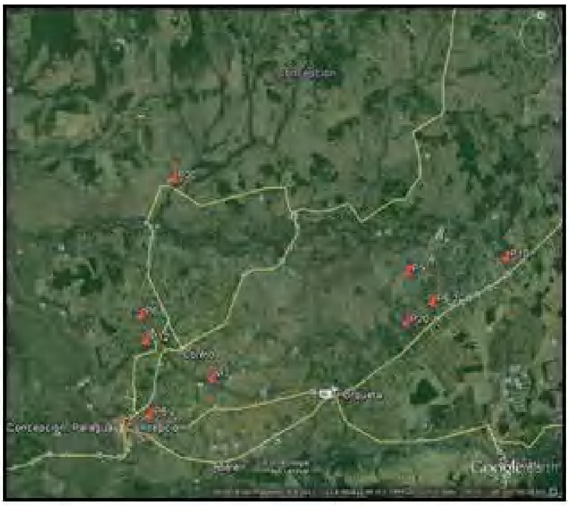


Imagen Satelital - Puentes Departamento de Concepción.

Figure 13 – Description of road works and their coordinates in the department of Concepción

Source: MOPC

Table 45 – Current infrastructure works in the project's DIA (2019)

Type	Current works	Longitude
Asphalt Paving	Section Concepción - Puerto Vallemi and Access to Concepción (1,5 km) and Variante (4,75 km)	6,25 km
Asphalt paving on cobblestone	Section Horqueta - Ypané River (Tacuatí) (Lot 1)	39 km
	Section Route 5 - Jhugua Ocampos - Ykua Jhovy - San Blas. 5th Tanda. Lot 3	17,56 km
	Section Loreto - Las Palmas - San Blas - Route 5. 5th Road Management Band. Lot 6.	15,1 km
Rehabilitation and maintenance contract	Road 3. Route PY05 Section Concepción - Pozo Colorado Km 372+260 to Km 416+222. Lot 3	44 km
Rehabilitation and maintenance	Route PY05. Section: Concepción - Yby Yaú (109 km). Lot2	109 km
Sanitary sewage works	Construction of sanitary units for communities benefiting from the sanitary sewerage project for cities in the Eastern Region	
Treatment plant	Wastewater collection and treatment systems and improvement of the drinking water system for the city of Horqueta	

Source: MOPC- Dirección de Planificación Vial

9.3.4.1.5.6 Means of Transportation

This section includes descriptions of the main means of transport available to the population of the Project's Area of Direct Influence: river, air and land transport.

River transport

The Paraguay River is navigable by vessels of greater draught, on the stretch from the confluence with the Paraná River to Asunción; on the stretch from Asunción to Corumbá (Brazil) and passing through all the ports of the Department of Concepción, medium-sized vessels can navigate[43]. As already presented, it is largely used by vessels transporting grain, lime, cement and livestock. Its tributaries, the Apa, Aquidabán and Ypané rivers, are navigable only by small boats[44].

The ship Aquidaban is considered an important means of transport, especially for the most isolated areas. This vessel transports products for sale and passengers between Concepción and Bahía Negra. It has a weekly frequency, leaving on Tuesdays from Concepción and the trip lasts 3 days out and 3 days back. It makes stops at all the ports in the department of Concepción and several riverside communities to offer its goods and to allow passengers to board and disembark.

Some boats offer their services for recreational purposes (trips and fishing), departing from Concepción: Boat Ten Caten, Boat Seven Cabrillas, Boat Santa Filomena, Freshwater Yacht, Yacht Cayman, Yacht El Dorado.

[43] MOPC-OPS/OMS. Update of the Paraguayan Water and Sanitation Sector Analysis. 2010.
[44] Municipal Development Plan. Concepción

Air Transport

The Military Air Transport Service (SETAM) is authorized to carry out flights for the transport of passengers; and has the resolution of approval of the current price list. The planned route includes departures from Asunción to Concepción, Puerto Casado, Vallemí, Fuerte Olimpo and Bahía Negra, with 2 weekly frequencies. This service was authorized by Resolution in April 2019, and there are no statistics available.

The lack of adequate airport infrastructure could be a factor in the lack of growth in this service segment in the Department of Concepción.

Terrestrial transport

The city of Concepción is relatively well connected by land with other major cities in the northern region of the country, and with Asunción. In general, transport companies only provide services to towns and cities located on national routes, without entering communities far from them. Table 46 lists the transport companies that provide daily services to other cities from Concepción.

Table 46 – Land transport companies from and to Concepción

Destination / Origin	Transport companies
Asunción	Norte Poty SRL
	NASA
	La Ovetense
	La Santaniana
Pedro Juan Caballero	Ciudad de Concepción S.A.
	Transporte y Turismo Ligero SRL
Vallemí	NASA
	Transporte y Turismo Ligero SRL

Source: Prepared by the external consultant Lic. Caren Kremer and team

The transport companies that provide services on the route to Vallemí also ensure the transport of passengers between Concepción and Loreto. While the companies that go to Asunción (by Route PY05) and Pedro Juan Caballero provide services to the inhabitants of Horqueta. With regard to the connection with the city of Belen, a local company called Puerto Ybapobo provides services to that city through Belen.

The city of Concepción has not had any urban public transport services (buses) for several years now. According to local digital media "motorcycles have displaced the company that was dedicated to this area a decade ago"[45].

In fact, most of the people who live in the Department of Concepción travel by motorcycle. This can be verified by simple observation on a tour of the city of Concepción and the surrounding districts. This preference for motorcycles is also evident in the number of vehicles available. The following table provides a summary of the number of authorized vehicles in the three departments of the IIA.

[45] Concepción Noticias. http://www.concepcion-py.com/2016/05/concepcion-esta-sin-transporte-urbano.html

Table 47 – Number of authorized vehicles by type, according to department (2017)

Department	Total	Motorcycle	Automobile	Vans	Trucks	Buses	others
Concepción	33.852	20.079	2.589	2.127	1.227	132	7.698
San Pedro	46.765	18.197	4.617	3.765	2.461	214	17.511
Amambay	49.475	26.030	6.105	2.918	1.538	160	12.724

Source: DGEEC, Anuario Estadístico, Año 2017.

In Concepción, almost 60% of the authorized vehicles are motorcycles, far exceeding the number of cars and vans (14%). The trend is similar in San Pedro and Amambay.

9.3.4.1.5.7 Information and Communication Technologies (ICTs)

This section presents information related to the population's access to Information and Communication Technologies (ICTs). First, statistical data on Internet access are presented, then cell phone and/or personal computer ownership, and finally data on telephone line access.

According to data from the Permanent Household Survey, less than half of the population of 10 years or more in Concepción had access to the Internet in 2017, the percentage is even lower in San Pedro (almost 38%). The population of Amambay had the most access with almost 65%.

Table 48 – Population of 10 years old or elder by gender, according to internet use (%)

	Concepción			San Pedro			Amambay		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Total	186.627	86.734	99.893	330.995	172.399	158.596	127.915	62.230	65.685
Used	46,05	47,07	45,17	37,63	39,16	35,96	64,61	62,57	66,55
Not used	53,95	52,93	54,83	62,37	60,84	64,04	35,39	37,43	33,45

Source: DGEEC. Permanent Household Survey 2017

As it can be seen in table 49, almost the totality of the internet accesses was made from a cell phone. Secondly, "at home" is indicated with slightly higher percentages than "at work". This use preference is common to all three departments and to both genders.

Table 49 – Population of 10 years old or elder who used the Internet by gender, according to place of access (%)

	Concepción			San Pedro			Amambay		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Total	85.946	40.826	45.120	124.537	67.503	57.034	82.648	38.936	43.712
At home	9,31	(*)	10,75	8,06	(*)	8,67	18,58	19,97	17,35
At work	9,14	(*)	(*)	6,88	(*)	(*)	14,89	17,12	12,9

In educational institution	8,14	(*)	(*)	4,76	(*)	(*)	7,34	7,82	6,91
At someone else's house	5,81	(*)	(*)				5,04	(*)	(*)
In a community access location							3,2	(*)	(*)
Through a cell phone	97,07	97,55	96,63	98,65	97,74	99,72	98,35	98,32	98,37

Source: DGEEC. Encuesta Permanente de Hogares 2017

The above figures are directly related to the ability of households to access durable goods, especially mobile phones and computers, notebooks or similar equipment. According to data from 2017, in Concepción, 96.63% of households have a cell phone and 11.88% have a computer/notebook, while 9.35% have access to the Internet[46]. In San Pedro 95.97% of households have a cell phone; 8.62% have a computer and 6.83% have access to the Internet.[47] In Amambay 98.46% of households have a cell phone; 24.79% have a computer (7.25% tablet or similar) and 18.60% have access to the Internet [48].

With regard to telephone line connection in Concepción 5.4%[49] of households have a fixed telephone line while in San Pedro the figure is 4.21% and 11.45% in Amambay.

9.3.4.1.5.8 Media

This section presents the main means of communication available in the Project's IIA, and those in the Department of Concepción.

According to data reported by CONATEL in 2017, there are 8 licensed commercial FM broadcasting stations and 5 licensed AM broadcasting stations in the Department of Concepción. There are also 13 TV broadcasting stations in the department. Table 50 presents the data corresponding to the 3 departments. [50]

Table 50 – Number of broadcasting stations and TV services, according to department. Year 2017

	Concepción	San Pedro	Amambay
Broadcasts Radio FM	8	9	8
Broadcasts Radio AM	5	2	4
Broadcasts TV stations	13	11	6

Source : CONATEL. Note PR N. 1138/2017

[46] DGEEC. Tríptico Encuesta Permanente de Hogares – EPH 2017 – Departamento Concepción – Agosto 2018
[47] DGEEC. Tríptico Encuesta Permanente de Hogares – EPH 2017 – Departamento San Pedro – Agosto 2018
[48] DGEEC. Tríptico Encuesta Permanente de Hogares – EPH 2017 – Departamento Amambay – Agosto 2018
[49] DGEEC. Resultados Anuales Departamentales – EPHC 2017-2018.
[50] National Telecommunications Commission CONATEL. PR Note N. 1138/2017. Received by the House of Senators on 07/07/2017

The following tables 51, 52 and 53 include details of the main media in Concepción, according to type of media:

Table 51 – Broadcast FM radio stations - department of Concepción

	Code	Station	Licensee	Frequency (MHz)	Location	N Decree / Resolution	Date (D/M/Y)
1	ZPV 36	Ita Porá FM	Integración S.A	98,9	Vallemí	587/00	01/09/2000
2	ZPV 45	Aquidabán	María R. Cristaldo Leguizamón	100,5	Concepción	3881/94	25/05/1994
3	ZPV 48	Los Ángeles FM	Liz Naida Giménez Ramos	89,9	Horqueta	1077/2002	03/09/2002
4	ZPV 65	Continental FM	Cesar Raúl Coelho de Souza Ibarra	95,3	Horqueta	9084/91	04/04/1991
5	ZPV 184	Norte Comunicaciones	José Alberto González Mármol	94,5	Concepción	397/99	09/09/1999
6	ZPV 478	Kaagata Publicidad 100.3 MHz	Nilda Concepción Canale de Silva	100,3	Yby Yaú	1692/2004	02/12/2004
7	ZPV 509	GlobalMix FM	José Adalberto Pavón	95,9	Concepción	901/2010	26/08/2010
8	ZPV 510	La Favorita FM	Noelia Rocío Irala Insfrán	93,3	Yby Yaú	901/2010	26/08/2010

Table 52 – Broadcasts radio stations AM – department of Concepción

	Code	Station	Licensee	Frequency (MHz)	Location	N Decree / Resolution	Date (D/M/Y)
1	ZP 8	Radio Concepción	Sergio Enrique Dacak	1380	Concepción	1290/89	27/06/1989
2	ZP 37	Radio Yby Yaú	Reichardt	1360	Yby Yaú	29291/88	20/07/1988
3	ZP 74	Radio Regional AM	Myryan Stella Bareiro de Denis	660	Concepción	1138/2012	25/08/2012
4	ZP 29	Radio Vallemí	Industria Nacional del Cemento	1450	Vallemí	1290/89	27/06/1989
5	ZP 42	Radio Guyra Campana	Guyra Campana SRL	1420	Horgueta	1290/89	27/06/1989

Table 53 – TV Broadcasting Services – department of Concepción

	Code	Station	Licensee	Frequency (MHz)	Location	N Decree / Resolution	Date (D/M/Y)
1	ZPD 277	Rep. Telefuturo - Ch 3+	Repetidora	TV Acción S.A.	Yby Yaú	10089/95	12/08/1995
2	ZPD 272	Rep. Telefuturo - Ch 9+	Repetidora	TV Acción S.A.	Concepción	10089/95	12/08/1995

	Code	Station	Licensee	Frequency (MHz)	Location	N Decree / Resolution	Date (D/M/Y)
3	ZPD 315	Rep. Red Guarani - Ch 18	Repetidora	Tevedos S.A.	Concepción	1292/2008	24/12/2008
4	ZPD 294	Est. Base Canal 40 TV Concepción - Ch 40	Estación Base	Televisión Concepción S.A	Concepción	577/2006	17/05/2006
5	ZPV 927	Rep. SNT Cerro Corá - Ch 11	Repetidora	Televisión Cerro Corá S.A	Concepción	15858/92	21/12/1992
6	ZPD 683	Rep. SNT Cerro Corá - Ch 12+	Repetidora	Televisión Cerro Corá S.A	Vallemí	177/2011	03/02/2011
7	ZPD684	Rep. SNT Cerro Corá - Ch 13	Repetidora	Televisión Cerro Corá S.A	Yby Yaú	177/2011	03/02/2011
8	ZPV 914*	Rep. EI 13 - Ch 7	Repetidora	Unicanal S.A.	Concepción	9948/91	18/06/1991
9	ZPV 910*	Rep. EI 13 - Ch 10	Repetidora	Unicanal S.A.	Vallemí	9948/91	18/06/1991
10	ZPD 675	Rep. Paravisión - Ch 4+	Repetidora	Paravisión S.A	Vallemí	177/2011	03/02/2011
11	ZPD 651	Rep. Paravisión - Ch 5	Repetidora	Paravisión S.A	Concepción	12938/96	12/04/1996
12	ZPD 676	Rep. Paravisión - Ch 8+	Repetidora	Paravisión S.A	Yby Yaú	177/2011	03/02/2011
13	ZPD 299	Rep. La Tele - Ch 4-	Repetidora	Hispanoamérica TV del Paraguay S.A	Concepción	790/2007	20/07/2007

With regard to the written press, all national newspapers are available in Concepción, San Pedro and Amambay, including the following: ABC, Ultima Hora, La Nación, Crónica, Popular, Hoy and 5 días.

As for local digital media in DIA, it can be mentioned:

Table 54 – Local digital media in DIA

Name	Link
Concepción al día. Revista interactiva de la Perla del Norte	http://www.concepcion-py.com/ ; https://www.facebook.com/concepcionaldiapy/
Concepción Digital. Periodismo Digital Creativo	https://www.concepciondigital.com/
Concepción informa	https://www.facebook.com/pages/category/Media-News-Company/Concepci%C3%B3n-Informa-
Horqueta Digital	https://www.facebook.com/HorquetaDigitaldeNoticias/
Horqueta Informa	https://www.facebook.com/pages/category/Media/Horqueta-Informa-

Source: Prepared by the external consultant Lic. Caren Kremer and team

No digital media were found for Belen and Loreto.

9.3.4.1.5.9 Tourism services and accommodation

This section presents information about available tourist services and rental capacity of the Project's Area of Influence.

For the development of the information on rental capacity, data has been obtained from the Ministry of Tourism of the Government and SENATUR (National Ministry of Tourism). The Department of Concepción has several tourist attractions that, according to the Local Health Plan (2014), contribute as an important source of income.

The city of Concepción preserves its historic center and a barracks from the time of the War of the Triple Alliance, both of which are witnesses to past eras, as well as the Fort of San Carlos, on the Apa River, from the colonial era. The Kurusu Isabel oratory, near the departmental capital, is a place of pilgrimage.

The region has countless rivers and streams that offer the possibility of water sports, fishing, sailing and beaches. Numerous spas have settled down in the area. In the crystal-clear Tagatiya stream and in the Aquidaban River, ecotourism services are offered. Some boats offer river tourism services on the Paraguay River, especially for trips and fishing. There are establishments that offer tourism of stay (camping, cavalcades, camping etc.); in addition, of the use of beaches and lagoons in their properties. In Vallemí, tours are offered to visit the characteristic caves of the place, while it is possible to visit the hills of San Luis and Paso Bravo.

According to official records obtained from the Secretary of Tourism of the Government, in the department of Concepción, there are 16 providers of tourist services, in addition to the accommodation whose majority offers gastronomic services. These can be classified as follows: 3 gastronomic establishments, 6 travel and transport agencies, 4 tourist guides and 3 that offer other services. In recent years, SENATUR has promoted a program of Tourist Inns, registering 2 in Concepción: Posada Doña Preta (20 beds) and Posada Isabel (60 beds), both in Vallemí. As for the rental capacity of the DIA, the results presented in Table 55 are as follows:

Table 55 – Facilities/installations, rooms and beds in DIA, by district

District	Number of installations	Number of rooms	Number of beds
Concepción	20	476	960
Belén	3	25	52
Horqueta (1)	5	22	43
Loreto	2	18	52
Total	**30**	**541**	**1.107**

Source: Ministry of Tourism, Government of Concepción; SENATUR. Prepared by the external consultant Lic. Caren Kremer and team
(1) No data: 3 establishments; (2) No data: 1 establishment
(*) Data from Vallemí and Yby Yaú are added (partial)

9.3.4.1.5.10 State presence

This item presents the public institutions that have a presence in the department of Concepción and in the districts of DIA. It also includes a list of instances of citizen participation attended by State representatives.

In the following table 56, the institutions with a presence in the department of Concepción are listed, marking those that also have a presence in the municipalities of the DIA.

Table 56 – Public institutions with a presence in the municipalities (original titles in Spanish)

Institutions	Concepción	Belén	Loreto	Horqueta
Gobernación	X			
Secretaría del Ambiente de la Gobernación	X			
Secretaría de Turismo de la Gobernación	X			
Secretaría de Salud de la Gobernación	X			
Ministerio de Agricultura y Ganadería (MAG)- Dirección de Extensión Agraria y Ganadera (ALAT)	X	X	X	X
Oficina Regional, Ministerio de Industria y Comercio (ORMIC)	X			
Ministerio de Salud Pública y Bienestar Social (MSPyBS), Primera Región Sanitaria (Concepción)	X			
Ministerio de Educación y Ciencias (MEC), Coordinación Departmental de Supervisiones Educativas / Supervisiones	X			
Ministerio de Urbanismo, Vivienda y Hábitat (MUVH), Agencia Regional N° 6	X			
Municipalidad	X	X	X	X
Junta Municipal	X	X	X	X
Consejería Municipal por los Derechos del Niño, Niña y Adolescente (CODENI)	X	X	X	X
Ministerio de Justicia (MJ), Penitenciarias	X			
Ministerio de Hacienda (MH), Subsecretaría de Tributación	X			
Ministerio de Obras Públicas y Comunicaciones (MOPC)	X			
Ministerio de Desarrollo Social (MDS)	X	X	X	X
Ministerio de Industria y Comercio (MIC)	X			
Ministerio de Justicia (MJ)	X			
Circunscripción Judicial, Juzgados de Paz	X	X	X	X
Ministerio Público (MP) o Fiscalía	X			X
Tribunal Superior de Justicia Electoral (TSJE)	X			
Registro Civil	X	X	X	X
Registro Electoral	X	X	X	X
Policía Nacional, Comisarías	X	X	X	X
Fuerzas Militares: 4° Regimiento de Infantería y Hospital Militar	X			
Instituto Nacional de Desarrollo Rural y de la Tierra (INDERT)	X		X	X
Servicio Nacional de Calidad Vegetal y de Semillas (SENAVE)	X			X

Institutions	Concepción	Belén	Loreto	Horqueta
Servicio Nacional de Calidad y Salud Animal (SENACSA)	X	X		X
Servicio Nacional de Erradicación del Paludismo (SENEPA)	X			
Servicio Nacional de Saneamiento Ambiental (SENASA)	X			X
Servicio Nacional de Erradicación del Paludismo (SENEPA)				X
Instituto Forestal Nacional (INFONA)	X			
Oficina Regional de Pesca del Ministerio del Ambiente y Desarrollo Sostenible (MADES)	X			
Centro Regional Ambiental del del Ministerio del Ambiente y Desarrollo Sostenible (MADES)				X
Dirección de Educación Agraria (DEAg), Escuela Agrícola de Concepción	X			
Servicio Nacional de Catastro	X			
Dirección Nacional de Aeronáutica Civil (DINAC)	X			
Instituto de Previsión Social (IPS), Hospital Regional	X			X
Administración Nacional de Electricidad (ANDE)	X			X
Empresa de Servicios Sanitarios del Paraguay S.A. (ESSAP)	X			
Compañía Paraguaya de Comunicación (COPACO)	X	X	X	X
Correo Paraguayo	X	X	X	X
Universidad Nacional de Concepción (UNC)	X		X	X
Universidad Nacional de Asunción (UNA)	X		X	
Banco Nacional de Fomento (BNF)	X		X	X
Crédito Agrícola de Habilitación (CAH)	X		X	X
Fondo Ganadero (FG)	X			
Administración Nacional de Navegación y Puertos (ANNP)	X			
Dirección Nacional de Aduanas	X			
Servicio Nacional de Promoción Profesional (SNPP)	X			

Source: Local Health Plan, Municipal Development Plan Prepared by the external consultant Lic. Caren Kremer and team.

In addition, different instances of citizen participation have been created with the participation of State representatives, which are listed in table 57.

Table 57 – Citizen participation instances, with the participation of State representatives

Agency	Concepción	Belén	Loreto	Horqueta
Consejo de Desarrollo Municipal	X	X		X
Consejo Regional de Salud	X			
Consejo Local de Salud	X	X	X	X
Consejo Distrital de Educación	X			

Local Health Plan, Municipal Development Plan Prepared by the external consultant Lic. Caren Kremer and team.

The Municipal Development Council is an instance of citizen participation, where the interaction of the public, private and civil society sectors is established, where joint actions are coordinated, articulated and implemented, for the benefit of the community. Seven working groups were set up for the municipalities of Concepción, Belén and Horqueta: Production, Health, Environment, Public Safety, Children and Adolescents, Infrastructure, Education.

9.3.4.1.6 Land Use

This chapter contains information on land use in the Project's Area of Indirect Influence and in districts of the department of Concepción.

Taking into account the agricultural vocation of the area, which has a direct relationship with the economy. Economy; where specific data related to the farms and their productive uses are presented, among others. In order to give clarity on the topic of land use, some tables already included in the section on economy are repeated here, which refer to farms and their uses. As in many other cases, the information cannot always be compared, due to differences in the survey methodology; however, it contributes to the analysis.

The predominant activity in the area, livestock, occupies three quarters of the department's territory according to the publication "Concepción, características demográficas y socioeconómicas, 2002", occupying 5% of the EAP, while only 4% of the total area is used for agriculture, which occupies more than 38% of the EAP. The forest area represents 17% of all land in the department, according to data from the Agricultural Sampling Survey carried out in 2002 by the Directorate of Agricultural Censuses and Statistics of the Ministry of Agriculture and Cattle Raising (Pereira, 2008).

According to the Agricultural Sampling Survey (2002), cited by the publication "Concepción, características demográficas y socioeconómicas", 76% of the territory used for livestock is used for natural and implanted pastures, 17% is natural or cultivated forest and the rest is temporary and permanent crops, is fallow or has other uses. Pereira mentions that the publication "Territory and Population" points out that there are 54 Brazilian-owned farms totaling an area of about 100,000 hectares in the district of Concepción. He also indicates that there are about eight estates with almost 50,000 hectares in the department.

The 2008 Agricultural Census includes data related to the number of farms, according to use per department and the number of hectares according to use per department, as shown in tables 58 and 59 [51].

Table 58 – Land according to its use in number of properties, by department as of 2008

Department	Number of farms with land	Farms with Permanent Temporary Crops and Vegetables	Farms with natural or cultivated pasture	Properties with natural woods or forest plantation.	Farms with fallow and resting land	Farms with land for other uses
Concepción	17.377	15.285	10.071	6.414	7.485	15.583
San Pedro	45.875	42.889	23.866	18.468	24.154	40.784

[51] El análisis de esta información se realizó en el apartado sobre economía.

Amambay	4.795	3.969	2.726	2.454	1.745	3.261
Total, Estimated IIA	68.047	62.143	36.663	27.336	33.384	59.628

Source: National Agricultural Census 2008. Prepared by the external consultant Lic. Caren Kremer and team.

Table 59 – Land according to its number in terms of surface area, by department as of 2008

Department	Total surface(ha)	Farms with Permanent Temporary Crops and Vegetables	Farms with natural or cultivated pasture	Properties with natural woods or forest plantation.	Farms with fallow and resting land	Farms with land for other uses
Concepción	1.619.416	71.431	1.218.911	233.300	50.394	4.538
San Pedro	1.739.232	321.156	909.500	276.656	81.091	150.828
Amambay	1.217.077	134.925	806.876	224.785	28.567	21.924
Total, Estimated IIA	4.575.725	527.512	2.935.287	734.741	160.052	177.290

Source: National Agricultural Census 2008. Prepared by the external consultant Lic. Caren Kremer and team.

According to Palau (2019), analyzing the report of the Statistical Synthesis Agricultural Production 2017-2018 prepared by the Ministry of Agriculture and Livestock (MAG in Spanish), it can be seen that the hectares destined for soybean cultivation in Concepción total 40,355 ha. Corn occupies 8,222 ha, sugar cane 321 ha and rice 51 ha. Peasant family agriculture covers 21,443 ha, of which some 11,000 ha are used for cassava cultivation.

With regard to protected areas, the Municipal Development Plan of Concepción of 2016 mentions the following:

- Serranía San Luis, with an area of 70,000 hectares.
- Itapucumí, with an area of 45,000 hectares.
- Estrella de Concepción, with an area of 2,400 hectares.
- Laguna Negra, with an area of 10 hectares, is in danger of extinction.

The district of Concepción has 8,490 km^2. The Municipal Development Plan (2016) mentions that, according to the DGEEC Atlas, the land to the north and east of the department, in the proximity of the Apa and Paraguay rivers, is high and with some isolated hills of relative elevation. The center and north are of low and flat topography, with extensive pastures destined to the shepherding, which are alternated with wooded sectors. The southern part has higher lands. In the district of Concepción, the land is high, slightly sloping, with forests of timber trees, used for carpentry and construction.

With regard to the distribution of land by district, according to data from the 2008 Agricultural Census, Concepción is the district with the largest number of farms and surface area, followed by Yby Yaú and Horqueta. It is worth mentioning that the areas of these two districts were modified after the Census, due to landslides and the creation of new districts. It is also worth noting that the vast majority of farms are managed by a single producer in the four districts of DIA, as well as in the entire department of Concepción. Table 60 presents data on this subject.

Table 60 – Land distribution by district, department of Concepción

Districts of the Department of Concepción	Number of Farms	Total Surface	Farm management				
			Single producer	Two or more associated producers (informal)	A legally constituted company or partnership	State	Others
Concepción	4.214	924.385	4.083	61	59	2	9
Belén	1.479	16.080	1.421	57	1	-	-
Horqueta	7.075	195.727	6.870	183	17	1	4
Loreto	2.062	41.560	2.032	28	2	-	-
San Carlos del Apa	86	62.146	77	9	-	-	-
San Lázaro	219	56.161	199	19	1	-	-
Yby Yaú	2.242	323.357	2.127	74	35	1	5

Source: National Agricultural Census 2008. Prepared by the external consultant Lic. Caren Kremer and team.

The dominance of a single producer in all farm management strata is verified, either through the use of family labor or contracted as laborer's day.

Public Colonies [52]

According to Rojas and Areco (2017), from 1891 to 2010, 61 colonies have been formed, totaling 388,247 hectares with 16,519 lots (almost 5,000 in the district of Concepción according to data provided by the local office); constituting 7% of the total number of lots authorized in the country. The average number of hectares per lot is 24. These colonies constitute 21% of the departmental territory. Of the 61 settlements, 36 per cent are in Horqueta, 23 per cent in the district of Concepción, 18 per cent in Loreto and the rest in the other districts. Table 61 presents a summary of the data for the Public Colonies formed between 1891 and 2010.

Table 61 – Public colonies formed between 1891 y 2010

Department	Number	(area) hectare	Lots	Average
Concepción	61	388.247	16.519	24
San Pedro	143	562.247	38.768	15
Amambay	42	176.605	8.626	20

Fuente: Elaborado por Rojas y Areco, 2017.

Rojas and Areco (2017) conclude: "The changes most frequently observed in the colonies, between the time of their formation and the present, were: 1) a reduction in the area of the colonies; 2) a significant increase in the number of plots in them; and 3) a sharp fall in the average size of the plots and the consequent growing smallholdings, moving away from the basic area required, as established in the Agrarian Statute".

[52] Peasant colonies (or settlements), legally recognized by the National Institute of Rural Development and Land (INDERT), the official body in charge of land policy in the country.

There are also the so-called "communal fields"; that is, areas for free common use by the community, this for productive purposes. These can be set up in colonial agricultural settlements (whether official or private), as described in Chapter IV of Law 1863/02 establishing the Agrarian Statute.

During the work of information collection in field, inhabitants of the localities near the zone prospected for the installation of the plant, mentioned to belong to groups that have communal fields, this in the communities of Curuzu Ñu and Mbocayaty (item 9.3.4.2.5.3: Economic activities and income).

9.3.4.1.7 Water resource use

This section presents information on water resource use in the Project's Area of Influence. Considering that the topic was already covered in previous items, general data on household use is provided, and other uses of the resource are incorporated.

In the document "Uses and governance of water in Paraguay", prepared by UNDP (2016), it is mentioned that the department of Concepción is located on the Quaternary aquifer, using 60% of it to cover the needs of its inhabitants. The other 40% is through surface water.

With regard to domestic water use, according to the Environmental Statistical Compendium (2017), Concepción has an ESSAP provider and 837 from SENASA at the departmental level. ESSAP has 7,572 connections; while SENASA has 19,624. There are also 6,689 connections corresponding to other providers. ESSAP takes water from the Paraguay River to supply its users.

With regard to sanitary sewerage, ESSAP is the only one providing this service in the capital of the department with 3,691 connections, which constitutes approximately 7% of the total population of the department and 20% of the district of Concepción. The rest of the department does not have this service. The population supplied with drinking water is 37,860 through ESSAP, 83,937 through SENASA and 34,114 others. On the other hand, the population sanitized by ESSAP is 18,455, which covers approximately 10% of the total of the department.

The evolution of drinking water connections has been from 5,246 in 2008 to 7,572 in 2017, an increase of more than 44% in less than ten years. This meant that the number of people with a drinking water supply rose from 26,230 to 37,860 during the aforementioned period. Connection to the sewerage network increased from 2,104 in 2008 to 3,691 in 2017, a 75% increase. The population benefited rose from 10,520 to 18,455 people.

The waters of the Paraguay River are also used for the operation of local industries that are supplied by the river. This is the case of Frigorífico Concepción, both in the meat industry and in the tannery. This industry takes water from the river, makes it drinkable in its own treatment plant, uses it, reconditions it through a decontamination process and returns it to the river. The Belén meat packing plant uses the waters of the Ypané to carry out its operations.

Similarly, fishermen use the river as a livelihood. There are two fishermen's associations in the city, one of which is inactive. The Nanawa Professional Fishermen's Association has 25 members and sells its fish at the roundabout at the entrance to the city.

Also, as mentioned above, the river is an important communication route, as ships, boats and barges ply its waters to reach various locations such as Puerto Pinasco, Puerto

Casado, Vallemí, Fuerte Olimpo, transporting food, fuel and passengers. The ship Aquidabán makes regular trips once a week from Asunción to Bahía Negra.

Regarding the recreational use of water resources, there are currently 18 spas, 5 of which are authorized by MADES. Taking into account the high temperatures in the country, an increase in the number of spas in the area can be observed annually. In some cases, these spas do not meet the optimal conditions for those who use them and, as mentioned, they do not have the corresponding authorization from the MADES either. Table 62 lists the spas.

On the other hand, from Concepción, there are options within the city to make trips for walking and fishing. The Ten Caten, Siete Cabrillas and Santa Filomena boats are some of those offering this service. These are private services available for those interested.

Table 62 – Resorts in the department of Concepción

Number of resorts	District	Qualified by MADES
2	Belén	1
7	Concepción	0
4	Horqueta	1
4	San Alfredo	2
1	Yby Yaú	1
Total: 18	5 districts	5 qualified

Source: Prepared by the external consultant Lic. Caren Kremer and team with information provided by the Ministry of Tourism of the Government

On the Aquidabán River in Paso Horqueta, 40 km from Concepción, on the road to Vallemí, there are public beaches. On the same river, there are also recreational areas in Paso Barreto (65 km from Concepción); and Paso Urundey, district of Horqueta, which is about 15 km from the route Bernardino Caballero, in km 70.

In Vallemí, there is a municipal waterfront on the Paraguay River. Likewise, 4 km away from the city, the Apa River offers a huge sandy area that is used by visitors.

The Tagatiyá stream, located in the district of San Alfredo, is one of the major tourist attractions of the department. It runs on a calcareous base and allows visitors to see the bottom through its transparent waters.

9.3.4.1.8 Ecosystem Services

Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types: (i) provisioning services, which are the products people obtain from ecosystems; (ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes; (iii) cultural services, which are the nonmaterial benefits people obtain from ecosystems; and (iv) supporting services, which are the natural processes that maintain the other services.

IFC PS 4, on “Community Health and Safety”, establishes that the decline or degradation of natural resources, such as adverse impacts on the quality, quantity and availability of fresh water, can cause risks and impacts related to the health of the communities.

Regarding this ecosystem service, it is worth to mention that, during field surveys, many people have expressed the use of water resources for recreation (bathing, beach, fishing), highlighting the Aquidabán river. Likewise it is common in the region to practice fishing, both for sale and for self-consumption (for example, the towns of Paso Barreto, Paso Mbutu, Islería).

Details regarding ecosystem services are within the complete report produced by the Fundación Natan, presented in the Plantations ESIA, social baseline chapter.

9.3.4.2 Direct Influence Area (DIA)

This section describes the main features in terms of demographic, social, cultural and economic indicators of the districts that make up the project's DIA; referenced in item 9.3.2.3 of this study.

In order to organize the existing information; the content was structured in two sections:

a. Summary of district characteristics in DIA In order to complement the quantitative records already indicated in the section on the characterization of the IIA referring to the DIA.
b. b. Summary of microterritories identified in the DIA from the communication routes that lead to the prospected property area. It will also be possible to access elements of the consultation process with key actors as central contributions to the characterization of the territory.

It is important to highlight that, for the characterization of the districts studied for DIA, 3 main sources have been taken into account (Local Health Plan 2014-2016 of each district, Municipal Development Plan and the DGEEC) as no other updated bibliographic sources are available.

9.3.4.2.1 Belén District

General Characterization

The city of Belén, in the department of Concepción, was founded on August 23, 1760, by Francisco José Sánchez Labrador y Hernández S.J. It is located 21 km from the departmental capital.

It is located on the banks of the Ypané River. It borders the districts of Concepción and Horqueta to the north, the municipality of San Pedro to the south, the district of Horqueta to the east, and the district of Concepción to the west. Its main road accesses are Route V General Bernardino Caballero and Route III Elizardo Aquino and a bridge located over the Ypané River [53].

As mentioned, it is located 21 km from the city of Concepción and 437 km [54] of the nation's capital. It has an area of 215 km^2, distributed in rural and urban areas. In 1917, a colony was created, corresponding to 433 lots and 7408 hectares [55].

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[53] Bethlehem Municipal Development Plan. Department of Concepción. 2016. Available at https://www.cird.org.py/institucional/documentos/PDM%20Belen.pdf
[54] Road distance, from the country's capital by Ruta 9 Don Carlos A. López
[55] Rojas, L. y Areco, A. (2017). Las Colonias Campesinas en el Paraguay.

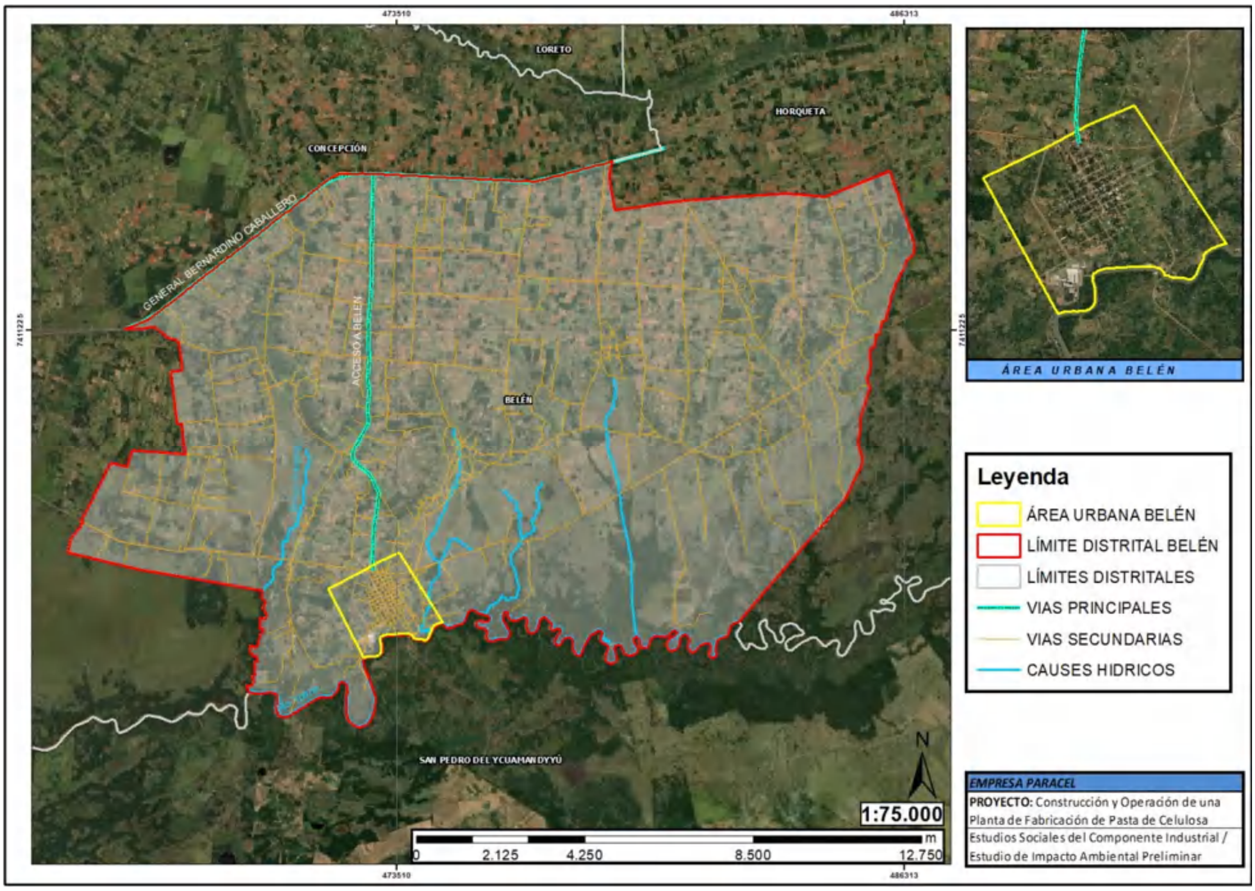


Figure 14 –Belén district Map

Table 63 – Additional information about the Belen District

Population	With regard to the population, the projection for 2019 is 13,014 inhabitants (6,766 men and 6,248 women) and for 2020 is 13,215 inhabitants (6874 men and 6,341 women)[56]. Of these, 73 inhabitants are indigenous (39 men and 34 women) from rural areas. [57]
Economic activity	The main economic activities are agriculture (fruit, yerba mate), industry, meat processing, tanning, commerce and forestry.
Tourism	For the exploitation of tourism, the city of Belen has five particularities that characterize it, Belen is the point where it crosses the tropic of Capricorn in the country; the large houses with colonial architecture that remain in the city; the spas located on the banks of the Ypané River, Pororó and Paso Pedroso; ecological tourism and stay and the Jesuit Ruins of Purutue Ka´i[58] located in Paso Urundey far 3.5km to north on the way to Horqueta.
Health	The district health service is organized as follows: 1 Belén Health Centre, 1 USF, 1 SOS Village Maternal and Child Centre (gynecological care, childbirth, general

[56] DGEEC. Dpto. Concepción. Población estimada y proyectada, según distrito, sexo y grupos de edad, 2000-2025. Available at: https://www.dgeec.gov.py/vt/default.php?publicacion=2

[57] DGEEC. III Censo Nacional de Población y Viviendas para Pueblos Indígenas, 2012. Available at https://www.dgeec.gov.py/default.php?publicacion=33

[58] Plan de desarrollo municipal Belén. Departamento de Concepción. 2016. Available at https://www.cird.org.py/institucional/documentos/PDM%20Belen.pdf

	medical clinic, laboratory and pharmacy), 5 Medicine Kits, 1 Private Family Medicine Clinic, 2 Empirical Midwives, Naturalists.[59]
Education	The district has access to 3 educational centers located in the urban area and 22 in the rural area [60].
Clean Water and Energy	Drinking water service is provided by urban and rural sanitation boards and electricity by the National Electricity Administration (Administración Nacional de Electricidad, ANDE in Spanish).
Drainage system	In the urban area, modern toilets with septic tanks predominate, there is no sewage system or network, and in the rural area common toilets or latrines predominate.
Collection / disposal / waste treatment	They do not have garbage collection service, the way to dispose of the garbage is by burning or burying it.

Figure 15 – Photo of route of access to the city

Figure 16 – City of Belen: representation of indigenous culture

9.3.4.2.2 Loreto District

[59] Plan Local de Salud de Belén, Departamento de Concepción 2014-2016. Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Belen.pdf
[60] Plan Local de Salud de Belén, Departamento de Concepción 2014-2016. Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Belen.pdf

General Characterization

The city of Loreto was founded on December 10, 1792 by the Jesuits. It is located 20 km from the city of Concepción and 437 km from Asunción. [61] It borders the districts of Horqueta, Belén and Concepción. The city can be reached by routes III Elizardo Aquino, V Bernardino Caballero and Coronel Franco-Chaco. It has an area of 996 ^{km2}. Organized in 31 rural companies and 4 urban districts [62]. From 1964 to 1981, 11 colonies were created, corresponding to 1969 lots and 46,323 hectares. [63].

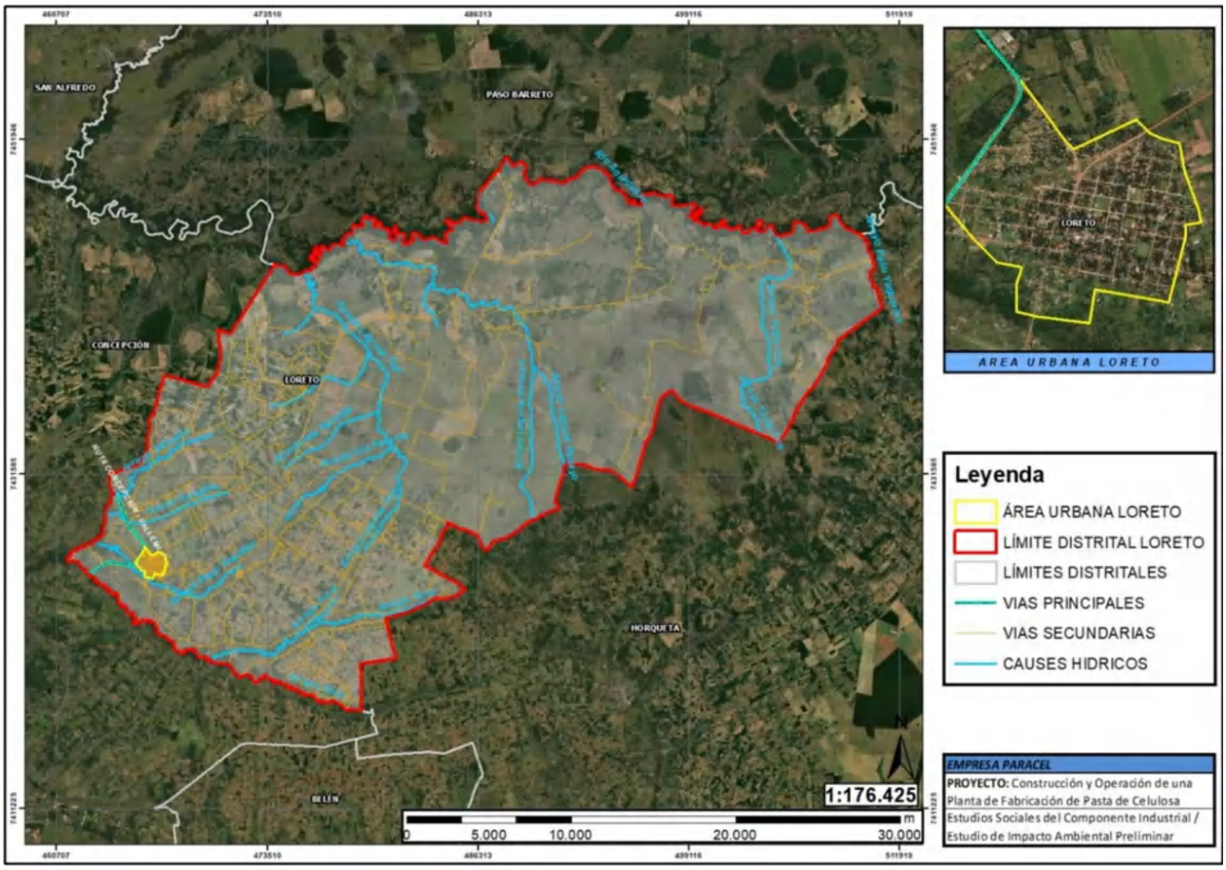


Figure 17 –Loreto district Map

Table 64 – Additional information about the district of Loreto

Population	As for the population, the projection for 2019 is 18,791 inhabitants (9,973 men and 8,818 women) and for 2020 is 18,879 inhabitants (10,034 men and 8,846 women)[64].
Economic activity	The predominant economic activities are small-scale agriculture (sesame, watermelon, melon, manioc, vegetables, etc.), production for local and departmental consumption [65],

[61] Road distance, from Asunción by Pozo Colorado.
[62] Plan de Desarrollo Municipal Loreto. Departamento de Concepción. 2016. Available at: http://www.municipalidadloreto.gov.py/wp-content/uploads/2014/11/plan-de-desarrollo-distrital-loreto2016.pdf
[63] Rojas, L. y Areco, A. (2017). Las Colonias Campesinas en el Paraguay.
[64] DGEEC. Dpt. of Concepción. Estimated and forecasted population, by district, gender and age groups, 2000-2025. Available at: https://www.dgeec.gov.py/vt/default.php?publicacion=2
[65] Plan de Desarrollo Municipal Loreto. Departamento de Concepción. 2016. Disponible en http://www.municipalidadloreto.gov.py/wp-content/uploads/2014/11/plan-de-desarrollo-distrital-loreto2016.pdf

	cattle raising, construction (handicrafts, fabrics, painting on canvas), wood industries, shops, fairs, etc.[66]
Tourism	In the district, the places taken into account to visit as tourist sites are the spas, giant statues in the squares, church, Aquidaban River and streams and the house of prayer dedicated to the Virgin of Tuparendá [67]. The panorama of the city is complemented by the large old houses and rural cottages. In one of them, the trophies of the Mcal. José Félix Estigarribia[68].
Media and transport	They have fixed telephone and internet service by the Paraguayan Communications Company (COPACO), as well as mobile telephone and internet access by private companies. Air and cable channels. AM and FM radios (community and commercial radios). The district does not have local transportation service, but they do use interurban and long-distance transportation and private means. The main access routes are Route V General Bernardino Caballero, Route III General Elizardo Aquino and Coronel Franco-Chaco. There is also a branch of the Paraguayan National Post Office (DINACOPA).
Health	In Loreto they have 1 Health Center, 2 Health Posts, 1 USF, 1 Dispensary, 1 Social Pharmacy, 6 Private Pharmacies and 15 Empirical Midwives.
Education	In the municipality there are 9 national schools and 32 basic schools.
Clean water and energy	The drinking water used in the area comes from the sanitation boards. They have electric power service.
Drainage system	The District does not have a drainage network. Only 16% in the urban area have modern toilets with a septic tank and septic chamber and 72% in the rural area use a latrine.
Collection / disposal / waste treatment	According to data from the institutional interviews, the municipality has a municipal dump, a part of the urban zone has access to collection service and in the rural zone they dispose by burning or burying.

Figure 18 – Access to Loreto

[66] Plan de Salud de Loreto (Loreto Municipal Health Plan) Departament of Concepción. 2016. Available at:
https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Loreto.pdf
[67] Loreto Health Plan. Department of Concepción. 2016. Available at:
https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Loreto.pdf
[68] Loreto Municipal Development Plan. Department of Concepción. 2016. Available at
http://www.municipalidadloreto.gov.py/wp-content/uploads/2014/11/plan-de-desarrollo-distrital-loreto2016.pdf

Figure 19 –Loreto City

9.3.4.2.3 Horqueta District

General Characterization

The city of Horqueta was founded on May 10, 1793, by Juan Manuel Gamarra and Andrés Salinas. It is located 50 km from the city of Concepción and 434 km from Asunción [69], 172 km from Punta Porá (Brazil) It borders the districts of Loreto, Concepción and the Aquidaban River to the north, the Ypané River to the south, the Yby Yaú district to the east, and the districts of Concepción and Belén to the west. It has an area of 2,925 km2 distributed in urban and rural areas[70]. From 1917 to 2001, 22 colonies were created, corresponding to 6,957 lots and 124,391 hectares [71].

[69] Road distance, from Asunción on the Transchaco Route and Route 5 General Bernardino Caballero
[70] Horqueta Municipal Development Plan. Department of Concepción. 2016. Available at: https://www.cird.org.py/institucional/documentos/PDM%20Horqueta.pdf
[71] Rojas, L. y Areco, A. (2017). Las Colonias Campesinas en el Paraguay.

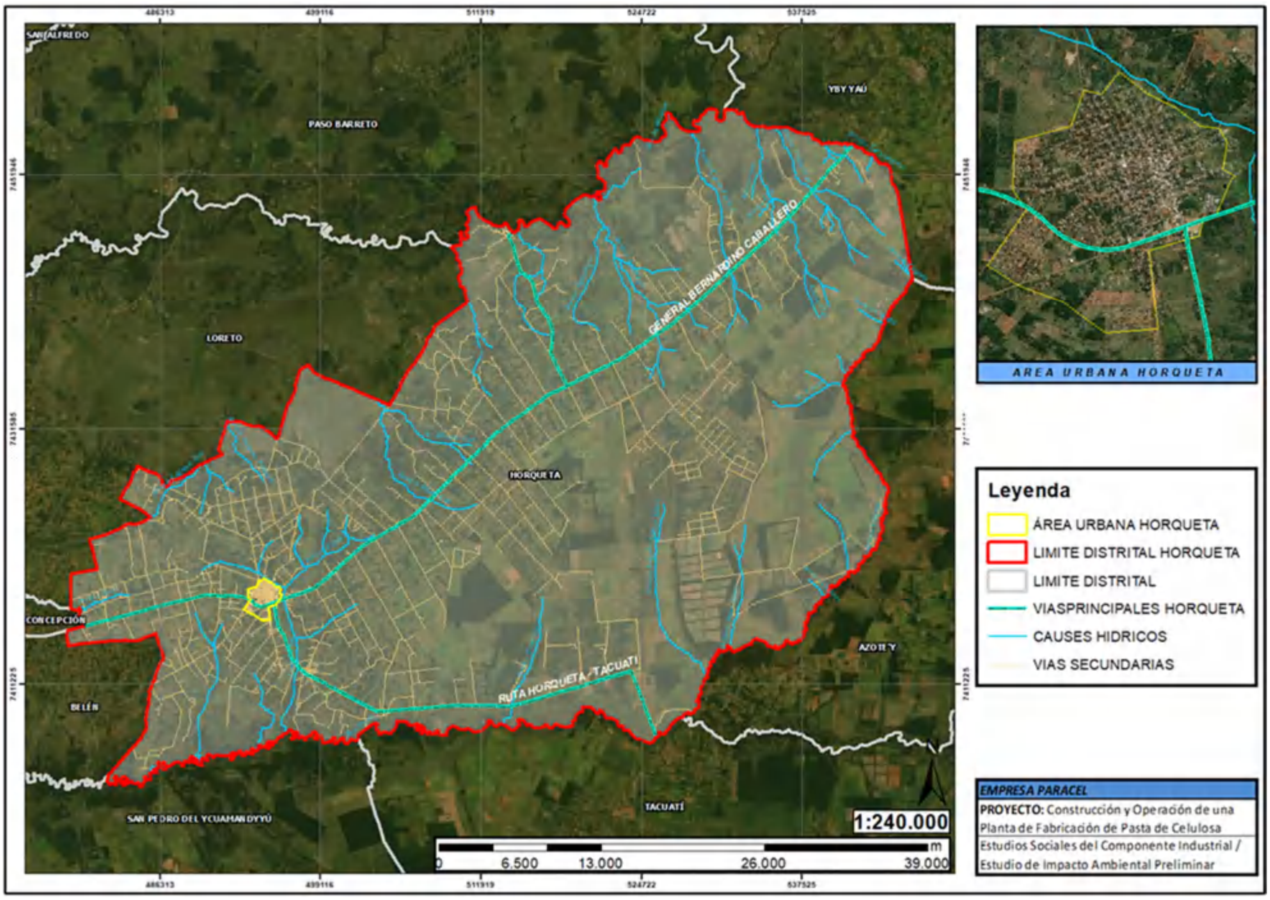


Figure 20 –Horqueta district Map

Table 65 – Other information about the District of Horqueta

Population	The population is forecasted to reach 62,008 by 2019 (32,152 men and 29,856 women) and 62,664 by 2020 (32,477 men and 30,187 women). [72] Of these, 339 inhabitants are indigenous (162 men and 177 women), all from rural areas. [73]
Economic activity	The main activities of the district are agriculture (ka'a he'ê, cotton, beans, manioc, corn, fruits, yerba mate), commerce and industry (agricultural products, cotton dismantle, oil, tanning), sawmills, forestry[74].
Tourism	The district has the museum called Las Raíces de Horqueta, Luis Alberto del Paraná Museum (Radio Guyrá Campana), Virgen del Rosario Church, José Antequera and Castro Square [75] and the white sand beaches on the banks of the Aquidabán River, Paso Horqueta and the Paso Horqueta Bridge[76].
Media and transport	According to information obtained in the institutional interviews, in Horqueta there is access to fixed telephony and internet services by the Paraguayan Communications Company (COPACO), as well as mobile telephony and internet access by private companies, there are air channels and cable channels and AM and FM radios (community and commercial radios).

[72] DGEEC. Dpt. Concepción. Estimated and forecast population, by district, gender and age groups, 2000-2025. Available at: https://www.dgeec.gov.py/vt/default.php?publicacion=2

[73] DGEEC. III National Census of Population and Housing for Indigenous Peoples, 2012. Available at : https://www.dgeec.gov.py/default.php?publicacion=33

[74] Horqueta Local Health Plan. Department of Concepción. 2016. Available at: https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Horqueta.pdf

[75] Domestic tourism in Paraguay. Available at: https://turismointernoparaguay.blogspot.com/2015/01/concepcion-atractivos-museos-y-centros.html

[76] Horqueta Municipal Development Plan. Department of Concepción. 2016. Available at https://www.cird.org.py/institucional/documentos/PDM%20Horqueta.pdf

	Currently there is no local public transport service, the means of transport used are inter-city or long-distance buses and private means of transport. The main accesses are Route V General Bernardino Caballero and Route III General Elizardo Aquino. There is also a branch of the Paraguayan National Post Office (DINACOPA).
Health	In the district there is the Horqueta District Hospital, 11 USF and 7 Health Centers.[77].
Education	According to the Municipal Development Plan (2016), the district has access to 20 urban and 113 rural educational institutions, corresponding to initial, basic, middle, public and private subsidized education. And higher education, public and private, with undergraduate and graduate degrees, in the following universities: Universidad Tecnológica Intercontinental (UTIC), Universidad San Carlos, Universidad Nacional de Concepción (UNC), Universidad Politécnica y Artística del Paraguay (UPAP). Also, the Institute for Teacher Training in Horqueta (IFD Horqueta).
Clean water and Energy	The drinking water used in urban and rural areas is the Agua Corriente system (80%) and the least used is well water (20%)[78]. Access to electricity is provided by the Costa Romero Sub-Static, which processes the energy from the Itaipu Hydroelectric Power Plant for the entire north [79].
Drainage system	The District does not have a drainage network. Only 16 % in the urban area have modern toilets with septic tank and septic chamber and 72 % in the rural area use a latrine.
Collection / disposal / treatment of waste	Regarding the garbage collection service, although the municipality has a municipal dump, only a part of the urban area has access to the collection service and in the rural area they dispose by burning or burying[80].

Figure 21 – Photograph of Horqueta

9.3.4.2.4 Concepción District

General Characterization

The city of Concepción is the capital of the Department. It was founded on May 25, 1773, by Colonel Agustín Fernando de Pinedo. It is located on the banks of the Paraguay River, with fluvial access (Port of Concepción), air (Airport of Concepción Lt. Carmelo Peralta) and land (Route V General Bernardino Caballero that connects with the other districts) [81].

[77] Horqueta Local Health Plan. Department of Concepción. 2016. Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Horqueta.pdf
[78] Horqueta Local Health Plan. Department of Concepción. 2016. Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Horqueta.pdf
[79] Horqueta Municipal Development Plan. Department of Concepción. 2016. Available at https://www.cird.org.py/institucional/documentos/PDM%20Horqueta.pdf
[80] Horqueta Local Health Plan. Department of Concepción. 2016. Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Horqueta.pdf
[81] Concepción Municipal Development Plan. Department of Concepción. 2016. Available at

It borders to the north with the municipality of San Alfredo, to the south with the districts of Belén and San Pedro, to the east with the districts of Paso Barreto, Belén and Loreto and to the west with the Paraguay River that separates it from the district of Presidente Hayes. It is located at a distance of 415km from the capital of the country. It has an area of 8,490 km2 distributed in rural and urban areas. From 1918 to 2008, 14 colonies were created, corresponding to 4408 lots and 113,807 hectares [82] [83] [84].

The urban area of the district of Concepción covers 16 neighborhoods and the rural area is made up of 16 companies [85].

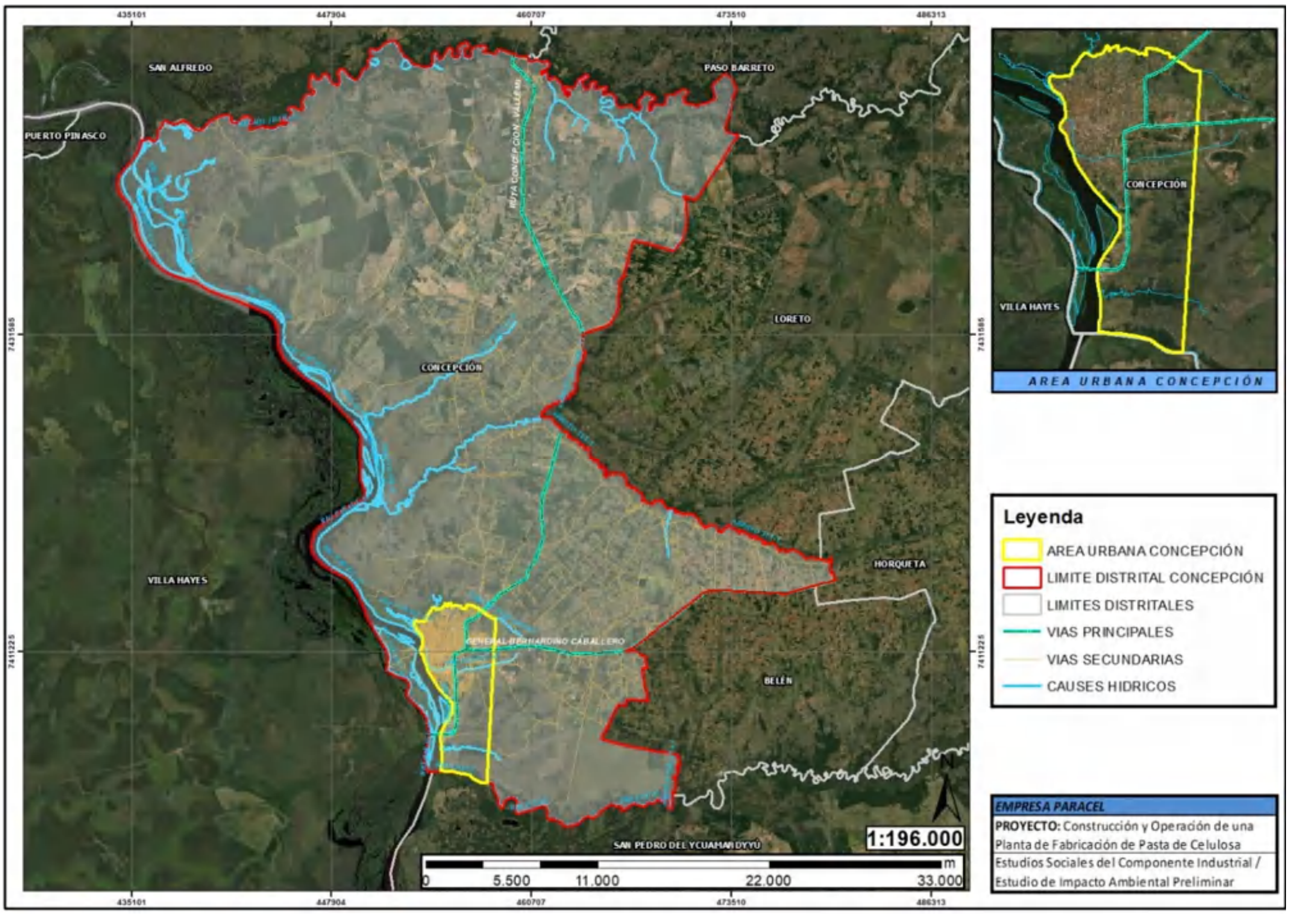


Figure 22 –Concepción district Map

Table 66 – Other information about the District of Concepción

Population	The population projection for 2019 is 85,876 inhabitants (43,306 males and 42,570 females) and for 2020 is 87,215 inhabitants (44,034 males and 43,181 females). Of these, 774 inhabitants belong to the indigenous population (407 men and 367 women), 393 in rural areas (206 men and 187 women) and 381 (407 men and 367 women) in urban areas ([86 and 87]).

[82] Road distance, by Route 9 Transchaco Carlos A. López - Pozo Colorado - Puente Nanawa Coronel Rafael Franco
[83] Concepción Local Health Plan, Department of Concepción 2014/2016. Available at: https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Concepcion.pdf
[84] Rojas, L. y Areco, A. (2017). Las Colonias Campesinas en el Paraguay.
[85] Local Health Plan, 2014
[86] DGEEC. Dpto. Concepción. Estimated and forecasted population, by district, gender and age groups, 2000-2025. Available at: https://www.dgeec.gov.py/vt/default.php?publicacion=2
[87] DGEEC. III National Census of Population and Housing for Indigenous Peoples, 2012 Available at:

Economic Activity	With regard to economic activity, the district is characterized by agricultural and livestock production, shops, public institution officials and industries. Among the main agricultural activities are the production of sugar cane, corn, sesame, pineapple and watermelon among others; among the livestock, cattle production in general and small livestock. Related to this last one, in the district there are important slaughtering plants, meat processing plants and leather shops[88]. In addition, the port of Concepción, which is the main port of the city with the most commercial and people movement.
Tourism	In the city of Concepción, as part of the tourism, are located the Municipal Museum of the Cuartel de la Villa Real and the Diocesan and Historical Museum of Concepción, where there are still objects from the time of the Chaco War and the War of the Triple Alliance; the Locomotive that worked until 1960 [89] and the Carlos Colombino House of Culture in Concepción [90] where ancient objects are also preserved.
Media and transport	In the district there is access to fixed telephony and internet services provided by the Paraguayan Communications Company (COPACO), as well as mobile telephony and internet access by private companies, air channels and cable channels and AM and FM radios (community and commercial radios). There is no local public transport service, the means of transportation used are intercity or long-distance collective transports and as private means there are used motorbikes, cars and vans. In addition, the Port of Concepción and the Airport of Concepción "Tte. Colonel. Carmelo Peralta." are used. There is also the branch of the National Postal Directorate of Paraguay (DINACOPA) and private services such as MC Courier Agencia in Concepción, A.Y.A Correo Privado, J.F. Courier SRL.
Health	The health service is provided by the Ministry of Public Health and Social Welfare (MSPyBS) through the 1st Health Region of the country, there is the Regional Hospital Concepción, 14 Family Health Units (USF), 2 Community Dispensaries, 2 Health Posts, 1 Indigenous Mobile Unit and the Regional Hospital of the Institute of Social Forecasting (IPS). One can also provide private health service, like clinics, sanatoriums, offices, laboratories and pharmacies.
Education	According to the Municipal Development Plan of Concepción (2016), in the district there are enabled 60 educational institutions in the urban area and 50 in the rural area, corresponding to initial, basic, middle, public and private subsidized education. In terms of higher education, there is the National University of Conception (UNC) with undergraduate and postgraduate degrees, and private ones, Universidad Católica Nuestra Señora de la Asunción (UC), the Polytechnic and Artistic University of Paraguay (UPAP), UniNorte Comunitaria de Concepción and the Universidad Tecnológico Intercontinental (UTIC).
Drinking Water and Energy	The drinking water service is provided by the Empresa de Servicios Sanitarios del Paraguay S.A. (ESSAP) and the Sanitation Boards, the electric power the National Electricity Administration (ANDE).
Drainage system	In the urban area, modern baths with wells or septic chambers predominate, but there is no sewage system or drainage network and latrines predominate in rural areas.
Garbage collection/ disposal/ treatment	In the urban area of the district, the garbage collection service is run by the municipality, not all neighborhoods have coverage and there is a municipal landfill. Health institutions have a system of collection and treatment of pathological waste, however, in the rural area, because they do not have garbage collection service or municipal landfill, the way to dispose of the garbage is by burning or burying.

https://www.dgeec.gov.py/default.php?publicacion=33

[88] Concepción Local Health Plan, Department of Concepción 2014/2016.

[89] Concepción Local Health Plan, Department of Concepción 2014/2016.

[90] SNC. Available at: http://www.cultura.gov.py/2014/05/se-inauguro-la-casa-de-la-cultura-carlos-colombino-de-concepcion/

Figure 23 – Bridge "Nanawa", on the Paraguay River, city of Concepción

9.3.4.2.5 Mapping, characterization and analysis of microterritories

9.3.4.2.5.1 Identification and presentation of microterritories

This section presents, as referred to in item 9.3.2.3: Description of the areas of influence, information related to the communities identified within an approximate 5 km radius around the area prospected for the construction of the plant.

It should be noted that taking into account the access roads located on the Vallemí-Concepción paved route, the peculiarity of the territory and the interconnections through the existing communication routes, it was considered pertinent to make a description of the microterritories that are within a 13 km radius around the project's property area, thus extending the 5 km cut initially defined.

Regarding this, the experience provided by field work during the information survey period allows the incorporation of some analysis categories to refer to aspects in terms of territory. The characteristics indicated here were gathered through community interviews and focus groups as part of the information gathering strategy. The data is built from the contribution of key actors in the area such as: representatives of neighborhood committees, productive committees, water, health and education committees, grassroots representatives of churches, young people and former residents of the area; in order to contribute elements from different representative groups of the population.

It should be noted that in view of the lack of systematized information regarding the boundaries and names of the communities located in rural areas of the district of Concepción, the territory was organized from the perspective of local actors.

It is pertinent to emphasize that the division presented in this section is an approximation based on the stories, the rescued perception and the observation records elaborated; covering aspects related to identity, cohesion, organization, common interests, communication channels, institutions, ways of life and other elements of significance for the inhabitants of the area.

In order to better visualize the system of relationships and the degree of interdependence, it was appropriate to subdivide the study zone into two micro-regions, based on the area of coverage assigned to the health units and the degree of proximity to the localities.

In this regard, it should be noted that the Family Health Units are formed under the assignment of a territory of responsibility; composed of "social micro-territories" (communities) in order to provide health coverage to a given population.

In accordance with the previous paragraph, the name of microterritories is acquired in order to name all those communities identified from the existing communication channels. Considering, those that are used to interconnect the communities and, on the other hand, those roads that lead to the prospected property area. The distribution of communities by micro-region determined for the purposes of this study is shown below.

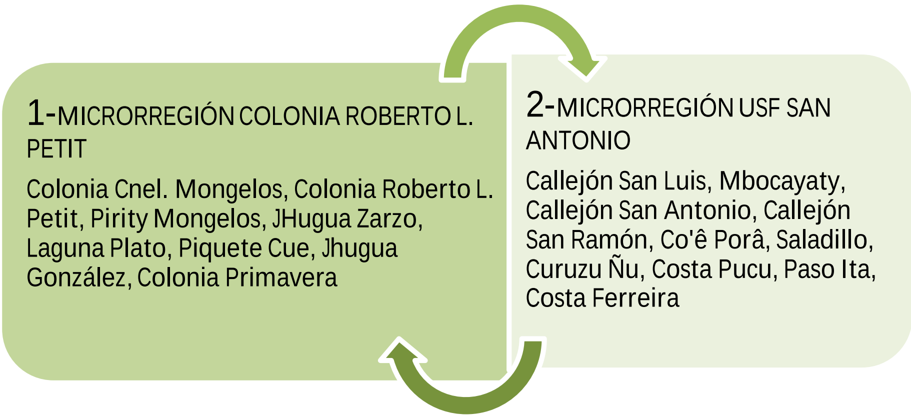


Figure 24 – System of relations and the degree of interdependence

The micro-regions cover an estimated total of 56,114 hectares. The community of Mbocayaty is the smallest and Laguna Plato the largest, according to data from the General Directorate of Surveys, Statistics and Censuses of 2012 referred to in the following figure.

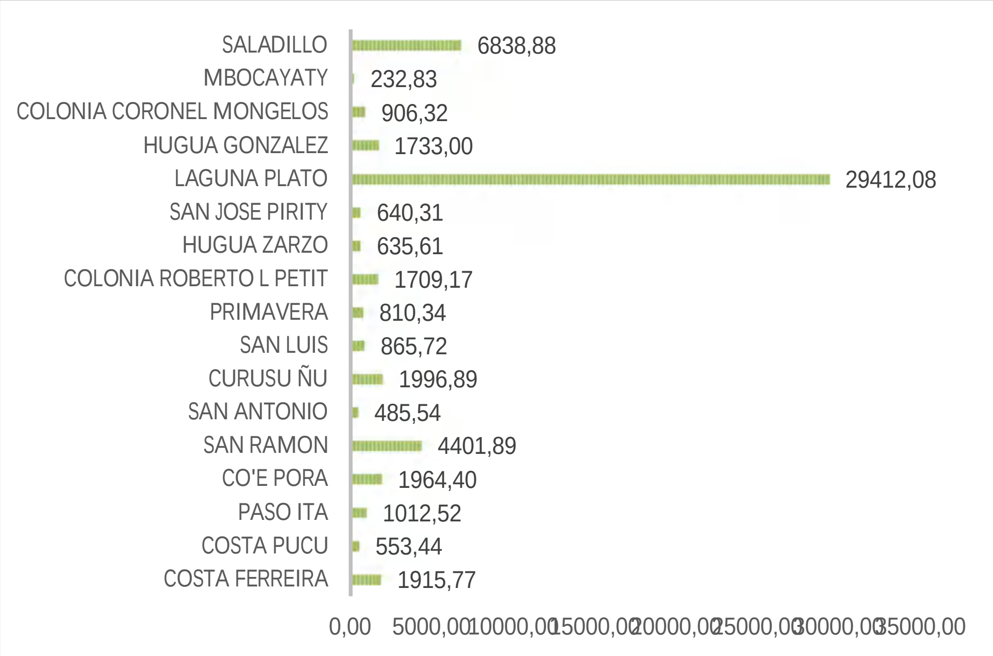


Figure 25 – Chart of dimensions in hectares of the microterritories of Concepción

Source: Elaborated from data of the General Directorate of Statistical Surveys and Census; year 2012.

In addition to the spatial dimensions, in terms of local capacities and available conditions, the following aspects were observed at the social and cultural level:

The presence of public institutions such as educational, health or security institutions are established by intervention zones. In other words, they are used by inhabitants of several micro-territories. In this sense, it is worth highlighting the following:

- These are the communities of Col. Roberto L. Petit, Callejón San Antonio and Jhugua González where the units that provide primary health care to a total of 4618 inhabitants are concentrated; except for the microterritories of Colonia Primavera and Costa Ferreira that belong to other health facilities.
- Although 83% of the microterritories have public schools, schools were only registered in the towns of Saladillo, Col. Cnel. Mongelós, Curuzu Ñu and Colonia Primavera.
- In terms of security, there is a police station in Colonia Roberto L. Petit and a police post in Laguna Plato

The internal roads are networks that link and interconnect the microterritories, make possible the exchange of products and access to the communities where the service institutions in health, security and education are concentrated. In addition, they provide links to paved roads and city centers.

In this sense, Saladillo and Costa Ferreira are the main communication routes used by the inhabitants of the area.

Organization and participation are aspects that give cohesion to the territory. It could be observed that all the communities have local commissions constituted and recognized. In addition, each micro territory has commissions that are activated according to specific needs by defined area of action (water, health, education, roads and others) in order to improve the quality of life of the inhabitants.

Cases were also recorded where the productive committees of each community were linked or grouped into Associations, which in turn brought together committees from different localities, demonstrating a high level of exchange and participation.

Spaces for expression and social interaction based on recreational activities, sports meetings and celebrations of a festive, cultural and/or religious nature organized by the micro-territory where inhabitants from neighboring communities also participate.

These elements show that at the moment of naming the territory there are aspects, perceptions and behaviors that give the microterritories identified as part of a symbolic unit; evidencing the dynamism and integration of the area in multiple dimensions of daily life.

9.3.4.2.5.2 Characterization of each identified micro territory

Figure 28 shows the registration of 18 microterritories that are structured in this document according to areas of influence of the study. In addition, as a strategy for approaching the territory, the roads that interconnect the communities and lead to the prospected property area are referenced.

The microterritories are described from the observed spatial characteristics, the relations and interconnections established in the social and geographical environment and the perception of the key informants; providing qualities that confer a collective identity of population that can be visualized in more detail in the following paragraphs.

The information presented in this section is based on field records prepared from community interviews conducted with key references in the area, within the framework of the project's socio-economic characterization of the DIA.

It should be noted that the territory has the peculiarity of being a rural area, and in its entirety depends on the municipality of Concepción.

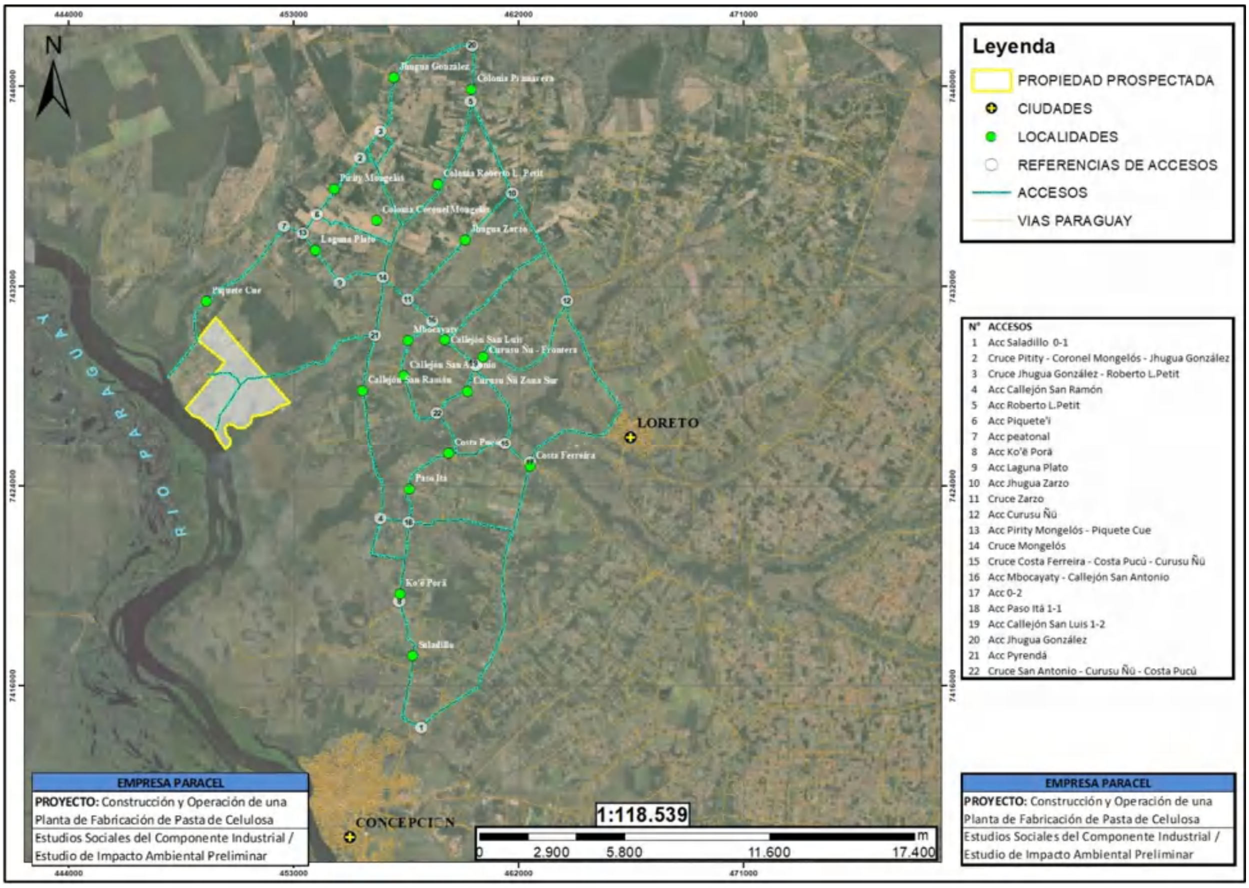


Figure 26 – Microterritories identified

The following table records information related to the mapped microterritories; which are expressed below according to the volume of data obtained by community in relation to:

- Year of establishment
- Approximate distance from the pulp mill (straight line distance),
- Approximate distance from the departmental capital (distance measured by route),
- Bordering microterritories,
- Access roads,
- Specificities and,
- Major holidays.

Table 67 – Summary description of identified microterritories

Microterritories	Description
 **Colonia Roberto L. Petit-** Approximate distance from the pulp mill: **6, 81 km.**	Approximate distance from Concepción: about 23 km from the departmental capital Bordering microterritories: Colonia Cnel. Mongelós, Mongelós Pirity, Jhugua González, Jhugua Zarzo. Most used access roads to the community: From Concepción, through Saladillo, passing by San Ramón and an intersection known by the inhabitants as Mongelós crossing (Piquete Cue access). From Loreto, through Costa Ferreira, passing through Curuzu Ñu and Callejón San Luis. Used less frequently: Vallemí - Concepción paved route, Jhugua González access. Paved route Vallemí - Concepción, access Jhugua Zarzo. Particularities: This micro territory fulfills a function of focus or center for communities of the zone, since in this one they concentrate institutions of health, security and education and a horse race where they make races of horses. In addition, due to its location it is used as a meeting point for different community organizations. The construction of the USF is scheduled to be completed in 2021. Temporary attention is given to the ACPN premises located in the adjacent community of Colonia Cnel. Main celebration: Christ the King, celebrated on the third Sunday of November.
 **Colonia Cnel. Mongelos** Approximate distance from the industrial plant: **6,67km.**	Year of establishment: It was established in 1921. Approximate distance from Concepción: It is located about 21km from the departmental capital. Bordering microterritories: Roberto L. Petit Colony, Pirity Mongelós, Laguna Plato. Most used access roads to the community: The community of Colonia Coronel Mongelós is connected through local roads (all weather), being the most used accesses, the same ones indicated in the description of the community of Colonia Roberto L. Petit. Particularities: A street divides the towns of Colonia Cnel. Mongelós and Colonia Roberto L. Petit. The School and the College are located 500 meters from the 18th Police Station of the neighboring town. At organizational level they are adhered in favor of the request of distraction of Paso Horqueta; the same as other residents of neighboring communities. Main celebration: The 24th of September is celebrated the day of the Virgen de las Mercedes; Patron Saint of the community.
 **Pirity Mongelós** Distancia aproximada con relación a la planta**: 4,54 km**	Approximate distance from Concepción: It is located approximately 25 km north of the capital of the department. Bordering microterritories: The adjacent communities are Colonia Cnel. Mongelós, Colonia Roberto L. Petit and Jhugua González. Most used access roads to the community: Mongelós Crossing, which joins the road from Callejón San Ramón to Saladillo (from Concepción), passing by Laguna Plato; and the Intersection between Colonia. Roberto L. Petit and Jhugua González. Special features: It is called Pirity because there is a water pirizal in the area. About 45 families live there. The community has a school, which is attended by children from the area and neighboring communities such as Laguna Plato and Piquete Cue. Main celebration: San José, March 19th.

Microterritories	Description
 **Jhugua Zarzo** Approximate distance from the plant**: 7,56km.**	Approximate distance from Concepción: 23 km from the departmental capital Bordering microterritories: Roberto L. Petit Colony, Colonia Cnel. Mongelós, Callejón San Luis. Year of establishment: In 1950 the first six inhabitants settled in the area; it was recognized as a community in 1988. Most used access roads to the community: It can be accessed through the Vallemí-Concepción paved road; using the Callejón San Ramón local road, connecting with Saladillo from Concepción. Another alternative is to enter the town of Costa Ferreira, passing through the community of Curuzu Ñu and Callejón San Luis, until the intersection known as Zarzo crossing. Particularities: Approximately 25 houses and 50 families are registered. The area has a school until the 6th grade. Most of them continue their studies in the school of Cnel. Mongelós. Main celebration: Sagrada Familia, celebrated on the last Sunday of December. There are bullfights, lottery games, Mass, Baptism, First Communion, and a party.
 **Laguna Plato** Approximate distance from the plant**: 3,43km.**	Approximate distance from Concepción: It is located 22 km north of the urban area of the city of Concepción. Year of formation: It was formed approximately 100 years ago, as was the neighboring community of Piquete Cue. Bordering microterritories: Piquete Cue, Pirity Mongelós. Most used access routes to the community: One of the routes to access the area is through the Mongelós intersection that joins the road to the town of Callejón San Ramón with Saladillo (from Concepción); or through the intersection of Colonia Roberto L. Petit and Jhugua González, passing through Pirity Mongelós. Special features: Through the Pro-Health Commission, the creation of a Health Post was requested, and construction work is expected to begin in the course of 2020. Main celebration: December 8th Virgen de Caacupé.
 **Colonia Primavera** Approximate distance from the plant**: 12,46km.**	Approximate distance from Concepción: 28km from the departmental capital. Bordering microterritories: Jhugua González, Colonia Roberto L. Petit. This micro territory is located in the district of Concepción, approximately 14 km from the city of Loreto. Most used access roads to the community: it can access the community by the Vallemí - Concepción route or by entering the side of the 18th Police Station in Colonia Roberto L. Petit. Special features: In the area there is an average of 80 houses and a total of 250 people. They have educational institutions and receive medical attention in Paso Horqueta. Main celebration: San Miguel, September 29th.
	Approximate distance from Concepción: about 25 km from the departmental capital. Bordering microterritories: Mbocayaty, Curuzu Ñu, Jhugua Zarzo. Most used access roads to the community: From Loreto, by Costa Ferreira access, passing the Costa Pucu and Curuzu Ñu crossing. From Concepción, by access to Saladillo, passing by Co'ê Porâ crossing located in Callejón San Ramón - Paso Itá, Costa Pucu and Curuzu Ñu. From Concepción, by access to Saladillo, passing through Co'ê Porâ, San Ramón, the intersection known as Mongelós crossing (access to Piquete Cue), Colonia Roberto L. Petit and Jhugua Zarzo crossing. Special features: In the area there are approximately 60 houses. It has the

Microterritories	Description
Callejón San Luis Approximate distance from the plant**: 6,65km.**	peculiarity of gathering periodically the inhabitants of Tres Cerros, San Alfredo, Paso Barreto, Loreto, Mbocayaty, Jhugua Po'i, Concepción, Piquete Cue, Callejón San Ramón, Callejón San Antonio, Callejón San Luis, Laguna Plato, Potrerito and others; because they have a club of Lazo where meetings with groups of Laceros take place. At present, work is being done on the construction of a concrete bridge that will facilitate the connection with the Vallemi- Concepción route. This route is mostly used by residents of the communities of Callejón San Luis, Jhugua Zarzo, Colonia Roberto L. Petit, Colonia Coronel Mongelós, Pirity Mongelós and Jhugua González. Main celebration: On June 21st, the day of San Luis González is celebrated
 **Jhugua González** Approximate distance from the plant**: 9,61km.**	Approximate distance from Concepción: 28 km from the departmental city. Bordering microterritories: The adjacent communities are Colonia Roberto L. Petit, Pirity Mongelós and Colonia Primavera Most used roads: The main access to the community is the Vallemí - Concepción paved road. it can also be used the local road from Colonia Roberto L. Petit and Colonia Coronel Mongelós, which connects with Saladillo from Concepción. Particularities: It is located approximately 5 km from the paved Vallemí-Concepción route. The area has a health post that offers health coverage to 134 families of the place. Main celebration: The 15th of November is the day of San Roque González de Santa Cruz.
 **Mbocayaty** Approximate distance from the plant**: 6,10km.**	Approximate distance from Concepción: it is approximately 19 km from the city of Concepción. Bordering microterritories: Callejón San Antonio, Callejón San Luis, Callejón San Ramón. Year of formation: The first inhabitants populated the place more than 50 years ago. Bordering microterritories: Callejón San Antonio and Callejón San Luis, Curuzu Ñu. Most used communication routes: From Costa Ferreira, passing through Curuzu Ñü, on the way to Callejón San Luis. By the road of Callejón San Ramón that connects with the access Saladillo, from Concepción. Special features: It is located in the center of the neighboring communities of Callejón San Antonio and Callejón San Luis. Formerly there was a ranch belonging to Florinda Peña that was named Mbocayaty and served as a reference to get to the place. As time went by, it became part of the identity of the area, officially acquiring that name. At present, a total of 20 houses and 21 families are registered. In addition, there is a communal field with 68 hectares of extension that are used for cattle raising; and a total of 44 associates.
	Approximate distance from Concepción: 15 km from the city of Concepción. Bordering microterritories: Mbocayaty, Curuzu Ñu, Callejón San Ramón, Costa Pucu. Year of establishment: approximately 51 years ago. Most used communication routes: To enter the community from Loreto, by Costa Ferreira access, passing the Costa Pucu and Curuzu Ñu crossing. From Concepción, by access to Saladillo, passing by Co'ê Porâ, San Ramón -

Microterritories	Description
Callejón San Antonio Approximate distance from the plant**: 4,76km.**	Paso Itá crossing, Costa Pucú and Curuzu Ñu. From Concepción, by access to Saladillo, passing through Co'ê Porâ, Callejón San Ramón, Mongelós crossing, Colonia Roberto L. Petit, Jhugua Zarzo crossing and Callejón San Luis. Special features: In the community there are a total of 52 families and 242 people. The micro territory is composed by an estimated total of 245 people. It is named Callejón San Antonio in honor of San Antonio de Padua. It has a USF that provides care to a total of 9 communities. They have a sub council of Health integrated by 3 representatives of each micro territory. Main celebration: June 13 is celebrated the day of San Antonio de Padua. The activities for that day consist of: procession, mass, sports activities, artistic festival and a dance party.
 **Paso Ita** Approximate distance from the plant**: 6km.**	Approximate distance from Concepción: about 10 km from the city of Concepción Borderline microterritórios: Costa Pucu, Co'ê Porâ, Costa Ferreira, Curuzu Ñu Most used routes of communication: From Concepción, entering through the community of Saladillo, passing through Ko'ê Porâ and the detour that connects with the community of Callejón San Ramón. -From Loreto, through Costa Ferreira access, passing the Curuzu Ñü crossing and the Costa Pucu community. Particulars: It is located in the center of the localities of Co'ê Porâ and Costa Pucu; and to 5km of USF of Callejón San Antonio. In the area there are approximately 60 families. Main celebration: Virgen de los Dolores, September 15th.
 **Costa Pucu** Approximate distance from the plant**: 6,67 km.**	Approximate distance from Concepción: It is located about 13 km from the city of Concepción. Bordering microterritories: The closest communities are Paso Itá, Callejón San Antonio, Curuzu Ñu and Costa Ferreira. Particularities: There are about 56 houses and an average of 200 people in the area. Most used communication routes: they are the same as those mentioned in the description of Paso Ita. Main celebration: Its inhabitants meet every 6th of May to commemorate the day of the Patron Saint Domingo Sabio.
 **Costa Ferreira** Approximate distance from the plant**: 9,86km.**	Approximate distance from Concepción: It depends institutionally on the municipality of Concepción and is located about 12 km from the capital of the department. Borderline microterritories: Curuzu Ñu, Costa Pucu. Most used roads: The community of Costa Ferreira is located on a paved road that links Concepción with Vallemí. The Access 0.2 is located in the community of Costa Ferreira. Particularities: Formerly known as Ferreira Cue. The first settlers settled in the area more than 100 years ago. It is a zone that counts on spas among them one of the most recognized, the Spas Paso Itá, with presence in the zone for more than 20 years. Main celebration: Santa Teresita, is celebrated on October 1st, there is a novena and a festival to celebrate.

Microterritories	Description
 **Curuzu Ñu** Approximate distance from the plant**: 7,78km.**	Approximate distance from Concepción: About 15 km from the city of Concepción. Bordering microterritories: It borders the microterritories of Costa Pucu, Callejón San Antonio, Mbocayaty and Callejón San Luis. Most used communication routes: From Loreto, through Costa Ferreira access, passing the Costa Pucu crossing. From Concepción, entering through the community of Saladillo, passing through Co'ê Porâ, Paso Itá and Costa Pucu. Particularities: It is divided in South and North zone; the second one is better known as Curuzu Ñu border. Both integrate a single water commission and there is a system that supplies both zones In the Southern Zone there is a communal field that has 660 ha for livestock and agriculture. Main celebration: San Pedro and San Pablo, June 29.
 **Callejón San Ramón** Approximate distance from the plant**: 2,99km.**	Approximate distance from Concepción: The micro territory is about 13 km from the capital of the department. Bordering microterritories: It borders the communities of Co'ê Porâ, Paso Ita and Callejón San Antonio. Most used communication routes: From Concepción through the community of Saladillo, passing through Co'ê Porâ; from Loreto through the community of Costa Ferreira, passing through Curuzu Ñu, Callejón San Luis, Cruce Jhugua Zarzo and the intersection known as Mongelós crossing; or through Costa Ferreira, passing through Costa Pucu, Paso Ita and San Ramón crossing. Special features: There are approximately 40 houses in the area. The school in the area has a schooling level up to the second cycle of basic schooling. Main celebration: The 31st of August the Patron Saint's festivity is celebrated in honor of San Ramón.
 **Co'ê Porâ** Approximate distance from the plant**: 7,16km.**	Approximate distance from Concepción: The community is about 6 km from the city of Concepción. Bordering microterritories: It borders the microterritories of Saladillo, Callejón San Ramón and Paso Ita. Most used communication routes: This micro territory is connected through local roads (all weather), being the most frequent From Concepción, by Saladillo. From Loreto, through Costa Ferreira, passing through Costa Pucu and Paso Ita. Special features: In the area there are approximately 150 families. Main celebration: Sacred Heart of Jesus; it is celebrated on the third Sunday of June.
 **Saladillo** Distancia aproximada con relación a la planta**: 10,93km**	Approximate distance from Concepción: it is located about 2 km from the departmental capital. Bordering microterritories: Co'ê Porâ Most used communication routes: it can allow to enter the community through two main routes: From Concepción by the paved route Concepción-Vallemí. From Loreto, using the access to Costa Ferreira, passing through Costa Pucu, Paso Ita and Co'ê Porâ. Particularities: It is called Saladillo because of the type of land; which has similar characteristics to the Paraguayan Chaco. It is one of the main routes used by the inhabitants of the area because it is less than 1 km from the route that connects Vallemí with Concepción. In the area there are approximately 90 houses with an average of 400 people in total. The community has a school, a college belonging to the Congregation of the Blue Sisters, a Recreational Center with swimming pools and a field used for

Microterritories	Description
	soccer tournaments for women and men. People of all ages and from different communities participate in this activity in order to encourage their teams or to share with friends and neighbors. Main celebration: San José 19 of March.

1. Source: Elaboration based on data obtained from interviews with key actors in the microterritories.

Register of identified institutions and reference sites

This section intends to graphically demonstrate the institutions and sites of interest identified by each micro territory. In the study area, educational institutions, spas, water systems, cemeteries, police stations, churches and some open spaces such as squares and sports sites were observed.

The spas are places frequented by local residents and other cities as a space for recreation and leisure; some charge a minimum admission fee so that visitors can make use of the facilities.

In the area of Saladillo, the 20 de October field is used for football tournaments for both men and women. It is frequented by neighbors and residents of the surrounding areas.

In the area there are almost no squares; only San Pedro Square, located in the Curuzu Ñu area, was registered. It is mainly used by local people.

Next, a photographic registry of the identified sites is exposed.

Table 68 – Register of recreational spaces

Photograph registers	Recreational spaces	Micro territory
	Balneario Sin Colales	Callejón San Ramón
	Balneario Vy’a Renda	Callejón San Ramón
	Balneario la Familia	Costa Pucu
	Balneario Ita	Costa Ferreira

	Recreative Centre San José	Saladillo
	Cancha 20 de October (pool)	Saladillo
	Plaza San Pedro	Curuzu Ñu

In the area, some cemeteries were identified that, although they are located in a defined micro-territory, are generally spaces shared among the communities. Cemeteries were recorded in the microterritories of Co'ê Porâ, Callejón San Ramón, Callejón San Antonio and Jhugua González. Reference photographs are shown below.

Cementerio Curuzu Ñu

Cementerio Co’ê Porâ

Comisaria-Colonia Roberto L. Petit

Puesto Policial Laguna Plato

Figure 27 – Reference photographs

In terms of surveillance, there is a police post in Laguna Plato and a police station located in Colonia Roberto L. Petit with an area of intervention for the communities of Colonia Cnel. Mongelós, Pirity Mongelós, Jhugua González, Laguna Plato, Piquete cue, Mbocayaty, Callejón San Ramón, Callejón San Luis, Callejón San Antonio, Jhugua Zarzo, Col.

Below, it is possible to visualize the geographical location of the sites of interest such as recreational spaces, water systems, educational and health units, churches and cemeteries.

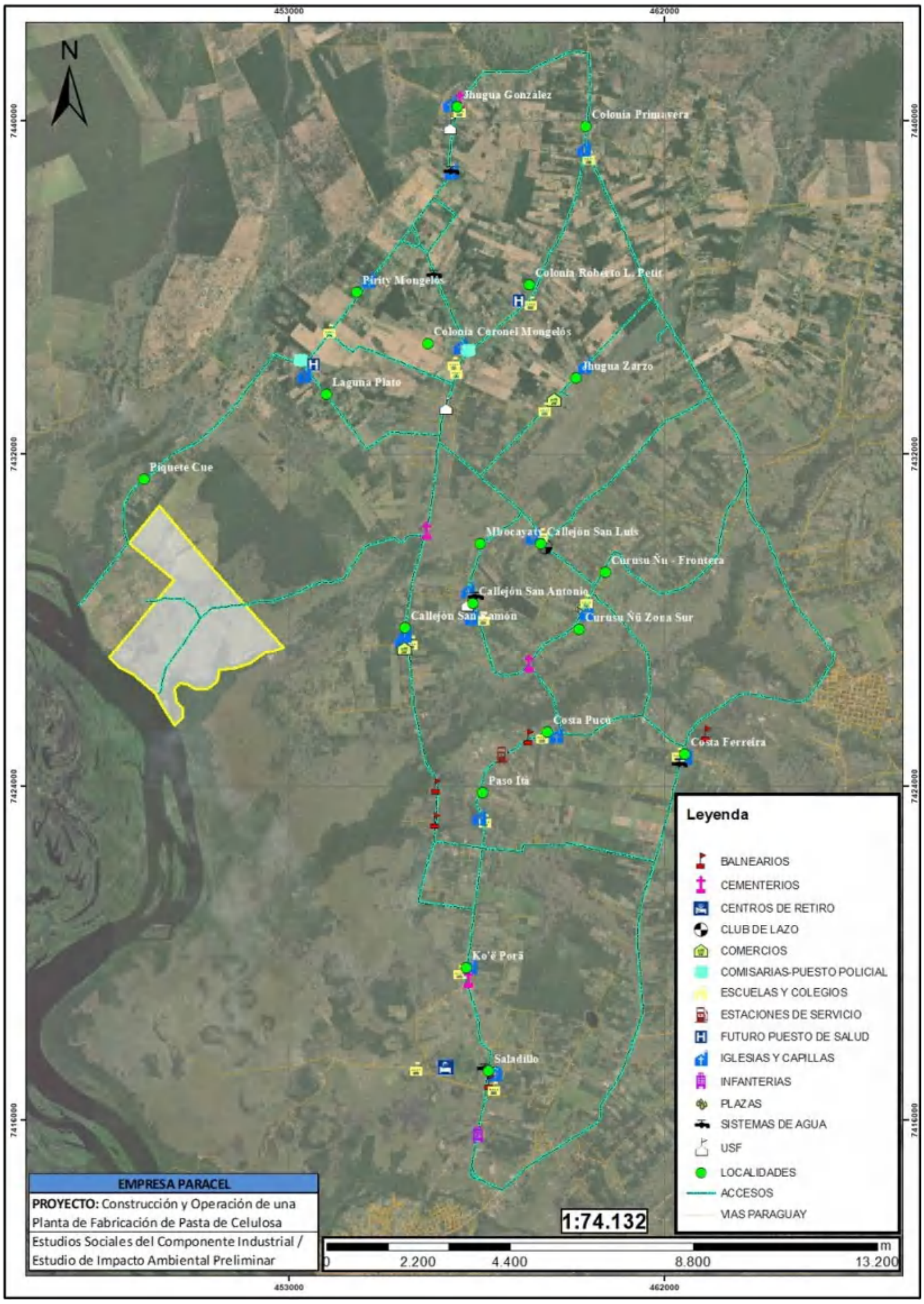


Figure 28 – Geographic location of institutions and sites of interest

9.3.4.2.5.3 Presentation of results generated from the field survey process

Population Density

According to projection data for the period 2020, the population of the district of Concepción is 87,215 inhabitants.

Based on the information obtained during the fieldwork carried out by the external consultant Lic. Caren Kremer and team, it became evident that in the microterritories there is a total of 4,866 inhabitants; corresponding to 5.58% of the estimated population according to the forecasted evolution.

Table 69 – Total population of microterritories in the district of Concepción

Micro region	Micro territories	Number of women	Number of men	Total General
1	Colonia Roberto L. Petit, Colonia Cnel. Mongelós, Pirity Mongelós, Jhugua Zarzo, Laguna Plato, Piquete Cue,	734	900	1.634[91]
	Jhugua González,	244	288	532[92]
	Colonia Primavera	-	-	250[93]
2	Callejón San Luis, Mbocayaty, Callejón San Ramón, Callejón San Antonio, Curuzu Ñu, Costa Pucu, Paso Ita, Co'ê Porâ y Saladillo			2.450[94]
	Costa Ferreira	-	-	120
Obs. In addition, disaggregated data by gender were obtained for eight communities. Two of the three health units provided official data in greater detail. The table presenting general data is based on the perception of key respondents.				**4.866**

Source: Elaboration based on data obtained from interviews with key actors in the micro territories.

Homes and Lodgings

According to data provided by the key references of the health micro-regions and inhabitants of the micro-territories, there is a total of 661 dwellings in micro-region 1 which includes the micro-territories of Colonia Roberto L. Petit, Colonia Cnel. Mongelós, Pirity Mongelós, Jhugua Zarzo, Laguna Plato, Piquete Cue, Jhugua González and Colonia Primavera.

In the microterritories that form part of micro-region 1, no official data were obtained during the interview with the health reference in the area with greater detail by microterritories. Therefore, approximate data are presented based on the data provided by some inhabitants. Being the total 356 dwellings without data of the microterritories of Callejón San Antonio, Curuzu Ñu, Co'ê Porâ.

[91] Entrevista referente Unidad de Salud de Colonia Roberto L. Petit. Fecha 17.01.2020
[92] Entrevista referente Puesto de Salud Jhugua Gonzalez. Fecha 20.01.2020
[93] Entrevista referente Comisión Vecinal Colonia Primavera. Fecha: 20.01.2020
[94] Entrevista referente de Unidad de Salud Callejón San Antonio. Fecha 21.01.2020

Table 70 – Number of lodgings 2

Micro territories	Housing (Lodgings)
Callejón San Luis	60
Mbocayaty	20
Callejón San Ramón	40
Callejón San Antonio	-
Curuzu Ñu	-
Costa Pucu	56
Paso Ita	60
Co'ê Porâ	-
Saladillo	90
Costa Ferreira	30
Total	**356**

Source: Elaboration based on data obtained from interviews with key actors in the micro territories.

Services

Water system

Most DIA interviewees mentioned that all micro territories have a water system from the local sanitation board, as already mentioned in the characterization of the project's IIA. Many times the communities are left without water due to permanent power cuts in the area; without it, the motor cannot be started. To alleviate or prevent these shortages, cases were observed such as those of the USF in Callejón San Antonio, which has its own water reservoir (tank) that is used when there is a shortage; but it is supplied from the same community water source. There are only 2 villages that have a well[95]. Others, such as the communities of San Luis, must travel to neighboring communities; or have water tanks; but this does not apply in all cases.

Waste treatment

In terms of final waste disposal, the description of the department of Concepción mentions that the majority of the population resorts to burning because they do not have waste collection services.

It could be observed that this statement is applicable to the microterritories of the project's DIA. In the following table it can be seen that 59% refer to the final treatment consisting of burning, 38% bury and on a smaller scale corresponding to 3% mention that they deposit their waste on the farm (this system is applied to organic waste).

[95] Entrevista referente de Salud. Fecha 21.01.2020

Table 71 – Treatment of Solid Waste

Micro territories	Incineration	Bury (digging)	Pull on the field
Callejón San Ramón	3	1	-
Callejón San Luis	2	1	-
Callejón San Antonio	1	1	-
Colonia Primavera	-	1	1
Costa Pucu	3	1	-
Jhugua González	1	1	-
Jhugua Zarzo	2	2	-
Co'ê Porâ	4	1	-
Curuzu Ñu	3	1	1
Laguna Plato	4	4	-
Mbocayaty	2	1	-
Pitity Mongelós	1	-	-
Colonia Cnel. Mongelós	-	1	-
Paso Ita	1	-	-
Colonia Roberto L. Petit	6	4	-
Saladillo	4	3	-
Costa Ferreira	1	1	-
Total	**38**	**24**	**2**

Source: Elaboration based on data obtained from interviews with key actors in the micro territories.

Also, vacant lots were identified near the city's urban radius that are used as garbage dumps in the absence of collection services in the area.

Figure 29 – Photograph taken in the micro territory: Saladillo on waste disposal

Sanitary landfill and rainwater drainage/sewerage system

There is no sanitary and/or rainwater sewerage for the disposal of sewage or waste; and a high percentage of households have latrines. This can be contrasted with the characterization of the IIA for the Department of Concepción and the results of the micro-territory interview processing in the IDA. In this sense, it can be observed that 43 percent refer to the use of latrines, 43 percent to cesspits, and 14 percent have a cesspit and/or septic tank for the disposal of sewage in the households.

Table 72 – Sanitary landfill or drainage system

Micro territories	Septic tank	Septic Chamber	Toilet vase
Callejón San Ramón	3	1	2
Callejón San Luis	2	-	2
Callejón San Antonio	1	-	1
Colonia Primavera	1	-	
Costa Pucu	2	1	2
Jhugua González	1	-	1
Jhugua Zarzo	2	1	1
Co'ê Porâ	5	2	3
Curuzu Ñu	3	1	3
Laguna Plato	2	1	5
Mbocayaty	1	-	2
Pirity Mongelós		-	1
Colonia Cnel. Mongelós	1	-	1
Paso Itá	1	-	1
Colonia Roberto L. Petit	4	3	5
Saladillo	4	-	4
Total	34	11	34

Source: Elaboration based on data obtained from interviews with key actors in the microterritories.

Communication channels

Considering the survey carried out, the most used roads indicated by the inhabitants are Saladillo, Costa Ferreira and San Ramon.

In the territory, it is possible to travel on local roads with gravel type paving in the areas of Saladillo, Callejón San Ramón, Paso Ita, Costa Pucu, Curuzu Ñu. Others, like the communities of Colonia Roberto L. Petit, Colonia Cnel. Mongelós, Mongelós Pirity, Laguna Plato, Mbocayaty, Callejón San Antonio and Jhugua González have dirt roads. As reported by the people interviewed, many of these roads are in poor condition. This means that on many occasions, the communities are isolated, especially during the rainy season, because the access roads become inaccessible.

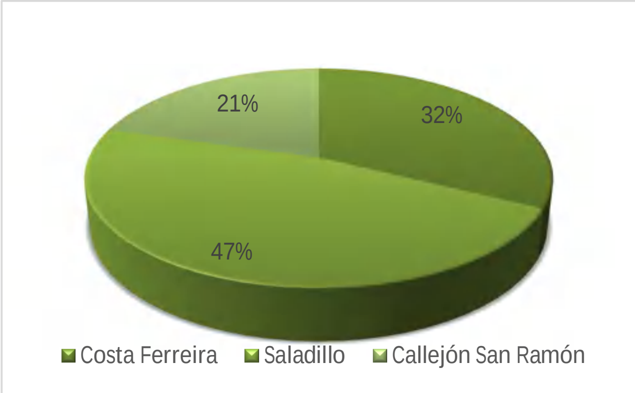


Figure 30 – Main Access roads

Source: Elaboration based on data obtained from interviews with key actors in the microterritories

Micro territory: Callejón San Ramón

Micro territory: Roberto L. Petit

Cruce Costa Pucu-Curuzu Ñu-Costa Ferreira

Micro territory: Callejón San Luis, desvío Mbocayaty

Figure 31 – Photographs of micro territories in the rainy season

Transportation

All of the interviewees stated that public transport has not been available in the area for approximately 15 years. This is due to the massive increase in the use of motorcycles to travel, which shows that it is the main means of transport used. The following is a reference photographic record at the district and micro territory levels of the DIA.

micro territory: Cruce San Ramón-Paso Ita

District: Concepción

District: Horqueta

District: Belén

micro territory: Saladillo

Figure 32 – Photographs of different places in the DIA

Use of technologies

As for the use of technologies, 53% said they have a cell phone, of which 47% have access to Internet connection, being the most used social networks Whatsapp and Facebook.

One of the problems identified by the inhabitants is the lack of signal in the area, which makes communication difficult. At the same time, they pointed out that it is necessary to install a network system to improve the service. The following table 73 is recorded by micro territory.

Table 73 – Use of technologies

Micro territories	Telephone	Internet	Whatsapp	Facebook
Callejón San Ramón	3	3	2	-
Callejón San Luis	2	1	2	1
Callejón San Antonio	1	1	1	1
Colonia Primavera	1	-	-	-
Costa Pucu	3	3	2	1

Micro territories	Telephone	Internet	Whatsapp	Facebook
Jhugua González	1	1	1	1
Jhugua Zarzo	1	1	1	1
Co'ê Porâ	5	5	4	4
Curuzu Ñu	3	2	2	2
Laguna Plato	4	3	5	4
Mbocayaty	2	1	2	2
Pirity Mongelós	1	1	1	1
Colonia Cnel. Mongelós	1	1	1	1
Paso Ita	1	1	1	1
Colonia Roberto L. Petit	5	5	3	2
Saladillo	4	4	4	4
Costa Ferreira	1	1	1	1
Total	**39**	**34**	**33**	**26**

Source: Elaboration based on data obtained from interviews with key actors in the micro territories.

Health services

In the area of study there are 3 health units that provide primary health care. They cover a total of 4516 inhabitants distributed in 16 micro territories.

The following table shows some of the main characteristics observed.

Table 74 – Health services

Category	Location	Micro territories	Population	Characteristics
USF	**Colonia Roberto L. Petit**	Colonia Roberto L. Petit, Colonia Cnel. Mongelós, Jhugua Zarzo, Laguna Plato, Pirity, Piquete Cue, y las estancias vecinas.	Total in the area: 1634 Women: 734 Men: 900 Children from 0 to 27 days: men 2 Children 28 days to 11 months: women 9, men 12 Children 1-4 years old: women 65, men 61 Children 5-14 years: women 147, men 186 Women from 15 to 49 years old: 340 Women from 50 to 64 years old: 100 Males 15-64 years old: 539 Men and women 65 years old and older: women 73, men 100	The FSU has 5 community agents; 1 auxiliary nurse, 1 graduate in Nursing and 1 doctor in Family Medicine. They are providing care at the ACPN headquarters while construction of the new facility is being completed.

Category	Location	Micro territories	Population	Characteristics
USF	**Callejón San Antonio**	Callejón San Luis Mbocayaty Callejón San Ramón Callejón San Antonio Curuzu Ñü Costa Pucú Paso Itá Co'ê Porâ Saladillo	**2450 people (total)**	20 years ago, it used to be a health center. For the last 10 years it has had the status of a Family Health Unit. This year the health council is being renewed, made up of sub-councils in each community. Each Sub-council of health has 2 to 3 members per community for representation. The USF has had 3 health agents for the last 4 months. In addition, there is 1 doctor for general medical care, 1 licensed nurse, 1 auxiliary nurse, 1 doctor for dental care.
Health Post (Centre)	**Jhugua González**	**Jhugua González**	**Total: 532** Women: 244 Men: 288 Children from 0 to 27 days: men 1 Children aged 28 days to 11 months: women 2, men 2 Children 1-4 years old: women 23, men 14 Children 5-14 years old: women 54, men 51 Women from 15 to 49 years old: 129 Women from 50 to 64 years old: 26 Women 65 years and older: 22 Males aged 15-49 years: 161 Men 50-64 years old: 26 Men 65 years old and over: 21	The health post has a Licentiate in Nursing, a Community Health Agent and a Doctor (general services). The opening hours are from 8:00 a.m. to 7:00 p.m. and the days for home visits are Tuesdays and Thursdays. They are currently struggling to set up a Family Health Unit.

Source: Elaboration based on data obtained from interviews with key actors in the micro territories

Educational institutions

There are a total of 15 educational institutions, all corresponding to the basic school.

There are a total of 4 middle level educational institutions located in the microterritories of Colonia Primavera, Colonia Cnel. Mongelós, Saladillo and Curuzu Ñu.

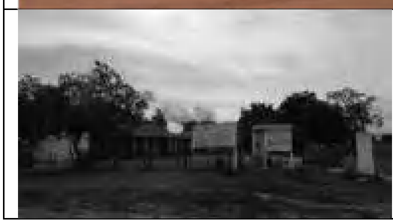
The towns of Mbocayaty and Laguna Plato do not have educational institutions; those who, for reasons of proximity, go to the educational center closest to the community.

According to the Municipal Development Plan of Concepción (2016), referred to in previous paragraphs, there are 50 institutions located in rural areas. In this sense, the institutions registered in the micro territories represent 30% of the existing rural educational offer in the district.

The following table contains a list of educational institutions corresponding to the levels of basic school education and secondary education.

Table 75 – Educational institutions

Photographic registers	Micro territories	Educational institutions
	Callejón San Ramón	Elementary school n. 4918 “San Ramón”
	Callejón San Luis	Elementary school n. 4917 “Florinda Arce de Páez”
	Callejón San Antonio	Elementary school n.2583 “San Antonio de Padua”
	Costa Pucu	Elementary school n.1729 “Santo Domingo Sabio”
	Jhugua González	Elementary school n.4922, San Roque González de Santacruz

Photographic registers	Micro territories	Educational institutions
	Jhugua Zarzo	Elementary school “Don Juan Antonio Zaracho”
	Co’ê Porâ	Elementary school n.841 “Sagrado Corazón de Jesús”
 	Curuzu Ñu	Elementary school n.1722 “San Pedro” National High School "San Pedro"
	Pitity Mongelós	Elementary school n. 2582 “Defensores del Chaco”
	Colonia Cnel. Mongelós	Elementary school n.2080 “Concepción Macedo de Denis” Colegio Nacional Coronel Mongelós,

Photographic registers	Micro territories	Educational institutions
	Paso Ita	Elementary school “Virgen de los Dolores”
	Colonia Roberto L. Petit	Elementary school n.2670 “Cristo Rey”.
	Saladillo	School Inmaculada Concepción “Irene Carduz” (Centro de Formación)
	Saladillo	Elementary school n. 4909 “Don Trifón Echague”
	Costa Ferreira	Elementary school n.1729 “Santo Domingo Sabio”
	Colonia Primavera	Elementary school n.1721- Jesús Misericordioso National Highschool Jesús Misericordioso

Source: Elaboration based on data obtained from interviews with key actors in the microterritories.

Poverty

From the data referred to for the department of Concepción in terms of poverty, it can be seen that approximately 107,097 people are in a situation of poverty and 15,911 in a situation of extreme poverty. Although the trend is towards the concentration of poverty in urban areas, the panorama for the rural sector is still a relevant indicator in quantitative and qualitative terms[96].

In this sense, the actors consulted in the micro territories pointed out aspects linked to social and economic problems. The following table shows data provided by key references of the studied micro territories. It presents the five main social problems, which are listed on a scale from 5 to 1, in order of highest to lowest priority.

Table 76 – Prioritization of social problems in the micro territories of the district of Concepción

Social and cultural issues	Priority 5	Priority 4	Priority 3	Priority 2	Priority 1	Total amount mentioned
Rustling (theft)	9	4	1	1	0	15
Access to education	2	-	1	3	1	7
Road unsafety	3	4	3	2	0	12
Uprooting	3	3	2	3	1	12
Emigration	2	3	-	1	1	7
Migration	5	5	4	3	4	21
Poverty	4	1	3	1	1	10
Insecurity/Theft	6	6	-	-	1	13

(purple)	Referenced on at least 3 levels of prioritization
(orange)	Referenced on at least 4 levels of prioritization
(yellow)	Referenced in 5 levels of prioritization

Source: Elaboration based on data obtained from interviews with key actors in the microterritories

Considering the system in place, the main factors in order of priority can be seen to be: cattle (priority 5), insecurity/theft (priority 4), migration (priority 3), access to education, migration and uprooting (priority 2) and migration (priority 1).

According to the assessment scale, migration was mentioned as the main problem in priorities 3, 2 and 1, and was also mentioned in priorities 4 and 5.

Given this particularity, it is interesting to visualize the degree of significance and importance that a factor acquires, considering not only the frequency of appearance, but also the fact of being identified in the different levels of prioritization. For a better visualization, the data are arranged in the following table.

According to the established system of prioritization, the factors referred to in all instances are: migration, uprooting and poverty.

Cattle, road insecurity, access to education and emigration are mentioned in 4 of the three levels; and insecurity/theft is highlighted in 3 levels of prioritization.

[96] Ver ítem sobre Pobreza, Distribución, Necesidades Básicas Insatisfechas

Social Problems	Number of Levels	Total Quantity
Uprooting	5 levels	12
Migration	5 levels	21
Poverty	5 levels	10
Cattle	4 levels	15
Access to Education	4 levels	7
Road Insecurity	4 levels	12
Emigration	4 levels	7
Insecurity/theft	3 levels	13

Source: Elaboración en base a datos obtenidos de entrevistas a actores claves de los microterritorios

Regarding the social issues; in terms of quantification, they represent in order of importance the following: migration 22%, theft of cattle 16%, insecurity/thefts 14%, uprooting and road insecurity 12%, poverty 10%, access to education and emigration 7%.

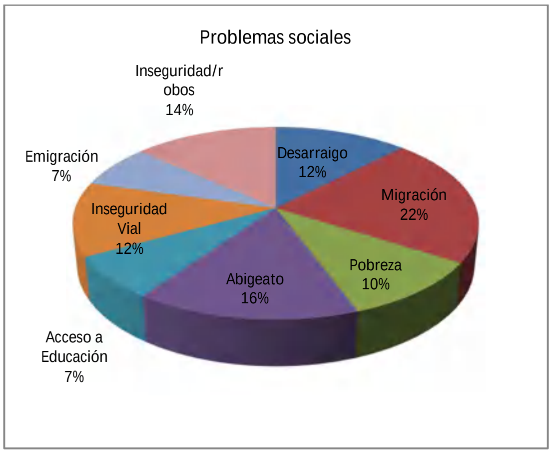


Figure 33 – Social issues

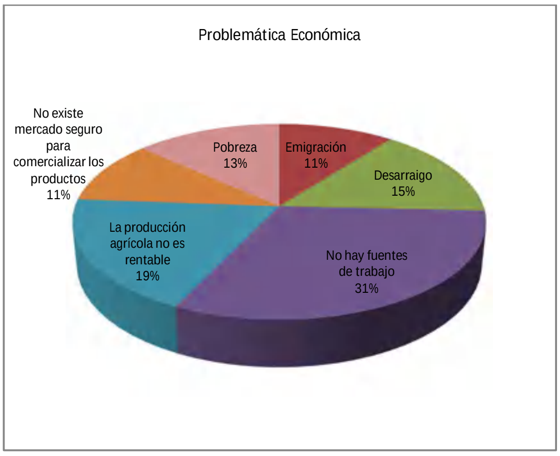


Figure 34 – Economic issues

Source: Elaboración en base a datos obtenidos de entrevistas a actores claves de los microterritorios

However, as economic problems are mentioned firstly the lack of sources of work (31%), followed by the lack of profitability of agricultural production (19%), uprooting (15%), poverty (13%) and fifthly the lack of a secure market to market the products and emigration (11%).

In both cases the form of valuation varies, but factors such as poverty, emigration and uprooting are referenced in the case of both social and economic problems. These factors refer to socio-historical aspects; therefore, they cannot be considered in isolation but as phenomena with a greater or lesser degree of interdependence according to the level of observation that is set up.

Economic activities and income

The average income in the department of Concepción is almost 40% lower than in Amambay and 7.45% higher than in San Pedro as referred to in the IIA characterization item [97].

Table 77 – Main economic activities

Economic Activities	**Agricultura**	Livestock	**Comercio**	**Laborer / Changa**
Callejón San Ramón	3	1	2	1
Callejón San Luis	2	2	1	2
Callejón San Antonio	1	1		1
Colonia Primavera	1		1	1
Costa Pucu	3	3	3	2
Jhugua González	1	1	1	1
Jhugua Zarzo	2	1	1	2
Co'ê Porâ	4	3	1	3
Kurusu Ñu	3	2	1	
Laguna Plato	3	5	2	4
Mbocayaty	2	2		
Pirity Mongelós	1	1		
Mongelós	1		0	1
Paso Ita	1	1		
Colonia Roberto L. Petit	7	7	4	3
Saladillo	3	3	3	2
Costa Pucu				
Costa Ferreira	1	1		1
Total	38	34	20	24

Source: Elaboration based on data obtained from interviews with key actors in the microterritories.

The economic activities identified in the area in order of importance are: agriculture, cattle raising, work as a day laborer/sweeper, and trade.

A small number of the population has access to permanent employment. Most of the inhabitants, both men and women, work in agriculture and livestock.

[97] See item on Poverty, Distribution, Unsatisfied Basic Needs

In the territory, there is a predominance of small-scale production destined to a greater extent for family consumption and a smaller percentage for sale. Establishments operating at a large-scale production level were also identified.

People who sell farm and orchard products report that the agricultural sector is not currently profitable compared to previous years, when crops such as sesame and tartar were sold at a better price and the loss of production due to bad weather and pests did not represent risks that were difficult to control.

It was also mentioned that low profitability is associated with the absence of a secure market for marketing, the high costs of moving production and the lack of sustained technical assistance from local government actors. Therefore, they point out the need for greater support from local authorities in terms of training and delivery of materials and inputs to work the land, in order to make the peasant family economy sustainable.

Considering the particularities observed in the field of agriculture and livestock. It is important to point out that the community of Curuzu Ñu has a communal field; that they are communal lands that operate under a system of solidarity contribution that is destined to improve the infrastructure of the place. At the moment they are 60 associates. The land was divided into lots in 1988, it has 60 hectares in total; where each member has his own wired lot. A fraction of the land is used for cattle raising and another for agriculture (farm and orchard).

This same system of community organization was observed in Mbocayaty. The land is used for cattle raising; therefore, the members use the land for breeding and grazing cattle.

Currently there are a total of 14 active members and 30 adherents. The active members must make a monthly contribution for maintenance and at the same time contribute to the cleaning of the land; the others are not obliged to contribute the stipulated amount.

On the other hand, 21% refer to the fact that a large fraction of the population is dedicated to working as day laborer's or doing piecework, which consists of remuneration for activity or service rendered and is generally linked to an occupation system based on the informal economy. The average daily wage is 65,000 to 75,000 guaraníes. In many cases they face precarious working conditions that are accepted in order not to fail to generate income. Among these are the fact that they work for more than 8 hours, must do other work in addition to what has been agreed, and are not paid the full amount established; among other things, they are part of a sector that is doubly vulnerable.

Under this logic, the work in the neighboring estancias and/or in the Chaco is grouped. They consist of the development of tasks for a defined period of time of one day or even months; which does not necessarily translate into a definitive change of residence. Among the activities they carry out are: fencing, painting, land cleaning, animal care, carpentry, sowing, among others. This is a predominantly male activity, both young and old.

While men are employed on the estates, women are left to take care of the home and raise the children. In addition, they are the ones who raise small livestock, sell the production from their gardens and farms and others that are usually offered at the fairs organized in squares or the market in the urban area of Concepción or are sold house to house to the neighbors in the area.

Other items that are grouped under this category are: the collectors, those who are dedicated to the sale of coal, logs (wood for firewood).

Figure 35 – Logging collectors - Callejón San Ramón

Figure 36 – Cattle farming

Some 17% mentioned trading as the main activity in the area; this is the fourth most pointed out aspect. In the microterritories, it is possible to observe the existence of small commercial and service enterprises such as: pantries, butcher shops, fuel supply centers, motorbike workshops, tire shops, hairdressing salons. Within the framework of the characterization of the DIA, some reference photographs are exhibited.

Figure 37 – Micro territory Curuzu Ñu

Figure 38 – Micro territory Colonia Coronel Mongelós

Figure 39 – Micro territory Co'ê Porâ

Figure 40 – Micro territory Pirity Mongelós

Most of these businesses are family businesses, in which household members (children, adolescents and adults), both women and men, have some degree of participation in the development of specific tasks such as: customer service, purchase of supplies and goods to restock the premises, collection and cleaning of the place, among others.

Since the money collected by families is part of their daily sustenance, even though the people who collaborate in the tasks receive no remuneration, they do have some degree of participation in the development of specific tasks, such as: customer service, purchase of inputs and merchandise to restock the premises, collection and cleaning of the place, among others.

Another activity identified in the area, but little referred to is fishing, both for consumption and for sale. The most popular area for fish extraction is Piquete Cue, where there is a road that connects to the river and is frequently used by local people and those living further away.

In the community of Laguna Plato there are four families whose economic activity has been fishing for several generations. They have been fishing, distributing and selling fish for more than 40 years. These families go to the riverside sites located on the grounds of Estancia Santa Clara and San Diego; in the community of Piquete Cue, for fish extraction and other times they cross the river in the direction of Isla Santa Bella to fish. For sale they have a variety of fish such as Surubi, Mandi'i, Boga, Pacu, Carimbata, Mangú; among others. Costs are stipulated in relation to weight and species. For example, the cost of Surubi per kilo is 20,000 gs.

Migration

According to Pereira, in his text "Departmento de Concepción. Riqueza y desigualdad social", approximately 40% of the people who migrated between 1997 and 2002 went to the Central Department, 16% to Asunción and 12% to Amambay. She also states that *"the emigration from the department of Concepción has a woman's face. 57 of every 100 migrants ... were women"*[98].

[98] Pereira, Hugo. *"Departamento de Concepción. Riqueza y desigualdad social"*. Available at: https://revistascientificas.una.py/index.php/RE/article/view/714

The migratory trends identified in the microterritories have similar characteristics to those mentioned in the previous paragraph, taking into account some particularities such as those mentioned in the following paragraphs.

The women who migrate mainly in Asunción and Concepción are mostly domestic workers and are seeking access to higher education and economic support for their families. The majority of women who migrate to Spain and Argentina also work as domestic workers, childcare workers and elderly people.

Previously, they sent remittances to the country more frequently. The crisis and the increase in the cost of living are factors that influence the amount and frequency of sending money. Many people no longer return to their home territory because the countries where they live offer better conditions and access to basic services.

Many young people migrate before completing their secondary education, work on the estancias in the Chaco because their parents cannot afford to pay for their studies and/or their families require higher incomes to survive.

9.3.4.3 Characterization of Directly Affected Area (DAA)

As mentioned in item 9.3.2.3 of the section Description of the Project's Areas of Influence, the study considers as part of the DAA, the social units and communities located in the immediate surroundings of the area prospected for the installation of the plant, within a radius of 1 km.

In this section, on the one hand, a description of the characteristics of the area as a result of direct observation and records prepared within this framework is made, and on the other hand, socio-economic information related to the social units identified will be presented. Both in the DIA and in this area the perception of the inhabitants regarding the undertaking was surveyed. The results obtained have been included in item 9.3.5: Survey of Social Perception.

It is important to highlight that there will be no displacement due to the project implementation, not even to the transmission line.

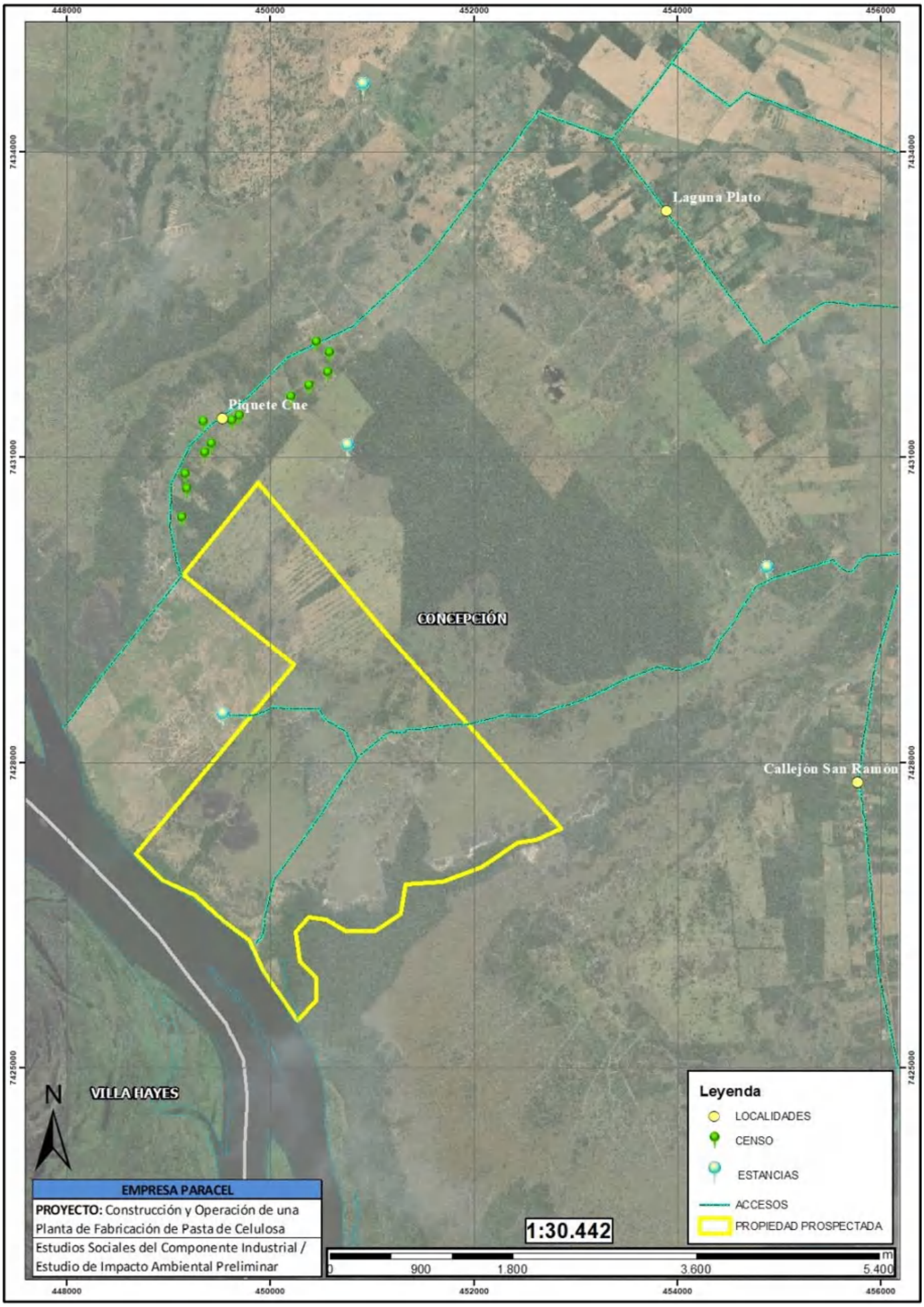


Figure 41 – Limits of Directly Affected Area (DAA)

Features of DAA

Taking into account the distance defined for the definition of the DAA, the information was collected in a micro territory called Piquete Cue, where 13 social units could be visited. These were located along approximately 3 km, mostly on the left side of the road (as this is the highest area) and at a distance of approximately 0.36 km to 1.49 km from the property area.

Likewise, as mentioned, it was possible to observe that there are ranches in the territory that are outside the radius of analysis established for the study. However, given the particularity of using the same access roads and being social units adjacent to the enterprise, it was decided to include them as part of the sample to be consulted during the process.

Figure 42 – Entrance by Piquete Cue

Source: Photographic record of field work. Consulting team. Concepción. January 2020.

Considering the complexity of obtaining information from secondary sources and taking into account the variants indicated in previous paragraphs, two alternatives were determined to access precise information that would make it possible to characterize the area and survey social perception, consisting of:

Methods

- Application of a socio-economic census to units within a 1 km radius;
- Application of semi-structured interviews to owners or managers of the estancias bordering the prospected area.

In the case of dwellings, 12 of the 13 units identified were counted because one of the owners was not there during the survey stage (for travel reasons). The persons consulted stated that the heads of household were 11 women and 10 men.

Seven establishments were identified, predominantly livestock farmers, and four interviews were held, three of which were with the managers or administrators and one with the owner of the establishment.

Two access routes to the community were also observed. One of the roads is located next to the Pirity Mongelós school; and has an exit to the curve before reaching the access gate to the San Diego ranch. This access road is frequently travelled on foot or by motorcycle due to its narrow.

Figure 43 – Access roads to the community

Source: Photographic record of field work. Consulting team. Concepción. January 2020.

Another way to access Piquete Cue is through the road that connects with the community of Laguna Plato. The road is located next to Police Station n. 6 in the aforementioned town and is used by smaller vehicles like motorcycles, cars, vans, and small trucks. It is also traveled on foot by residents and used for transporting and grazing animals, since one of the livelihoods of the area is small-scale cattle farming.

Following this path, in a straight line, it is possible to reach the access gate of another of the rooms in the area. At this point, on the right-hand side, it is possible to see a narrow path that can be travelled on foot or by motorcycle. The path leads to the waters of the Paraguay River and is frequently used by local people and nearby communities for fishing and recreation.

Figure 44 – Access roads to community
Source: Photographic record of field work. Consultant team. Concepción. January 2020

According to the inhabitants, the community has been in existence for more than 100 years. The families listed in the census stated that they had been established in the area for a minimum of six years and that they were between the ages of six and 94. They also mentioned that they live in their homes as indicated in the following table:

Table 78 – Time of establishment in the structure

Time of establishment in the structure	number	percentage
0 to 10 years	8	66,67%
11 to 20 years	1	8,33%
21 to 50 years	2	16.67%
51 to 80 years	1	8,33%
TOTAL	**12**	**100%**

Source: Socio-economic census, January 2020

Of the total of 12 families in the census, 8 declared that they had taken root between the ages of 0 and 10, 2 families with roots between the ages of 21 and 50, 1 of which had the most years of roots (between 51 and 80); and 1 family with roots between the ages of 11 and 20.

With regard to the characteristics of the structures visited, it can be stated that they are all family dwellings; 50% of them carry out productive activities for self-consumption and 50% are dwellings that also have a business and/or some productive activity for sale.

The predominant economic activity in the area is livestock farming. The families registered in Piquete Cue work mainly on nearby farms (several on the Cerrito farm), and also produce milk, cheese and raise animals for their own consumption and/or sale.

It could be observed that there are 2 cases (16.67%) in which the condition of the structure is good; and the majority, that is; 10 of 12 (83.33%) have the regular structure, considering the construction materials that predominate in the unit and the condition in which they are found. With respect to tenancy, the vast majority claimed to be owners, specifically 11 and 1 case in which the dwelling was ceded. When asked if they have another property in the area, 10 of them stated that they have only the property visited, and 2 people have said that they have another property (Concepción, Barrio San Roque and in Coronel Mongelós).

Regular housing conditions

Good condition housing

Figure 45 – Common houses in the DAA

Although it was observed that more than one dwelling is located on the same property, the people surveyed stated that only one family lives in each dwelling, this in its totality.

Number of persons living in the house

A particularity revealed during the census is that, of the 13 families identified, only one belongs to a different family group. As regards the number of persons living in the dwelling, as can be observed in the following table, there are cases in which the dwelling is inhabited by only one person, unlike others in which there are 7 persons.

Table 79 – Number of people per house

Number of people per house	Number of families	Percentage
1 Person	2 families	16,67%
2 persons	1 family	8,33%
3 Persons	3 families	25,00%
4 Persons	3 families	25,00%
5 Persons	1 family	8,33%
6 Persons	1 family	8,33%
7 Persons	1 family	8,33%
TOTAL: 43 personas	**12**	**100%**

Source: Socio-economic census, January 2020

Table 80 – Number of people per age group

Under 18 years old	Adults 18 to 64 years old	Adult over 65 years old	Women	Men	Total
14	21	8	22	21	43

Source: Socio-economic census, January 2020

No cases of pregnant women and people with disabilities were recorded. When asked about people with a chronic illness in the family and residing in the home, they commented on 2 cases.

Number of people working / looking for work currently

When consulted on this point, they mentioned in full 16 family members who currently have some kind of employment, either outside the home or developing economic activities within it (7 women and 9 men), they also commented that there are women who work exclusively as housewives (4) and 11 people, family members living in the homes visited who are currently looking for work.

Access to basic services

When it comes to access to services, it was possible to reveal that with respect to:

Electricity: 100% of the families in the census (12) have electricity.

Clean/drinking water network: Although the majority of the department's population, according to the permanent household survey, has accessed drinking water supply services via SENASA and/or the local sanitation board between 2017 and 2018 [99], in the case of Piquete Cue's houses, none of them has a drinking water network and the

[99] item 9.3.4.1.2.3: Hogares, vivienda.

main source of water that the members of the household drink is the well. Practically no family carries out any treatment, except for one of them (applies product - bleach after the rains). The distance from where it is drawn is less than 10 blocks in all cases.

The water that the members of the household drink arrives, in 25% (3 of 12) by pipe inside the house, 50% (6 of 12) has pipes outside the house, but inside the land. 8.33% (1 of 12) have a well inside the land and 16.67% (2 of 12) through the neighbor.

The water that results from this source is used, in 100% of the cases, for drinking, food preparation, laundry, personal hygiene and cleaning of the house.

Table 81 – water distribution to population

The drinking/clean water arrives by	Housing	%
Pipe system inside the house	3	25
Piping outside the house but inside the property	6	50
From neighborhood	2	16,67
Well inside the property	1	8,33
TOTAL	**12**	**100**

Source: Economic Census, January 2020

Solid waste disposal

Regarding solid waste disposal, burning is a method used by the majority (11), not exclusively, but it is evident that this is still a deeply rooted practice, in accordance with the departmental level, as indicated in item 9.3.4.1.2.3 of the present study that mentions burning as the main form of waste disposal, besides highlighting that only a third of the population of Concepción has access to garbage collection services. In the DAA there are also cases (8) where waste is buried, and in a smaller proportion, thrown in a vacant yard/vacant lots, street and/or recycled. No family has a municipal collection service.

Similarly, the lack of availability of sewage, considering that no family in the census has such a network, reflects what is happening at the departmental level, since only 6.55% of households have access to the sewage network in Concepción [100].

The census has also revealed other aspects related to access to services, such as:

- Access to telephone service 100%;
- 58.33% access to the Internet, that is, 7 families out of the 12 that took part in the survey and;
- The absence of public transport service in the area. The communities in the area (such as Piquete Cue) mainly use motorcycles as a means of transport. There is only one road that is used by its inhabitants to move to other communities in the area, and from there to other access points to other parts of the district and department, also for the transfer of animals.

[100] ítem 9.3.4.1.2.3 Hogares, vivienda.

Access to health services

According to the census people, the community does not have health services in the place, so they must go to the nearest health posts or centers to receive medical attention. Based on the information referred to, the following data are obtained:

- 8,33 % (1 of 12) mentioned that they attend the Health Centre in the city of Loreto; located 25 km from the community;
- 8,33 % (1 out of 12) mentioned that they attend the Health Centre of Concepción; located about 40 km from the community;
- On the other hand, 91.67% (11 of 12) of the population studied attends the Health Post in Colonia Roberto L. Petit which is located between 9 and 17 km; (approximately one hour by motorcycle).

Access to education

At the time of the census, family members who are currently in school were consulted as to their academic level, the educational institution they attend, and the distances travelled to attend, among other things. It was stated that 13 people were attending educational institutions, 11 at the primary level, 1 at the secondary level and 1 at the tertiary level. The majority attend public educational institutions (11), 8 people attend the Defensores del Chaco school in the town of Pirity Mongelós, 1 person attends the Coronel Mongelós school and 2 people attend the Concepción Macedo de Denis school in the town of Colonia Cnel. Mongelós, finally 1 person attends the Rosa Mística Institute and 1 person attends the Don Bosco school, both in the city of Concepción. The distances traveled daily vary between 1 km and 10 km (primary and secondary school) and 25 km (tertiary level).

Existing neighborhood organizations/commissions in the community

The totality of the people registered responded that there is no organization in the community of Piquete Cue. However, 3 people commented that they belong to an organization, as indicated in the following table, they are not in Piquete Cue.

Member of any organization	Number	Percentage
Yes (Asociación Karape de Laceros and Comisión pro Centro de Salud Laguna Plato)	3	25%
Does not belong to any organization	9	75%
Total	12	100%

Source: Socio-economic census, January 2020

Finally, by way of a summary of the characteristics surveyed for each dwelling located in the DAA, the following table is presented, containing the location, data on roots, number of people living in the unit, employment situation and the photographic record of each one of them:

Table 82 – Summary matrix of Piquete Cue homes and their characteristics

Family	Coordinates	Features registered	Photographic records
1	-57.497371, -23.234877	- Roots: 6 years of being in the roots of the structure - Persons residing in the home:2 adults and 1 child under 18 - Employment status:1 employed and 2 looking for a job	
2	-57.496780,-23232404	Roots: 32 years of roots in the structure Persons residing in the dwelling: 2 adults, 1 person over 65 and 1 child under 18. Employment status: 3 people in employment and 0 looking for work	
3	-57.496887, -23.230906	- Roots: 11 years of rooting in the structure - Persons residing in the home: 2 adults and 2 children under 18 - Employment status: 1 employed person and 2 job seekers	
4	-57.495075, -23.229251	- Roots: 5 years of rooting in the structure - Persons residing in the home: 2 adults, 1 person over 65 and 2 children under 18 - Persons residing in the dwelling: Employment status: 1 person employed and 0 looking for work	
5	-57.494401, -23.228139	- Roots: 74 years of roots in the structure - Persons residing in the dwelling: 1 adult and 1 person over 65 - Employment status: 1 employed and 1 looking for work	
6	-57.495193, -23.226429	- Roots: 7 years of rooting in the structure - Persons residing in the dwelling: 1 person over 65 years old in employment	

7	-57.492462, -23.226415	Roots: 10 years of rooting in the structure Persons residing in the home: 2 adults and 1 child under 18 Employment status: 1 employed and 1 looking for work	
8	-57.491872, -23.225842	Roots: 10 years of rooting in the structure Persons residing in the home: 2 adults and 1 child under 18 Employment status: 2 employed and 0 looking for work	
9	-57.48687, 23.22382	Roots: 8 years of rooting in the structure Persons residing in the dwelling: 1 person over 65 years old without employment (not looking for)	
10	-57.485053, -23.222897	It was not registered	
11	-57.48345, 23.22187	Roots: 3 years of rooting in the structure Number of people living in the house: 2 adults, 2 people over 65 and 3 children under 18 Employment status: 4 employed and 2 looking for work	
12	-57.483039, -23.220062	Roots: 50 years of rooting in the structure. People living in the house: 3 adults, 1 person over 65 and 2 children under 18 Employment status: 1 employed person and 2 job seekers	
13	-57.48425, -23.21912	Roots: 10 years of rooting in the structure Persons residing in the home: 3 adults and 1 child under 18 Employment status: 3 employed and 1 looking for work	

Source: Prepared by the external consultant Lic. Caren Kremer and team based on the information collected in the field. Concepción- 2020.

Ranches in the DAA

As mentioned at the beginning of this chapter, seven estancias were identified adjacent to the area prospected for the construction of the plant - Estancia Zapatero Cue. Four interviews were carried out to register and characterize these; only one of them involved an interview with the owner; the other consultations were carried out with the authorized personnel, who were responsible for or administrators of the plant. Information was obtained from 5 establishments because one of those consulted is the administrator of two of the existing estancias.

Considering the above, data on the estancias visited are mentioned in terms of location, extension of the territory, personnel and main activities carried out. The following general characteristics may be considered from the records obtained:

- Most of the access gates to the rooms are located in the Piquete Cue area;
- One of the establishments rents a fraction of the area prospected for the installation of the plant. The predominant activity is large-scale cattle raising, although some are also dedicated to agricultural production;
- The ranches have permanent personnel and others are hired for specific tasks for determined periods of time. The average number of permanent workers is between 4 and 20, and the maximum number of personnel hired per product is 35;
- The property with the largest extension of land has 5,850 ha and the one with the smallest proportion has a total of 600 ha.

Specific data from each establishment as indicated by the interviewees is presented below:

The Pyrenda farm has 4 permanent workers and other people are hired for specific jobs. Its production line is cattle raising and it leases a total of 1,200 ha. The closest health post for those living in the area is in Colonia Roberto L. Petit and the school is in the Mongelós Pirity community.

The estancia Irene Carduz is currently owned by the Blue Sisters. The property originally belonged to the person whose name the estancia bears who donated such lands to the organization in 1945. Since then, they have devoted themselves to carrying out social works in the community. The estancia has a total area of 5,850 hectares starting from the first curve located in Saladillo. The Calaverita stream divides the property in the southern limit of the land.

A fraction of the land is used for agriculture for the production of corn, cassava and another for livestock: there is a total of approximately 880 heads of cattle, they also have pigs and are dedicated to raising poultry. There is also a religious technical school and a boarding school for children between 15 and 18 years old. They have a total of 16 workers on a permanent basis and 6 people are hired for specific jobs on a daily basis. There are 4 land tenants; 3 of them are engaged in small livestock farming (between 10 and 15 heads) and 1 of them in large scale with 1600 heads of cattle.

Estancia Cerrito has a total of 600 ha, bordering Estancia Zapatero Cue and as mentioned by its owner it leases 900 ha of it for cattle raising. There are 7 permanent workers from Paso Barreto and Concepción.

Estancias San Diego Agroganadera and San Miguel belong to the same owner. Estancia San Diego Agroganadera has 5,000 ha of land and Estancia San Miguel has 2,400 ha of land. Both estancias border the Cerrito and Zapatero Cue estancias. San Diego has a total of 20 permanent workers; and San Miguel 5 and both indirectly employ in different seasons approximately 35 people.

Ranch Pyrenda

Entrance in the ranch Irene Carduz

Figure 46 – Ranches in the area

Entrance in the ranch San Miguel

Ranch Cerrito

Figure 47 – Ranches in the area

Ranch San Diego

Figure 48 – Ranch in the area

9.3.4.4 Cultural heritage

This section presents the main content and findings of the "Cultural Heritage Report", prepared by the external consultant Mr. Enrique Bragayrac, specialist in cultural heritage and team.

9.3.4.4.1 Synthesis of the main findings

The evaluation of the state of the cultural heritage, had as objectives the recognition of the cultural assets (archaeological, architectural, historical, ethnographic, etc.) present in the area of the project (including the districts of Concepción, Loreto, Belén, and Horqueta); the individualized evaluation of the impact that its execution could cause on these assets and the design of corrective measures directed to the suppression or attenuation of such impact, seeking the compatibility of the conservation of the cultural heritage and the execution of the project involved in it.

The methodology and fieldwork were based on the location of the project area (DAA), adjacent to the Paraguay River, with two land accesses, with extensions of livestock enterprises, and with small agricultural communities. Due to the characteristics of the study site, with areas differentiated by their current and natural uses, it was impossible to work through quadrants, due to the ruggedness of some places, wire fences, and the gallery forest with flooded soils of difficult access. For this reason, the planialtimetric control by areas and observation points was based on the natural and anthropic systems present (Map 12) in the DAA's limits, which are well delineated, with defined surfaces at the territorial level and satellite mapping.

The superficial archaeological characterization was carried out extensively throughout the DAA, in order to monitor the potential direct and indirect impacts on the cultural landscape and identify the heritage values at risk, through sampling and observation points in the areas identified in the field, which are: agricultural area (1,322 ha), forest cover (1,531 ha), herbaceous (1,586 ha), and water (438 ha). The field documentation was carried out by arbitrarily selected field observation points (georeferenced), recording those sectors of the land that offered natural (erosion areas), cultural or other special features.

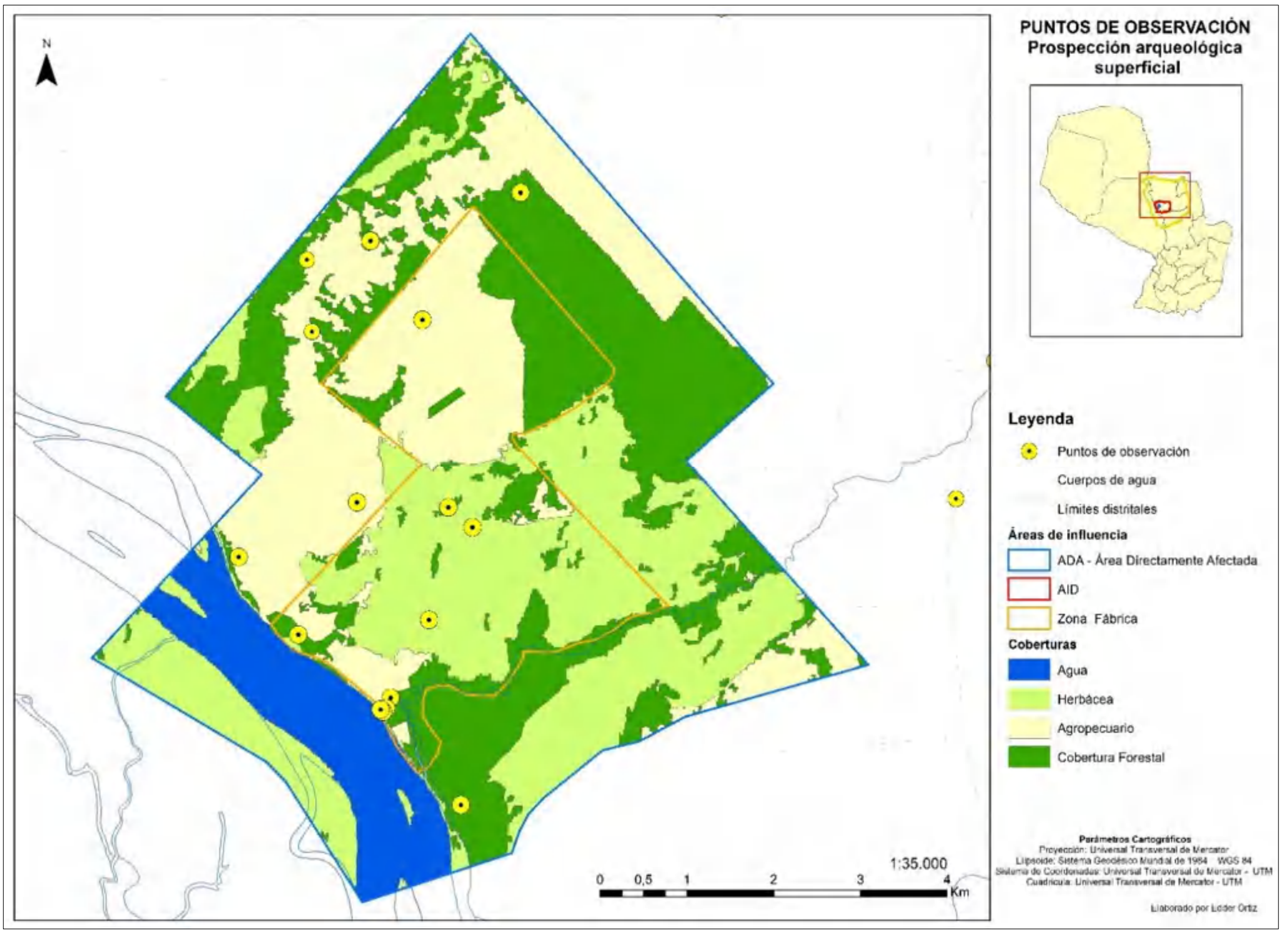
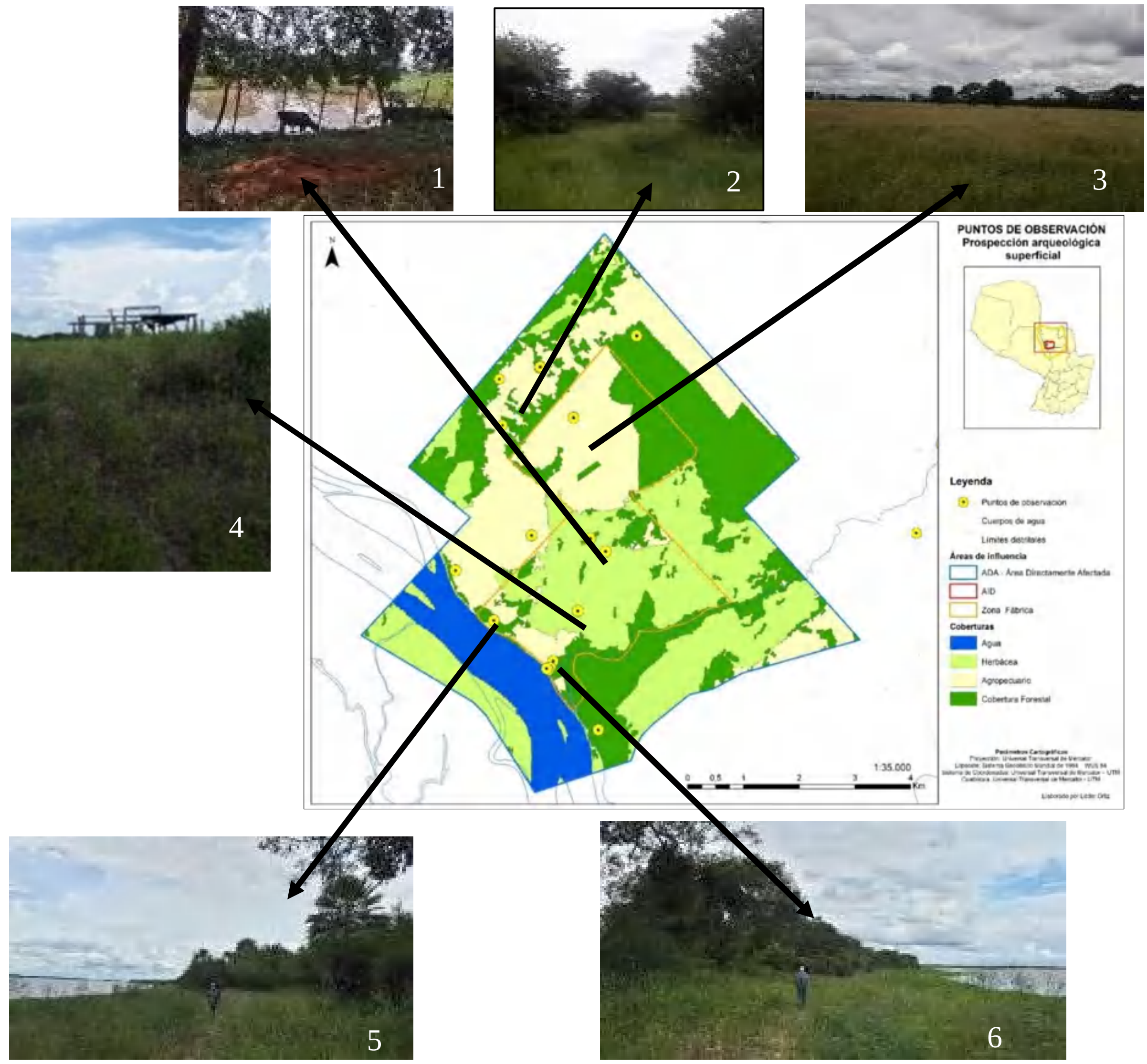
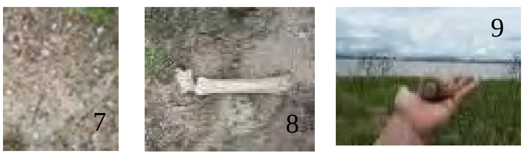


Figure 49 – Map of DAA

In the first campaign, the northern and northwestern sectors were evaluated, showing the most relevant anthropic transformation, with extensive livestock areas. The second campaign evaluated the southern and southeastern sectors, taking the Paraguay River as the limit, with greater relevance near the gallery forests formed by water courses, forest cover in its environment and the river. Since it is an undisturbed area, with natural runoffs in its beds, its dynamics leaves surfaces with cultural evidence in dragging and outcrops of contexts, which is not the case in this entire natural system, since no surface evidence was found to indicate a historical occupation and/or other relevant cultural elements. The DAA is released because it does not present superficial contexts of archaeological remains present.





REFERENCES
(1) Tajamar, livestock use /ZH. - (2) Natural field - livestock use - (3) Intensive agricultural zone - (4) Former dock construction - (5) Forestry area/southwest sector/transects - (6) Forest area in forest gallery/southeast sector/transects - (7, 8, and 9) Soil and remains found

NOTE: After the completion of the cultural heritage study, the current boundaries of the prospected property were updated over the same area, without representing changes for the evaluation and results of the present analysis.

Figure 50 – Reference areas categorized and presented in spotted layer formats

For the project's DIA and IIA, a quantitative inventory was made of the cultural heritage present, characterized by exceptional and particular architecture from a historical period. For the territorial registration of movable/tangible heritage, geographic coordinates, obtained through the Avenza Map application, were used to identify and create categorized reference points and presented in layered formats with points referring to the registered immovable heritage and adjusted to the cadaster.

For the dating of archaeological sites in similar contexts along the Paraguay River, current research validates and complements these links; and indicates the presence of pre-Hispanic societies along the entire length of the Paraguay River, with radiocarbon dating from ca. 100 BC to ca. 300 AD for the Pantanal Tradition (Lamenza, 2015). Reports of rock art findings in the project area are mentioned for the site called Barrero

Guaá, near Gamarra-cué, a site located at the headwaters of the Tagatiyá stream (AII), department of Concepción (Díaz-Pérez, 1904). It is also important to note reports of paleontological remains (Báez Presser, et al. 2004), for flora (fossil vegetables: fern and conifer woods - Itapucumí Group), as well as fauna.

From a primary assessment, based on the secondary information available, it is possible to affirm the importance of a deep-rooted cultural territory, with local testimonies that are alive and present in its experiential imagination. With regard to the potential impacts generated, specifically with regard to cultural heritage, it can be noted that it will be significantly affected (intangible or immaterial heritage), due to changes in habit and significance as social capital.

Table 83 – Assessment and impacts on the evaluated cultural heritage

Areas / Impacts	Material Heritage			Immaterial Heritage			Notes
	H	M	L	H	M	L	
AREA DIRECTLY AFFECTED			X	←	X		MH/Low impact on the subsoil/potential presence of associated cultural context MH/Moderate to high impact due to increased vehicle traffic. MH/Moderate/high impact - on livelihoods/productive areas and immediate environment/social capital.
DIRECT INFLUENCE AREA	←	X		←	X		MH/Moderate impact MH/Moderate to high impact due to increased vehicular traffic and possible new settlements for goods and services MH/Moderate to high impact on livelihoods and natural environment/ecosystem services HI/Moderate/high impact on loss of collective memory/migration/territorial roots/identity.
INDIRECTLY INFLUENCED AREA		←	X	←	X		MH/Low to moderate impact/ on the architectural heritage, which is protected and there is a citizen awareness of respect - tax exemption are municipal benefits for heritage safeguarding. MH/Moderate/high impact on livelihoods and cultural identity. HI/Moderate impact/ loss of collective memory/population growth

Reference: (H) High – (M) Medium – (L) Low - (MH) material heritage – (IH) Immaterial heritage

In Table 83, it can be seen that the most relevant impacts are in the Direct Influence Area (DIA), since it directly affects their livelihoods and the provision of ecosystem functions and services, initiating a process that would weaken their natural and social capital, with the loss of collective memory. New settlements and increased vehicular traffic are part of impacts that will affect livelihoods.

For the area of indirect influence, there is a low to moderate impact on tangible heritage (architectural and historical), since they are protected by Municipal Ordinance and their intervention/conservation is authorized through a municipal resolution, as well as their tax exemption (district of Concepción). However, for the districts of Loreto, Belén and Horqueta, the heritage houses are around their main squares, all of which are preserved, and others have been restored. The collective respect of the population and institutions in the districts affected by DIA for their material/tangible heritage is part of their cultural identity.

In the potential impacts identified by areas of intervention (DAA/DIA/IIA), the loss and need to strengthen livelihoods and cultural identity, present in all stages of the process of implementation of the plant, in order to generate a rooting, human development and cultural appropriation.

9.3.4.4.2 Assessment and methods

The cultural heritage of a people comprises the works of its artists, architects, musicians, writers and scholars, as well as the anonymous creations that have emerged from the popular soul, and the set of values that give meaning to life, i.e. the material and non-material works that express the creativity of that people; the language, rites, beliefs, historical sites and monuments, literature, works of art, and archives and libraries (definition drawn up by the UNESCO World Conference on Cultural Heritage, held in Mexico in 1982).

Geographical, human and cultural diversity is expressed in its tangible or tangible (movable and immovable property) and intangible or immovable (intangible heritage) heritage; and it becomes meaningful through the appropriation assumed by communities.

The present study, due to its cultural, historical and archaeological character, defines a geographical space or territory as a stage for action, where a historical construction and a cultural practice were developed, and where the cultural identity of the community or communities that sustain it is clearly reflected.

The Baseline of this section begins with the Foundation of the Royal Village of Concepción (1773), its current characterization, its historical milestones, and the legal support that allows the protection and revaluation of heritage, specifying to which area of intervention of the project it is applicable. The identification of the existing types of heritage is disaggregated by their specificity and valuation.

The study area is located on a territory founded in 1773 by Agustín Fernando de Pinedo, with the name of Villa Real de la Concepción. This name, like other frontier towns founded under the reign of Charles III, recalls the Purísima Concepción, patron saint of Spain. It was a military town for 40 years, until in 1812 the town council was founded, with which the town became a civil settlement. The arrival of Italian, Syrian-Lebanese and Catalan immigrants around 1880 boosted the district as a commercial port and initiated a sustained process of development of Italian-style architecture. At the beginning of the 20th century, the Port of Concepción was an active center of trade and product exchange, especially with Matogrosso, Brazil (Yubi, 2011).

The survey of cultural and archaeological heritage focused on identifying tangible (material) and intangible (intangible) heritage, through secondary and primary information, as well as local testimonies of its social dimension. In the case of architectural heritage, which was the most relevant due to its magnificence, the selection and assessment criteria are described, and in this way its originality, attributes and relative temporality can be assessed.

Based on the location of the project area, on the banks of the Paraguay River and two land accesses, the surface archaeological characterization was carried out extensively throughout the Area Directly Affected (497 ha) and the Central Area (1,211 ha), the

Direct Influence Area (278,070 ha), and the Indirect Influence Area (3,329,828 ha) for the purpose of monitoring potential direct and indirect impacts on the cultural landscape and identifying heritage values at risk. The design of the archaeological characterization was made taking into account the variables that are controlled (intensity) and not controlled by the researcher (visibility, accessibility), in order to maximize the probability of finding archaeological records in a broad sense (artifact, structure and any feature)[101].

The entire area was surveyed in search of areas of open terrain or erosion in order to prospect for archaeological indicators, taking as reference the natural and anthropogenic systems observed on Map 14 duly identified as study areas through observation points: agricultural zone (1,322 ha), forest cover (1,531 ha), herbaceous (1,586 ha), and water (438 ha).

The first field campaign was aimed at prospecting in the agricultural areas and observation points of the areas with forest cover and native herbaceous plants. As well as interviews with inhabitants settled in the Area of Direct Influence. In this same campaign, data was collected from the historical center of the main towns in the Area of Direct Influence, as well as interviews with local authorities and cultural and social references.

In the second campaign, a tour was carried out in the central area of the project with observation points of the areas of livestock use, both implanted pastures and grasslands and savannahs, up to the river bank and dry riverbeds. These observation points sought to find materials that would allow us to understand possible cultural contexts present.

The documentation of the terrain was carried out by arbitrarily selected field observation points (georeferenced), recording those sectors of the terrain that offered natural (erosion zones), cultural or other particular windows where superficial archaeological indications were most likely to be found. In the course of the surface prospection, points of observation of the terrain were recorded and documented in the following figure.

For the project's DIA and IIA, a quantitative inventory was made of the cultural heritage present: movable, immovable, gastronomic, historical events, popular festivals and other elements that the local imagination recognizes as heritage. Since this is a quantitative inventory and a record of the state of conservation of tangible and intangible, spiritual and archaeological heritage, methodologies were combined, according to the specificity of each element and heritage good identified. The use of online systems was the basis of the work, because of the combination of digital support information in real time.

For the territorial registry, the geographic coordinates obtained through the Avenza Map software were used to identify and create reference points that were categorized and presented in layered formats with reference points to the registered tangible heritage, adjusted to the national registry.

[101] For this purpose, the criteria of Schiffer, Sullivan and Klinger were followed (1972),

Table 84 – Selection and assessment criteria for the study of architectural cultural heritage

Selection criteria	Valuation criteria
1. Testimony of cultural and symbolic tradition Be associated with living events or traditions of a local, regional and national nature.	1. History Construction period - Construction date.
2. Quality of the building It represents the quality of the design of the property at a typological and morphological level, the relevant constructive and decorative elements, the technology used in the construction system and the use of materials, the visual impact caused by the building within the immediate environment at an urban and natural level.	2. Architectural-aesthetics Style or stylistic influence. Volumetric and design; Architectural plastic (scale, unity, rhythm, harmony, color, texture, symmetry, asymmetry, composition, proportion, balance, highlighting). Integral elements: decorative, ornamental, structural.
3. Integrated with the urban environment (formation of urban complexes) Preserve homogeneity in typology, morphology, construction system and use of materials. The rhythm, the disposition of the openings and fills, the height of the buildings are some factors that express a clear language of architectural unity within an urban set.	3. Classification and function (Functional-Typology) Location, distribution and relationship of the spaces (accesses, portals, hallways, patios, gardens, orchards, green areas, galleries, stairs, porches, circulation elements, social, intimate and service areas) Identification of the typology (traditional building, vernacular, haciendas, villas, etc.) Type of use: original, current.
4. Associated with the cultural landscape Establish a relationship between the human being - architecture - physical environment (cultural landscapes).	4. Technical-constructive Technology and/or traditional construction systems. Contemporary technology and/or construction systems. Mixed materials / mixed construction.
5. Associated with historical events Be associated with significant historical events that occurred in the property at the local or national level.	5. Historical - testimonial - symbolic → Socio-cultural-economic value. → Associated with a historical event(s) or with the collective memory related to important character(s) and/or representative of the place. → Urban, architectural, productive landmark.
	6. Architectural - urban environment → Property integrated into the urban environment. Urban complexes. → Generate visual impact. → Favors the urban perspective. → Urban environment. → Related to archaeological sites or deposits.

Selection criteria	Valuation criteria
	7. Authenticity and integrity → Volumetric / form, - Design, - Integral, decorative, ornamental, structural elements, - Internal distribution of spaces, - Technology and construction systems, - Urban design (orientation, form, design, dimensions, construction materials and finishes).

9.3.4.4.3 Description and evaluation of the cultural heritage in the project area

For the purposes of this study, cultural heritage will be understood as the set of tangible and intangible assets that constitute the heritage of a human group, that emotionally reinforce its sense of community with its own identity and that are perceived by others as characteristic.

To better understand the concept of Cultural Heritage, its appreciation will be divided into tangible and intangible heritage, in order to study and treat it.

9.3.4.4.3.1 Material or immaterial cultural heritage

It is made up of objects that have physical substance and can be preserved and restored by some type of intervention; they are those manifestations supported by material elements that are products of architecture, urbanism, archaeology, and craftsmanship, among others. It is composed of the movable and immovable goods made by the societies of past.

- **The movable cultural heritage (PCMU - in Spanish)** is the set of cultural heritage that communities, social groups and public and private institutions recognize as part of their memories and identities, or as part of the memories and identities of the nation, since they attribute to them, among others, collective, historical, aesthetic and symbolic values. These assets are generally protected and transmitted to future generations. The properties that make up movable cultural heritage may be representative: 1) for a group, collectivity, community or village; 2) for a municipality; 3) for a district; 4) for a department; 5) for the nation; or 6) for the world. [102]
- **The immovable cultural heritage (PCIMU)** are movable cultural heritage that are an expression or testimony of human creation or the evolution of nature and therefore have an archaeological, historical, artistic, scientific and/or technical value. Examples are: an aqueduct, a mill, a cathedral, an archaeological site, an industrial building, the historical center of a city, among others.

For the case of the survey of immovable cultural heritage, they were categorized as follows, according to the historic center of the city of Concepción, identified through Municipal Ordinance Number 09/04 on zoning - land use; Number 12/04 establishing the protection, conservation, recovery and transmission of the cultural and natural heritage of the Municipality of Concepción, and Number 13/04 establishing the general

[102] https://www.mincultura.gov.co/areas/patrimonio/patrimonio-cultural-mueble/Paginas/default.aspx

catalog of assets that make up the cultural and natural heritage of the Municipality of Concepción; and testimonies of the local imagination, with the following categories: Mansion - Casonas - Houses and Port Area.

This category was also applied to Belen, Loreto and Horqueta, where only historic homes stand out.

- Mansion: Buildings that have more than two levels or floors, worked with details in walls and cornices. They are buildings that have a larger built area and a large internal courtyard. It predominates the facades type cover ornamented with pillars in the walls and gables like auction. The pilasters had moldings in the shaft and in the capital with acanthus leaves, characteristics of the European houses with mixtures of styles like the classic one, neoclassic, Renaissance among others. Relative temporality: 19th century.
- "Casonas": Buildings that have a certain bearing similar to mansions, but do not have as many details on the in front. It has predominantly a covered front. They were used as residences as well as local and regional businesses since they brought products from the surrounding settlements. They have the smallest patio in comparison to the mansions. Relative temporality: 19th century.
- Dwellings: Buildings intended for smaller residences in comparison with the other categories, predominantly tapa type facades and colonial galleries where the inhabitants sat to share traditional drink "terere" under their shade. It presents similar characteristics to mansions, but with less ornamentation. Relative time: 19th century.
- Port area: Buildings dedicated to port activities, is an area of interconnection between coastal towns and commercial exchange of the time. The dwellings closest to the port have a greater architectural presence since the inhabitants were dedicated to this trade, both fishing and commercial exchange. As one moves away from the site, one can observe more precarious dwellings. Relative time: 19th century.

Figure 51 – Heritage grids present in the city of Concepción with hierarchical symbols

The following is a list of the relevant tangible heritage of the city of Concepción, where there are 209 registered and declared for the Historic Center of the City of Concepción, by the Municipality of Concepción.

Table 85 – List of relevant material heritage of the city of Concepción

	Material Cultural Heritage	Location	Notes
1	Municipal Theater	Concepción (DIA)	Resolution SNC number 217/2019 was declared of cultural interest to the project of "Reformation and remodeling of the Municipal Theater Don Pedro Gregorio Antonio Alvarenga Caballero".
2	Railway "Nacional Norte"	Concepción (DIA)	Declared Heritage by Ministerial Resolution #1 (January 4, 2008) (components that were elements of the National Northern Railway, which are in the Department of Concepción, linking the departmental capital-Concepción, to the Captain Gumersindo Sosa Station - Arroyo Karé). Source : SICPY http://sicpy.gov.py/busquedas/index.php?categorias-3=&page=96
3	Museum of Contemporary Art	Concepción	It no longer exists. It was in the Autumn Mansion. It revolved around the work of Carlos Colombino.
4	Church "Nuestra Señora de la Concepción"	Concepción	Its construction began in 1960, after the collapse of a large part of the old church factory and the demolition of what remained. The work was completed in 1968 and the inauguration took place in December of that year. Its interior houses a holy water font carved in pink marble, a wooden sculptural group of the Crucifixion, the images of the Virgin of Carmen, Saint Joseph and the Sacred Heart of Jesus, a painting by Carlos Colombino and the altar that is the work of the latter, and the painting of the Virgin of Chestokowa, a gift from Pope John Paul II. https://www.bienvenidoaparaguay.com/showdata.php?xmlcity=22&xmldestino=64
5	Church "San José"	Concepción	Built at the time of the European mandate. Front building -cover with neoclassical reminiscences. It stands out for the beauty of its façade among other religious buildings in spite of the transformations it has undergone in its mortar altarpiece, the work of Don Pedro de Alcantara. It has a bell brought from Italy in 1911, which is owned by the Conception people. A huge Carrara marble tombstone inside it reminds us of the great benefactor Don Julián Quevedo y Gómez de la Pedrueza, who contributed a large sum of money to the construction (Catalogue N. 200 - Municipality of Concepción and Cultural Association of the Royal Village of Concepción)
6	Museum of the Cuartel de la Villa Real	Concepción	The Headquarters was built as soon as the city of Concepción was founded in 1773. It was not until 1862 that it began to be "modernized" when the Mcal assumed the presidency. Francisco Solano López. The War of the Triple Alliance began and ended in this place. Madame Lynch's cart is the most attractive relic in the Museum. (Catalogue N. 85 - Municipality of Concepción and Cultural Association of Villa Real)
7	Mansion Paciello	Concepción	Today UTIC University. Declared Patrimony of Concepción.
8	Mansion Villa Ida Albertini Quevedo.	Concepción	It has an incredible coffered ceiling made by hand by Quevedo himself. The President of the United States, Theodore Roosevelt, passed through there in 1913. Declared Patrimony of Concepción.
9	Mansion Aquino Quevedo	Concepción	Declared Patrimony of Concepción.
10	Mansion Chatelain – Jantou	Concepción	Declared Patrimony of Concepción
11	Mansion Peluffo Quevedo	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04

	Material Cultural Heritage	Location	Notes
12	Casona Miltos Herrero	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04
13	Casona Ugarte Zabala	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04
14	Casona de Gobierno de 1947	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04
15	Villa Heyn	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04
16	Hotel Francés	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04
17	Zavala, Benítez, Cabrera y Cía	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04
18	Cine Teatro Paradeda y Pampliega	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04
19	Solar del Gral. Francisco Isidoro Resquin	Concepción	Declared Patrimony of Concepción - Ordinance #. 13/04

Within the architectural heritage, the old town of the first Foundation of Concepción stands out, with houses, mansions and mansions of greater hierarchy, on a plot of the old port of Concepción and the Cuartel de la Villa Real de Concepción (1773 - 1864). Map 15 shows the boundaries of the historic center, where it also shows in georeferenced points the existence of a greater number of large houses, as well as mansions, all having their main entrance in corners, with two facades on two streets and hallway, which marks a greater social hierarchy. Outside the limits of the historical center only some relevant mansions can be observed.

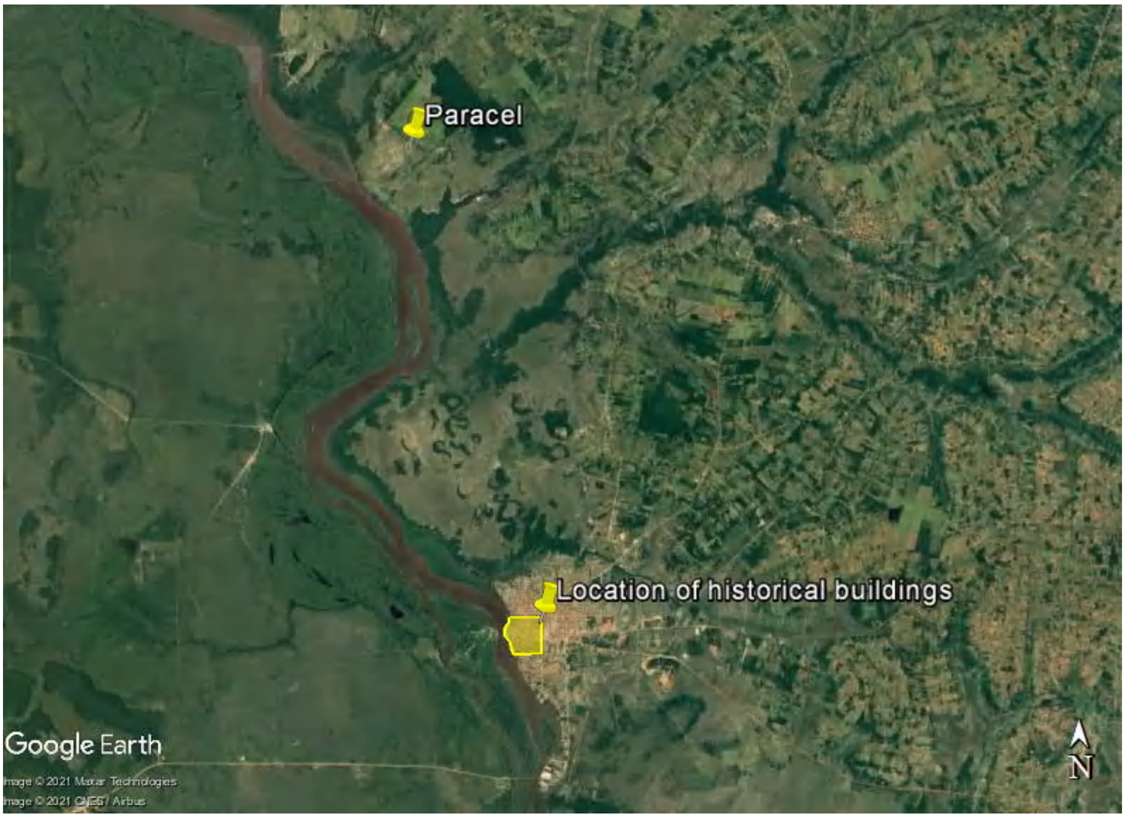


Figure 52 – Location of historical buildings, within the old town of Concepción, in relation to Paracel mill

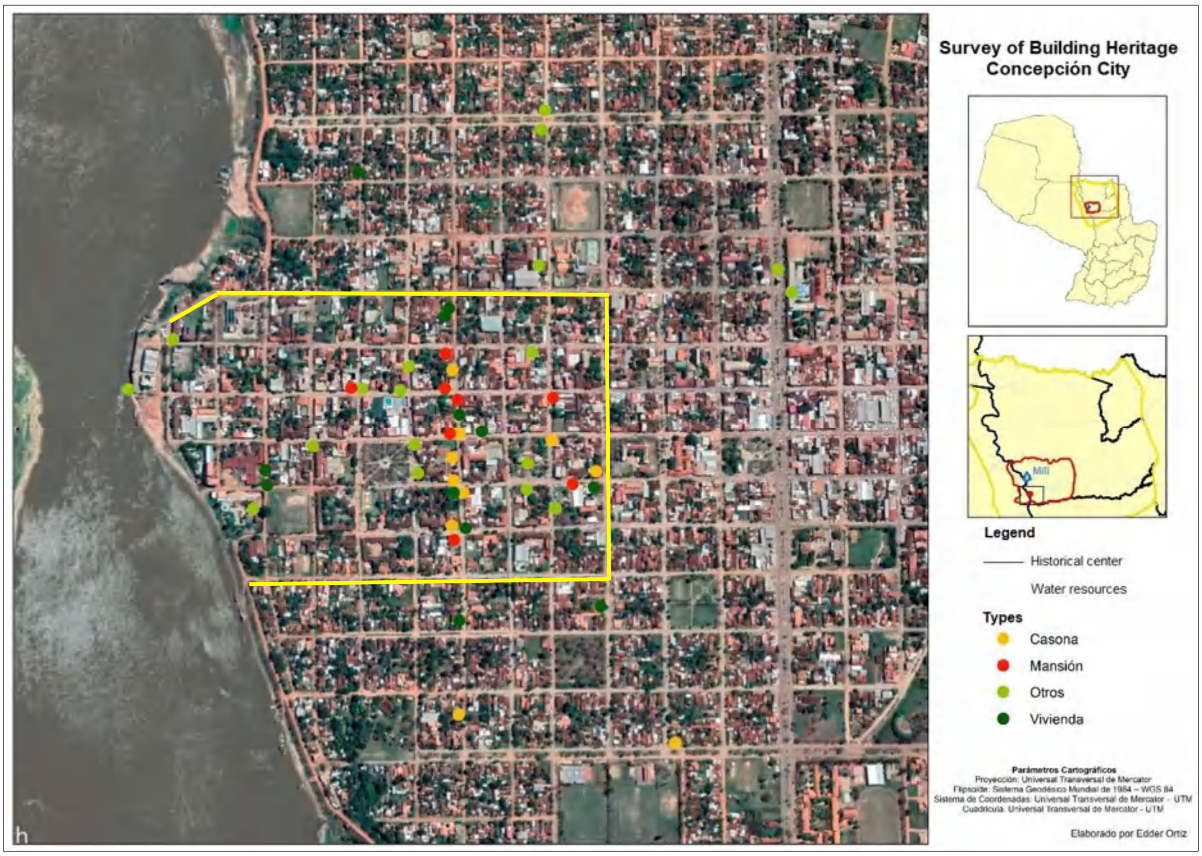


Figure 53 – Mapping of historical buildings, within the old town of Concepción, connection to the Paraguay River

The Museum of the Cuartel de la Villa Real de Concepción

History: 1773 – 1864

Figure 54 – Photography: Cuartel de la Villa Real de Concepcion -1886

The originality of this infrastructure, which was a main headquarters, represents the oldest building, dating from the foundation of the city of Concepción in 1773. It was not until 1862 that it began to be "modernized" when El Mcal became president. Francisco Solano López. In this place the War against the Triple Alliance began and ended. In spite of what is written, it was never Lopez's Barracks but rather the Barracks of his time that he reopened in 1864, with the presence of the president. The facilities were refurbished in 1862-64, during the time of Lopez. (Catalogue N. 85 - Municipality of Concepción and Cultural Association of Villa Real).

The materials that it has protected through its presentation represent historical moments of high patrimonial value, many of them "unique". Among them it can be mentioned Madame Lynch's cart, considered a relic and what it represents for the local and regional imagination. The cart dates from 1864 and was used to transport the belongings of the wife of the Mcal. Lopez [103] .

Currently, this Museum is restored and open to the public, with two municipal officials responsible. Its restoration was done through the Workshop School created in the Municipality, with the support of the Spanish Cooperation. At its best, this school trained more than 30 young people in different trades, with emphasis on the restoration of the Museum (1999). It is still in operation. [104]

According to the museum's certificate of reference to the building, placed in its entrance, it mentions that on May 25, 1773, the city of Concepción was founded by Brigadier Don Agustín Fernando de Pinedo y Valdivieso, a member of the Spanish army designated to govern for a period of six years. Its Spanish-Paraguayan style is reported by Du Graty, and published in Europe in 1862. This building is also called "La casa del Rey" (The King's house). Its urban territorial location, places it in the current lot, which overlooks the Plaza Mayor (current Plaza de la Liberta).

[103] https://www.abc.com.py/edicion-impresa/suplementos/centinela/el-museo-de-concepcion-una-opcion-turistica-1615023.html
[104] Testimony M. Ibañez/Museo Cuartel de la Villa Real

Figure 55 – Photograph: Current museum front. 2020

Figure 56 – Museum's internal gallery

In the Internal Gallery where can be seen its current conservation, after its restoration. It can be seen the space facing the internal courtyard, a ceramic brick floor, a carved column with a molding on its capital that supports the weight of the main beams of the roof, the braces are made of caranda and the seat of Spanish tiles is in section.

The openings are made of solid wood of great thickness with a curved crossbar that works as a lintel.

The walls are plastered and painted with rustic finish.

Figure 57 – Municipal Museum of the Cuartel de la Villa Real

Special attention deserves activities around cemeteries[105], where the local population accompanies, with much devotion and respect, forming a group of friends of the cemetery. This activity is carried out every year, in the two cemeteries of the city. These tours, called necro-tourism, are carried out by the Cultural and Historical Studies Association of Villa Real, specifically in the old areas of the Municipal Museum, where there are characters who contributed to the history of the city and the country [106].

The cemeteries located in the communities of the Direct Influence Area stand out.

In the image in the middle, the pantheon belongs to Mrs., Caballero de Saviex and in the image on the far right appears the pantheon belonging to the Isnardi Family, known as the neo-Gothic " Castillito". Photos Cultural Association of Villa Real. Posted January 12, 2019.

Figure 58 – Old sector cemetery - Villa Real de la Concepción

The pantheons present very elaborate architectural designs, including neo-Gothic, classical, neo-classical and others (Fig. 22). Major Rufino Pampliega Franco, Major Lorenzo Medina, Captain Gumercindo Sosa, Lt. 1 Manuel Irala Fernández, "Yacaré Valija"; Lt. 1 Aniano Cabrera, Vicente Cabañas, Pedro Céspedes, Ladislao Cabrera are some of the hundreds of heroes that rest in the "Pantheon of the Heroes of Concepción"..

Figure 59 – Dwelling - typology

[105] Testimonio Porfirío Báez, presidente de la Asociación CVR
[106] https://www.abc.com.py/nacionales/realizan-necroturismo-en-concepcion-1583796.html

Architectural heritage of the cities of Bethlehem, Horqueta and Loreto (DIA)

In the case of the cities of Horqueta, Belén and Loreto, located within the DIA, they present different periods of construction and settlement, many of them of immigrants or part of a rural development project implemented by the National Government. All relevant architectural manifestations are around the central square and church, with monoliths representing their saints, or a feature that makes it visible in the collective memory, as is the case of Bethlehem and the imaginary line of the Tropic of Capricorn. The relevant historical element that defines the collective memory of these cities is given by the events of the War of the Triple Alliance.

BELEN. The city of Belen, capital of the district of the same name, is also called "the city of the Tropic" because the imaginary line of the Tropic of Capricorn passes through it. It is considered the oldest city in the department of Concepción. The district of Belén was founded on August 23, 1760, in a place known as Paso Mbayá.

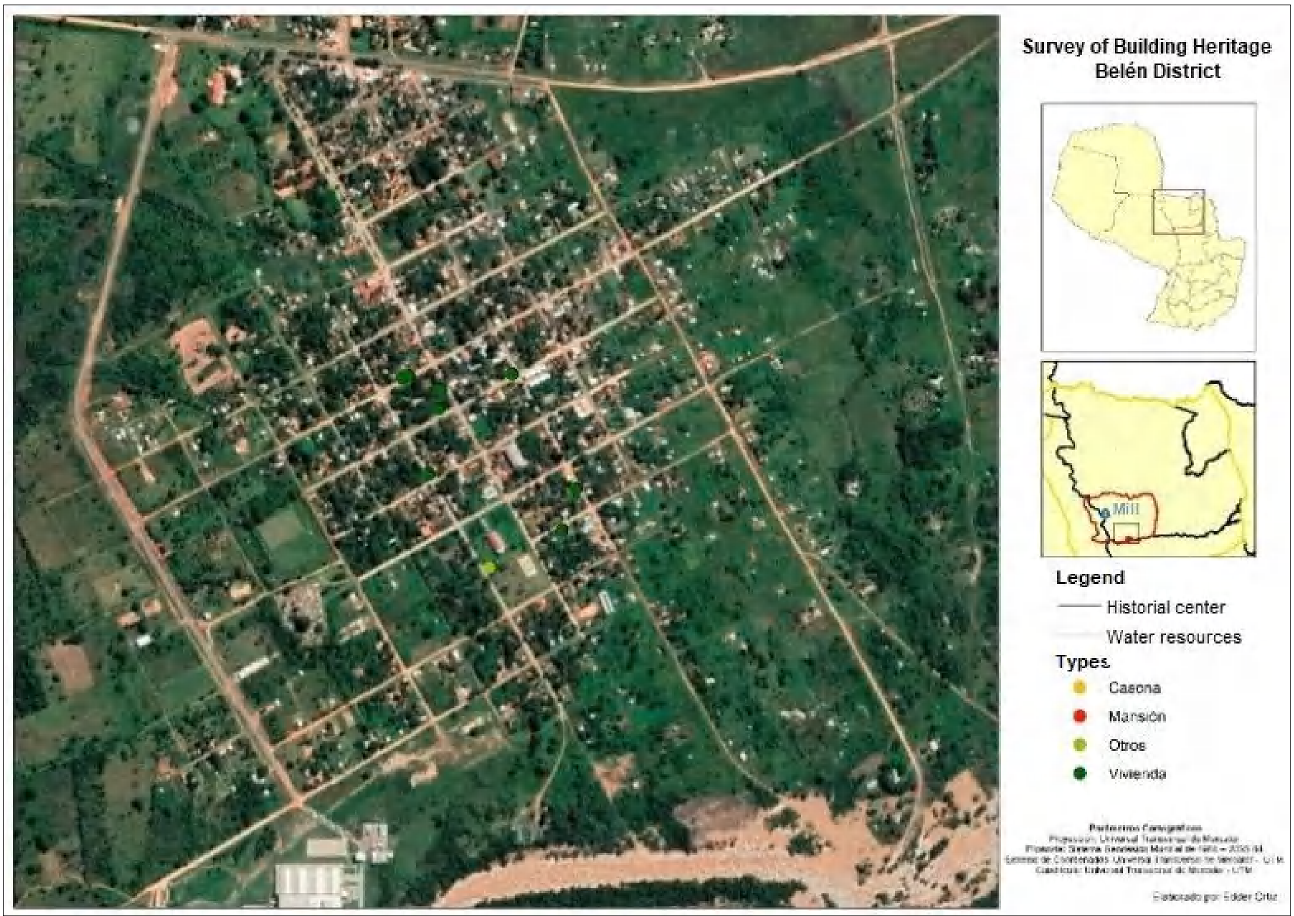


Figure 60 – Satellite image of the city of Belen - heritage survey

Figure 61 – Side facing of the church of Belen (Lat. 23°28'21.19 "S Long 57°15'43.84 "W)

Figure 62 – Back facing of the church of Belen (Lat. 23°28'21.19 "S Long 57°15'43.84 "W)

Figure 63 – Colonial house with front gallery. Padre Sanchez Avenue e/Uruguay. Belen

Figure 64 – Corner house with frontage type cover (Lat 23°28'12.57 "S Long 57°15'45.89 "W)

Figure 65 – Colonial house with front gallery with details of Jesuit style columns (Lat. 23°28'10.18 "S Long 57°15'49.90 "W)

Figure 66 – Colonial house with front gallery with details of Jesuit style columns (Lat. 23°28'9.72 "S Long 57°15'47.76 "W)

Figure 67 – Tropic of Capricorn Monument. Belen, Concepción Latitude 23º26''21''. Tourist point and of relevance for the city.

HORQUETA. It is a city that had its origin as a chapel, in the 18th century, officially founded in 1793. It was the first city with a pedestrian street in the country. The city is called Horqueta, because it is located at the fork in the road, hence its name (Tape Horqueta). The first construction was a mansion where a family settled, and since then the place known as Paraje Horqueta or Tapé Horqueta, became a place where the traveler had a roof and a barnyard, where they could rest and give the animals a break. To this first family, several others came, occupying the four corners of TAPE HORQUETA, with time new immigrants already arrived, forming a conglomerate of ranches of farmers and hunters. It is located 50 km from the city of Concepción.

Figure 68 – Satellite image of the city of Horqueta

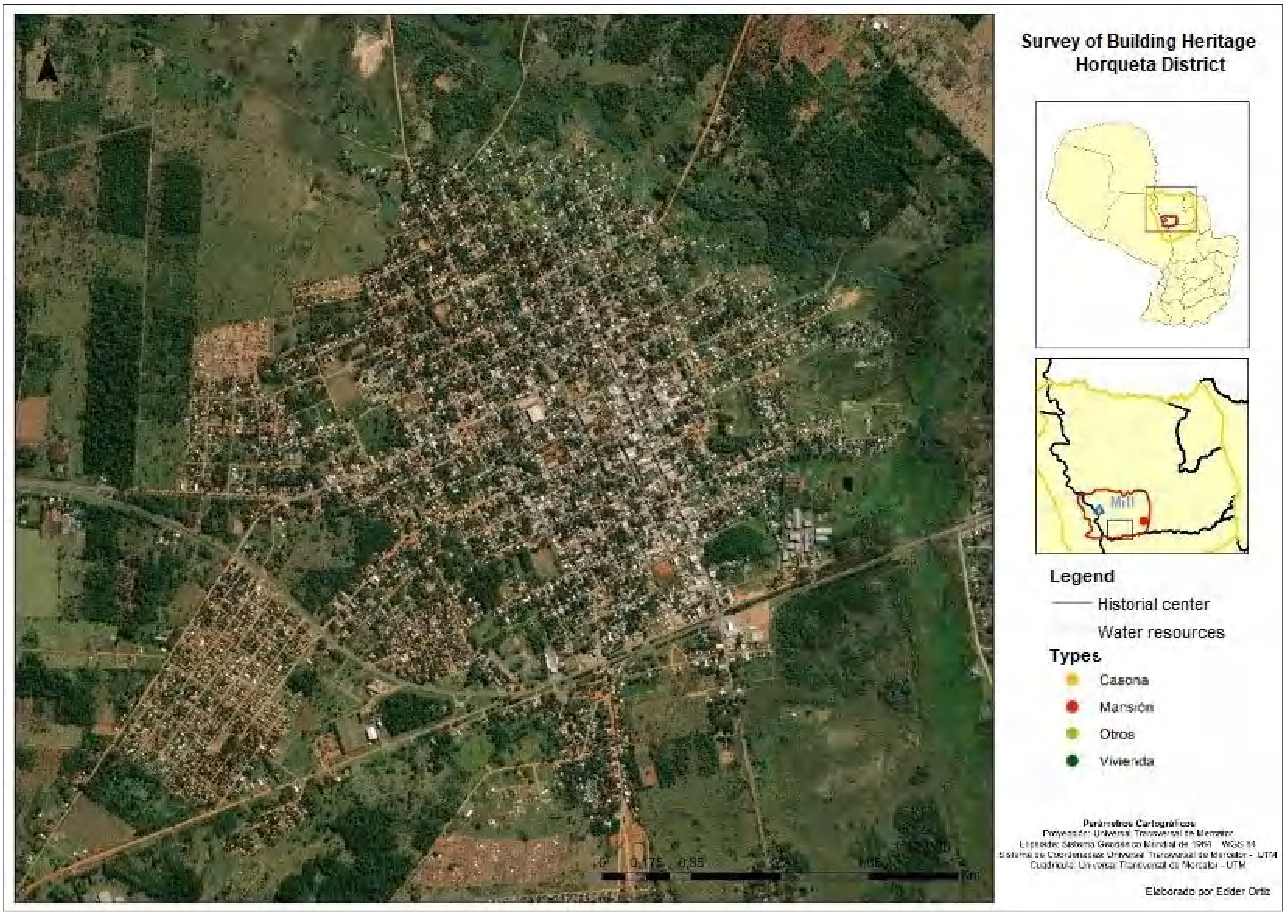


Figure 69 – Vivienda transformed into a corner with a front cover and gables on the cornice Location: Mariscal José Félix Estigarribia, corner of Curupayty. Horqueta.

Figure 70 – Vivienda in the corner with a front type cover and gables on the roof top and balcony. Location: Mariscal José Félix Estigarribia e/Curupayty. Horqueta.

LORETO. The city of Loreto, capital of the district of the same name, is known firstly as "Paraje Jui'y", then "Capilla Zarza", to be later called Loreto, in honor to "Nuestra Señora de Loreto", it was founded by Jesuits, who arrived in 1686. The city of Loreto was founded on December 10, 1792. In the urban layout it is observed that the oldest houses are located in the center of the city and the newest ones in the outside.

Figure 71 – Map of the city of Loreto – heritage survey

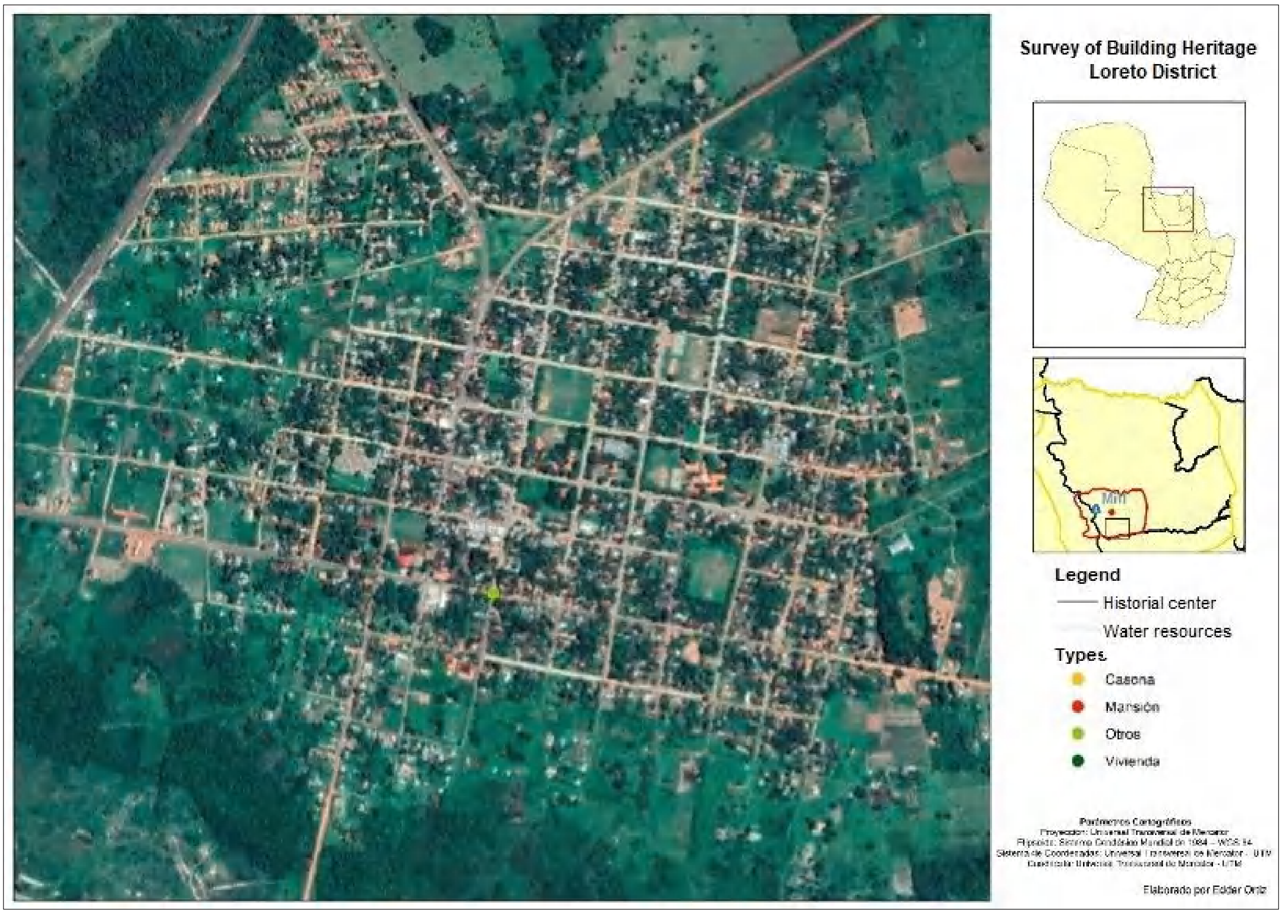


Figure 72 – Vivienda - Corner house with front "tapa" type

Figure 73 – Colonial style house with front terrace (-23 16 37 -57 19 38)

9.3.4.4.3.2 Immaterial or intangible heritage

El Intangible cultural heritage has been defined as: "*the practices, representations, expressions, knowledge and skills - together with the instruments, objects, artefacts and* *cultural spaces associated with them - that communities, groups and in some cases individuals recognize as an integral part of their cultural heritage. This intangible cultural heritage, which is transmitted from generation to generation, is constantly recreated by communities and groups on the basis of their environment, their interaction with nature and their history, giving them a sense of identity and continuity and thus helping to promote respect for cultural diversity and human creativity"*[107].

Table 86 – List of relevant immaterial heritage in the DIA

Heritage	Location/District
Pieces of the Municipal Museum of Cuartel de la Villa Real de Concepción.	Concepción
Pieces of the Museum Diocesano de Arte Sacro	Concepción
Monument to the Virgen María Auxiliadora	Main road - Av. Agustín Fernando de Pineda. Concepción
The obelisck to Virgen de Fátima	Concepción
Obelisk to the indio (indigenous)	Concepción
Monolith of the Tropic of Capricorn	Belén
Monument to the Republic.	Plaza de la libertad o Plaza Fundacional, Concepción.
Background of the Foundation of Concepción	Plaza Pinedo - CONCEPCION
Museum Aire libre	In Boulevard Este, Concepción

Patron saint's day. The patron saint's festival or major festival is understood to be the set of solemnities with which a town - in the case of large cities, these may be neighbourhoods - celebrates the date of its patron saint every year. This is a tradition that is essentially established in countries with a Hispanic culture. These festivities usually include religious acts as a solemn service and pagan celebrations that take place in the streets of the town, such as parades, concerts, dances, festivals, fairs, children's games, bullfights and mechanical games.

[107] Convención para la Salvaguardia del Patrimonio Cultural Inmaterial convocada por la UNESCO, celebrada en París, 2003.

Table 87 – List of relevant "patron" holidays

	Patronal Party/celebration	Date	Location/District
1	Nuestra Señora de La Paz	January	Belén (DIA)
2	Festival del Paje - Aniversarío del Ciudad de Belén	January	Belén (DIA)
3	Desfile Civil, Estudiantil, Policial y Militar en Homenaje a la Ciudad de Horqueta	January	Horqueta (DIA)
4	Fiesta Patronal a María Auxiliadora	January	Concepción (DIA)
5	Festival Estudiantil - Fundación de Concepción.	May	Concepción (DIA)
6	Desfile Estudiantil, Civil, Policial y Militar/homenaje a la Fundación de la Villa Real de Concepción	May	Concepción (DIA)
7	Fiesta Patronal: San Juan Bautista	June	Yby Yaú
8	Fiesta de la Integración	July	San Lázaro (en Vallemí)
9	Expo Norte	September	Concepción (DIA)
10	Festival en Homenaje a la Juventud Concepcionera	September	Concepción (DIA)
11	Festival del río Paraguay	October	Concepción (DIA)
12	Fiesta Patronal: Virgen del Rosarío	October	Horqueta (DIA)
13	Festividad Nuestra Señora Aparecida	October	Yby Yaú
14	Fiesta Patronal: Virgen de Fátima	October	San Lázaro (en Vallemí)
15	San Carlos de Borromeo	November	San Carlos del Apa
16	Festival del río Apa.	November	Vallemí
17	Nuestra Señora de la Inmaculada Concepción	December	Concepción (DIA)
18	Nuestra Señora de Loreto	December	Loreto
19	San Lázaro	December	San Lázaro

Figure 74 – Monolith “María Auxiliadora” in the main street

9.3.4.4.3.3 Natural heritage

It is the set of natural, or environmental, resources and possessions that society has inherited from its predecessors. It is composed of: natural monuments consisting of physical and biological formations or groups of such formations which are of outstanding universal value from the point of view of aesthetics or science, geological and physiographical formations and strictly defined areas which constitute the habitat of animal and plant species, threatened or endangered, natural sites or strictly defined natural areas (such as national parks, nature reserves, conservation areas, etc.) which are of outstanding value from the point of view of science, conservation or natural beauty [108].

[108] https://moodle2.unid.edu.mx/dts_cursos_mdl/lic/ET/FT/AM/09/Patrimonio_clasificacion_y_definiciones.pdf

Table 88 – Relevant natural heritage list: Protected areas and reserves in the project area/DIA

	Natural Heritage	**Surface** (ha)	**Law**	**Link to PARACEL Project**
1	National Park Paso Bravo	93.612	Decree n. 20.712/98	IIA
2	National Park Serranía San Luis (1991/2010)	10.282	Decree n. 11.964/91	IIA
3	National Park Bellavista	7.397	Decree n. 20.713	IIA
4	Private Natural Reserve Cerrados del Tagatiya	5.281	Decree n. 7.791/06	IIA
5	Private Natural Reserve Tagatiya mi	28.755	Decree n. 10.396/07	IIA
6	Natural Monument Santa Elena	36	Law n. 4.577/11	IIA
7	Natural Monument Caverna Kamba hopo	17	Law n. 4.577/11	IIA
8	Natural Monument Tres Cerros	140	Law n. 4.577/11	IIA
8	Natural Monument Cerro Morado Caverna Ycua pa`i	77	Law n. 4.577/11	IIA
10	Private Natural Reserve Guayacan I, II y III	1.447	Decree n. 1230/	IIA
11	Private Natural Reserve Kai Rague	1.769	No data	IIA
12	RAMSAR Site Estero Milagro	26.503	Law n. 350/94	IIA
13	Private Natural Reserve Arrecife	7.812	No data	IIA
14	IIA of Biosphere Reserve of Cerrados del Río Apa		267 836 ha.	IIA
		183.128		

Source: MADES, 2018; Guyra Paraguay, 2007 IBas. Among the areas of importance as bird conservation sites (Ibas) there are 4 recognized for the study zone (Guyra, 2017): Middle Ypane - Arroyo Tagatiya - Estrella and Cerrados de Concepción.

9.3.4.4.3.4 The cultural-natural heritage

The Cultural-Natural Heritage is made up of elements of nature, which are maintained in their original context, intervened in some way by man. Examples are: archaeological or historical remains in their original natural context; paleontological fossil remains associated with human activity in situ; underwater remains of human activity; and the cultural landscape, produced in a certain time and space, which has remained unchanged.

For the project area, it can be noted the presence of reported paleontological remains (Baez Presser, et al. 2004), both in flora and invertebrates. In the case of Flora, they cite that the first fossilized plants in Paraguay, such as fern and conifer woods, were found in the surroundings of the city of Villarrica, Guairá Department, by Carnier in 1911, who was quoted in Eckel (1959). Predominantly carbonate expositions of the Corumbá Group in Brazil, known as the Itapucumí Group in Paraguay (Concepción area), present a paleontological content that includes the macroscopic alga Tyrasotaenia sp. (Zaine, 1991), and is associated with the invertebrates *primitivos Claudina lucianoi* and

Corumbella werneri and the microfossil *Sphaerocongregus variabilis* (Zaine, 1991) (*Bavlinella faveolata cf. Boggiani et.al.*, 1993)[109].

About the archaeological sites, it can be noted the presence of potential sites of native Mbayas people and others, associated with the use of temporary fishing areas. Reports of archaeological investigations mention the presence of shells, bone remains and ceramics with graffiti and painted designs, at the level of the upper parts of the banks of the Paraguay River, up to the area of Corumba, Brazil, and linked by Susnik (1978) for Paraguay, with the archaeological findings in Belén (department of Concepción).

Current research in Brazil and Argentina validates and complements these links, and indicates the presence of pre-Hispanic societies along the entire length of the Paraguay River, with radiocarbon dating from ca. 100 B.C. to ca. 300 A.D. for the Pantanal Tradition (Lamenza, 2015).

Regarding the rock art in the project area, there are reports of findings and photographs by Dr. Carlos Teichmann (1904) in a place called Barrero Guaá, near Gamarra-cué, a place located at the headwaters of the Tagatiyá stream (AII), Department of Concepción (Díaz-Pérez, 1904).

9.3.4.4.3.5 Culinary heritage

Culinary heritage is understood to be the element of cultural communication, and in this, both the cultural traditions themselves and the natural idiosyncrasies of a place are manifested. Cooking and gastronomy imply an indissoluble relationship between rural life and the service sector. Thus, gastronomy is local development and also tourist development [110].

In 2017, the National Secretary of Culture decided: "To declare as Intangible Cultural Heritage of Paraguay the production, handcrafted and traditional preparation of four typical Paraguayan foods still in use, such as vori-vori, locro, Paraguayan soup and yopará (a mixture of beans and locro); and also their recipes, knowledge, practices and know-how that are transmitted from generation to generation and document the material and immaterial elements associated with it (corn, in its different varieties) as a cultural manifestation"[111]. Table 89 lists the relevant culinary heritage as follows.

[109] https://www.researchgate.net/publication/263727484_ALGUNOS_ANTECEDENTES_PALEONTOLOGICOS_DEL_PARAGUAY
[110] Francesc Fusté-Forné - Universitat de Girona. 2016. Los paisajes de la cultura: la gastronomía y el patrimonio culinarío. En: DIXIT vol.24 N.1 Montevideo. Available at: http://www.scielo.edu.uy/scielo.php?script=sci_arttext&pid=S0797-36912016000100001
[111] http://www.cultura.gov.py/2017/08/cultura-declara-patrimonio-cultural-inmaterial-del-paraguay-la-sopa-paraguaya-el-vori-vori-el-locro-y-el-jopara/

Table 89 – Listing of typical food items surveyed with local testimonies (in Spanish to preserve the integrity)

	Food	Ingredients in Spanish	Testimonies
Based on flour and vegetables			
1	Pirón	Cebolla, aceite o grasa, agua, fariña de mandioca, y sal.	**JB**, Type... In cast iron pot, the fat melts... it is fried and mixed with the wheat... should be mixed to avoid burning and generating lumps.
2	Locro	Locro y verduras fritadas con condimentos varíos	**PAEZ**. Mentions the Páez family, who are dedicated to the manufacture of desserts and sweets... that today the locro is no longer like before... it is smaller and it is no longer consumed as before. Its preparation process starts in the early hours, as it takes a lot of cooking time
3	Poroto Ipokue (Poroto con pata)	Poroto, pata de la vaca, verduras, y condimentos varíos.	**PAEZ**. The preparation process would begin with the frying of vegetables (Onion, locote, tomato and garlic), and species... you pour the water, the bean and the cow's foot... it is boiled until it is soft and flavorful
4	Polenta - Mbaipy	Harina de maíz, grasa natural, queso Paraguay, y carne picada como salsa final.	**PAEZ**. The sautéed onion, garlic, tomato and locote and species... is filled with water and boiled with corn wheat, until it thickens... then the meat is chopped and a separate tomato sauce is made, which is put on top of the polenta.
Based on fish			
	Sardina	Pescados chicos, condimentos y vinagre.	**JB**. Small fish... are boiled in pressure cookers... and add vinegar to make it sit.
	Piracaldo	Pescado: Surubí, Mandi'i, Tres Puntos y/o Pico de Pato; queso Paraguay, leche, cebollas, locotes y ajo	Brown the vegetables in a cooking pot, put hot water in the pot, place the fish fillet wait to cook and pour water, mix and wait for its boil.
	Chupín		**CD**. It has the same process as the broth pyre, but milk or cream milk is placed.
Meat based			
	So ‘o hu`û (carne blanda)	Carne y menudencia	**CD.** The meat is boiled with other glibets.
	Morcilla - Mbusia	Tripa gruesa	**EO**. In family gatherings, an animal is carneed... blood and intestines are collected, which are cleaned and postponed to be filled as sausage....this work begins in the early hours... and you start preparing the filling of the Mbusia... and should be finished by 10 a.m., where its broth with the black pudding and other menudness (churra)... and is served as a first dish of roasts and preferably for older adults.
	Caldo Ava	Menudencias cebolla, cebollita de verdeo, locote, locote picante y perejil.	It is a broth or soup that is obtained by boiling in water all the smallness of the cow, cooking them, mainly the mondongo (intestines and belly of the beef), the booklet (the third of the four cavities in which the stomach of the ruminants is divided), the fat gut and the chinchulin, the latter the edible small intestine.

Food		Ingredients in Spanish	Testimonies
	Akangue yvyguy (cabeza enterrada)	Cabeza de vaca	**JC.** First, a well of approximately 75 x 75 centimeters is dug in the ground in which pieces of firewood are placed for an hour that acquires the necessary heat for cooking. A banana leaf bed is then made, where the cow's head wrapped in banana leaves, bundled with wire, is then wrapped in a burlap cloth and tied with wire. In the past banana leaves were placed on top of which was covered with earth and with wooden lid. Currently, a sheet metal is placed and on top of the ground, for half a day of cooking.
	Asado a la estaca	carne	**EO; JC.** This meal is usually for large events as the pieces of meat are whole pieces selected, crossed with guayaibi sticks of approx. 1.50 meters. A well is made where curupay firewood is burned in such a way that the fire does not spread, and the stakes rested on another wood that serves as a support.
	Caldo Ava	Menudencias	It is a soup of the smallness of the cow, has a dense and dark consistency, but of good flavor and a lot of caloric value.
	Arroz carretero	Cecina	There are several ways of cooking, one is to fry the vegetables, place water and then the rice, cut the cecina into small pieces and place it on the rice, the order usually varies.
Sweet			
	Dulce de leche	Leche de vaca y azúcar	**CC.** Sugar melts to the point of caramel... the milk is poured and stirred until it has a solid, thick, creamy consistency.
	Dulce de calabaza – andai	Andai/calabaza y azúcar	**JC**. The sugar is boiled with the water... until fully diluted... then the pumpkins are placed and left boiling until the water evaporates.
	Dulce de mamón	Mamón y azúcar	**JC.** The sugar is boiled with the water... until fully diluted... then the rested sucker is placed a day in advance... it is cleaned... and is left boiling until the water evaporates.
	Dulce de pata de vaca (gelatina de pata de vaca)	Osobuco de la pata de vaca, leche, clavo de olor y azúcar.	**JC.** The cow's foot is boiled until the osobuco softens, with the obtained broth mixed with milk and sugar, left boiling stirring until all the ingredients are mixed, at the end the clove is placed and allowed to cool at room temperature until hardened like a custard.

Fuente: CC: Crispín Concha (Piquete Kue) – JC: Juana Cubilla (Horqueta) – EO: Edder Ortiz - CD: Celeste Díaz. - PAEZ: Familia (Concepción). -ID Irene Díaz (Concepción). Prepared by the external consultant Lic. Caren Kremer and team.

9.3.4.4.3.6 Final considerations

From a primary archaeological and historical assessment, based on the secondary information available (historical background and local testimonies), added to the field survey conducted in the area of direct and indirect impact of the project, it can be mentiones the importance of a cultural territory rooted, with local testimonies alive and present in their experiential imagination. For each of the documented testimonies, an assessment is made and measures are proposed to generate cultural roots and protect the present collective memory.

With regard to the valuation and potential social impacts, both in the Area of Direct and Indirect Influence of the project, specifically with regard to the intangible cultural heritage, it can be mentioned that it could suffer a moderate to significant alteration, due to changes in habit and significance as social capital. The presence of external personnel, to complete in the first part the spatial modification of the project, is also considered a cultural impact on the uses and forms of appropriation (livelihoods).

9.3.5 Survey of social perception

9.3.5.1 Presentation of results about survey of social perception

As indicated in the map, and as mentioned in item 9.3.3 of Methodology for the Elaboration of Social Studies, the work carried out in the territory had as a transversal axis the survey of the social perception regarding the socioeconomic characteristics of the area and the installation of the plant.

This work of collecting both quantitative and qualitative data in the territory was carried out in the DAA and the DIA through the use of several techniques that allowed access to individual information, such as census to families located in the immediate surroundings of the project's prospecting area; interviews to key institutional and community actors, as well as surveys in strategic points of the districts involved. Likewise, community focal groups and a participative workshop of institutional actors were carried out in the city of Concepción, capital of the department, spaces from which qualitative information was obtained and used (in the case of this section) as a complement to the analysis to be presented.

The information collection process involved all 316 people in the district of Concepción, including the community of Piquete Cue and estancias located in the DAA; and the existing microterritories in the area and the accesses to the pulp mill, also in the districts of Loreto, Belén and Horqueta. Most of these people showed openness and predisposition to consultations and the delivery of information by the team in each of the spaces generated for this purpose.

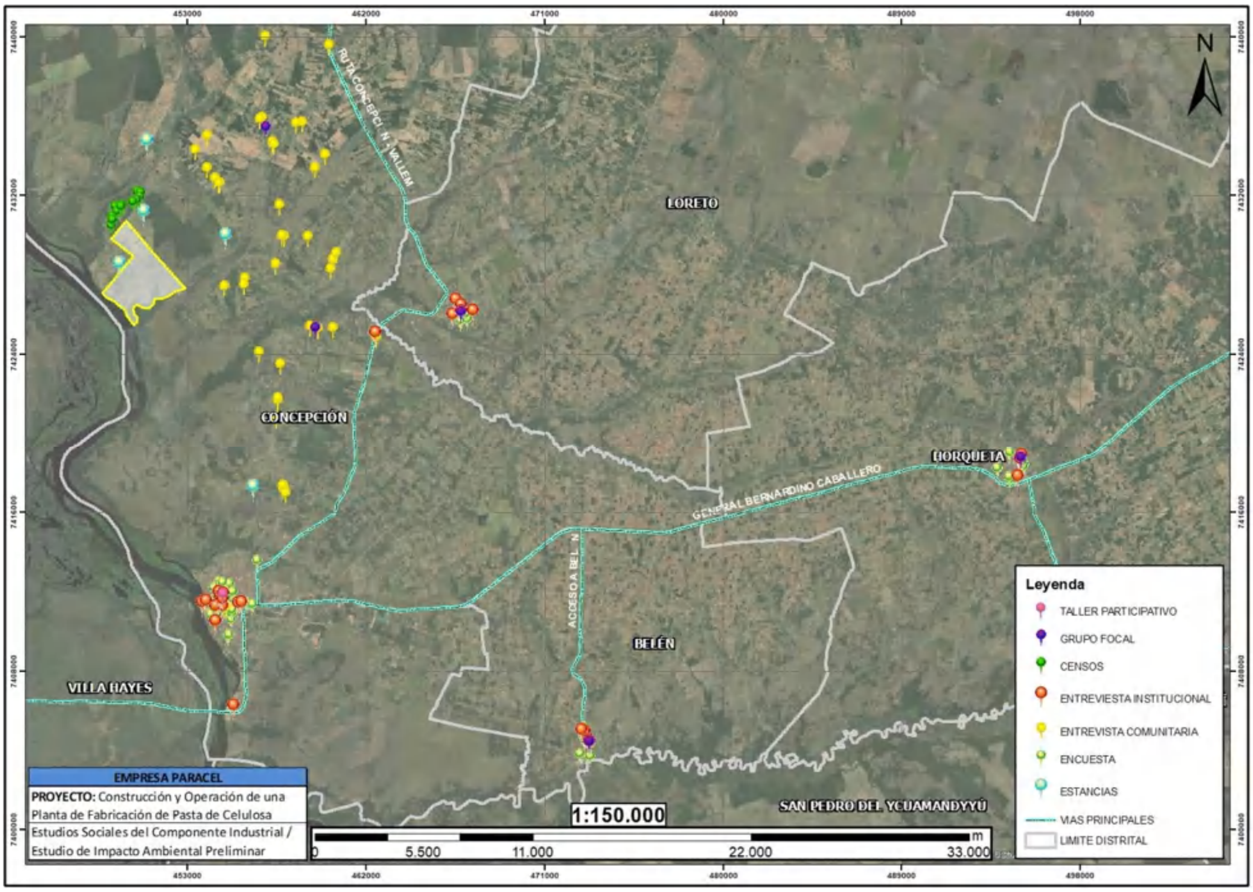
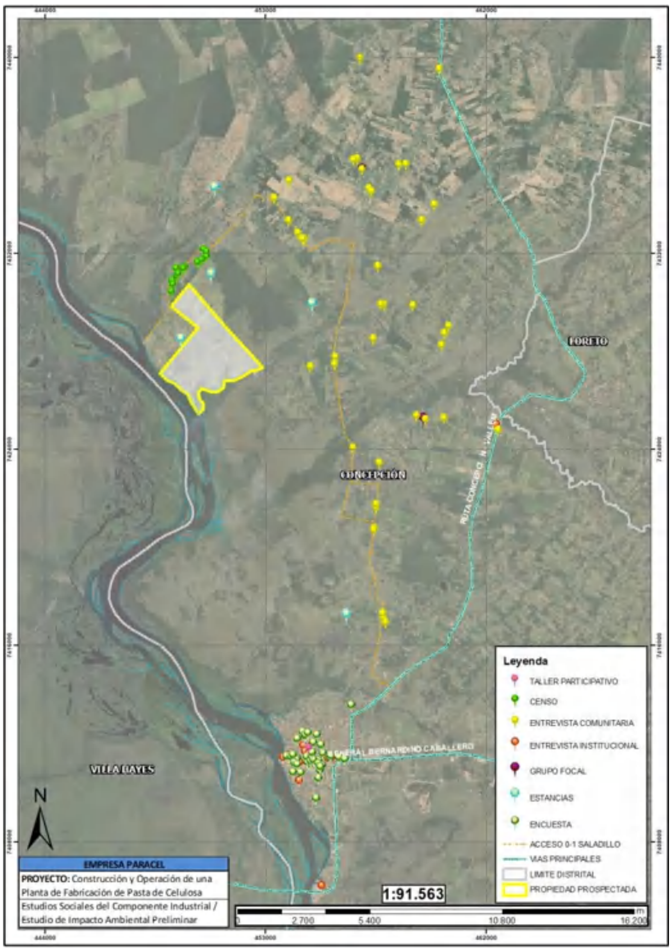


Figure 75 – Geo processing of field survey areas

Figure 76 – Location of the collection process



Distrito de Concepción

Areas where information was collected from people in the district of Concepción, including the community of Piquete Cue and the DAA farms; and micro-territories in the area of future PARACEL industrial facilities.

Distrito de Belén

Distrito de Horqueta

Distrito de Loreto

Table 90 describes each of the techniques used by area, number of people consulted and the resulting sources of verification.

Table 90 – Techniques used in the intervention

Activity	Zone / District / Micro territory	Number of people involved	Resulting Verification Sources	Photographic Record
Census- socioeconomic Census cards were applied to families living in the immediate neighborhood of the PARACEL mill.	DAA- Comunity of Piquete Cue	12 heads of household	Census file Case-by-Case Templates Photographic record	
Farm Interviews Semi-structured questionnaires were applied to owners or managers of mainly farming activities.	DAA-Comunidad de Piquete Cue y zonas aledañas	1 owner and 3 persons in charge of stays	Photographic record Written record of each interview	
Interviews with key players Semi-structured questionnaires were applied to key actors in public institutions, the private sector, civil society organizations, among others.	DIA- distritos de Concepción, Loreto, Belén y Horqueta	28 actors/referents from the Governor's Office of the department, municipalities, regional offices of ministries and national secretariats, universities, associations, social and religious organizations, among others.	Photographic record Written record of each interview	
Interviews with Stakeholders in the Community Semi-structured questionnaires were applied to references of the microterritories identified in the area near the plant.	DIA- distrito de Concepción y 18 Microterritorios ubicados al margen de las vías de acceso a la zona de la planta.	44 takeholders/ referents from educational institutions, small businesses, tourism and recreation enterprises, sanitation boards, neighborhood committees, among others.	Photographic record Written record of each interview	
Participatory workshop with institutional actors from the city of Concepción A program was generated including the delivery of official information by the company and semi-structured questionnaires were applied in working groups during the day.	DIA- Ciudad de Concepción	11 representatives from sectors such as public, private, academia, civil society, among others.	Form of signatures (Signature sheet) Photographic record Written record of the activity	

Activity	Zone / District / Micro territory	Number of people involved	Resulting Verification Sources	Photographic Record
Focus groups with community actors Semi-structured questionnaires were applied during the development of all 5 focus groups.	DIA – Districts of Concepción (Microterritories), Loreto, Belén y Horqueta	67 referents from neighborhood committees, peasant organizations, water and sanitation boards, educational institutions, small businesses, tourism and recreation enterprises, among others.	Signature sheet Photographic record Written record of the activity	 
Perception surveys They were applied by developing a tool with mostly closed and open questions, taking into account interest groups according to profile.	DIA – Districts of Concepción, Loreto, Belén y Horqueta	150 people, students, university students, teachers/managers of educational institutions, shopkeepers, hotel and tourism references, staff in target, people in religious, recreational and organizational spaces	Signature sheet Photographic record	

Source: Prepared by the external consultant Lic. Caren Kremer and team, based on the field work carried out during the months of December, January and February 2020.

The results obtained are presented below, and will be presented in a general way. That is, considering the totality of people consulted and each technique involved per district. However, it is important to highlight the following aspects:

- Certain results will be specified by zone of influence or group differentiated by technique used whenever it is considered important to highlight aspects; otherwise, they could be lost in the generality;
- Although the general results are presented, the results according to the technique used and the zone of influence can be consulted in annexed documents;
- The information recorded from the focal groups and participatory workshop has served as a complement when analyzing both quantitative and qualitative

results, in most cases, reaffirming positions and/or opinions from answers obtained through the other techniques used;

– The number of factors mentioned by the people consulted were taken into account in processing the information and presenting the results, considering the number of times each one was mentioned.

9.3.5.2 Social perception of the socio-economic characteristics of the area

As part of the territorial survey, a range of questions were included regarding the way in which people perceive the place they live, social, economic, cultural characteristics, etc.; the frequent problems, the strengths of the area, aspects considered by them as fundamental for development, among others. The results will be presented considering the areas of influence in which the social field work was carried out, initially in the DAA and later in the DIA.

9.3.5.2.1 Socioeconomic Characteristics of DAA – social perception

In the DAA, the 12 families and 4 references of the estancias bordering the prospected area (Piquete Cue) were consulted.

Main economic activities of the district/town

Both the families registered located in the immediate surroundings of the Plant and the interviewed references of the farms, when consulted about the main economic activities of the area, have mentioned mainly Livestock and Agriculture, with a predominance of small-scale livestock (between 10 and 15 heads) mainly for consumption and sale. In the case of the estancias, the interviewees commented on the roles in the families, "men work on the neighboring estancias doing specific tasks and others go to estancias in the Chaco while women stay to take care of the house and the animals" (referring to those who work as day laborers). It was also mentioned that there are small shops in the area, such as pantries, motorbike and mini-loading workshops (for cell phones), among others.

Table 91 shows the results of the socio-economic census for this item.

Table 91 – Main economic activities of population

Main economic activities mentioned	Number
Agriculture	7
Cattle farming	12
Coal / Coal production	3
Commerce of cheese	1

Source: Socioeconomic census in the DAA - Piquete Cue. January 2020

As it can be observed, cattle raising was mentioned by 100% of the people registered, that is to say; 12 times as the main economic activity of the area and in particular of Piquete Cue.

Positive aspects of living in the community

As for the positive aspects of living in the community, in the DAA, the people consulted agreed that the "tranquility" factor is a very valuable aspect of the area, being mentioned not only by 100% of the people surveyed but also by all the interviewees of the estancias involved in this area.

Table 92 – Aspects mentioned by the population as positive

Positive aspects of living in the community	Number
Environment/landscape	8
Security/surveillance	6
Peace	12
People	4
Low pollution level	1
Others: roots	1
Total	**32**

Source: Socioeconomic census in the DAA-Piquete Cue. January 2020.

Problems identified in the community

The persons involved in the relevance in the DAA mentioned, among the main problems identified in the community, the emigration and migration (first of all), the interviewees from the estancias offered an example of workers who are forced to move to Chaco before the lack of job offers in the area where they live, also who for the same reasons emigrate to Spain or Argentina, losing their link with their places of origin. Subsequently, both groups mentioned, in turn, at the time the labor supply, the access problems due to poor condition or lack of roads, it was abject as a latent difficulty in all cases of estancias and also the scarce police presence in the area.

Table 93 – Problems identified by the families surveyed

Main problems identified in the community	Quantity
Abigeo (theft, theft of animals)	2
Emigration and migration (rural-urban)	**6**
Low job offer	**4**
Alcoholism	**2**
Little cultural and recreational offerings	**1**
Insufficient communication service	**1**
Access problems: Lack of more roads and poor conditions compared to those there are	**3**
Insecurity	**1**
Total	**20**

Source: Socioeconomic census in the DAA-Piquete Cue. January 2020.

Priority issues for community development

In the DAA, a prioritization was requested regarding the aspects that people consider important to increase the development of their community. In view of this, the factor mentioned most often within the highest range (5) by the people registered corresponds to "work" -7-, then the factor "Access to basic services (mainly water)" -3- and finally "Education and Culture"-1-. And the majority of those interviewed in the estancias referred that the main factor to promote the development of the area is related to the generation of sources of work. The second factor is access to education due to the training needs to access jobs and the need to have Family Health Units (FHU) according to the needs of the area. Finally, the importance of the "Arraigo" and the improvement of roads was mentioned.

Table 94 – Priority issues selected by the Piquete Cue (ADA) census takers

Priority aspects for community development	Priority rank					quantity
	5	4	3	2	1	
Access to basic services (mainly water)	3 (25%)	2 (16,67%)	1 (8,33%)			6
Education and culture	1 (8,33%)		1 (8,33%)	1 (8,33%)	1 (8,33%)	3
Work	7 (58,33%)		1 (8,33%)	-	1 (8,33%)	9
Communication and Transport	-	2 (16,67%)	1 (8,33%)	2 (16,67%)	-	5
Territorial development	-	1 (8,33%)	3 (25%)	1 (8,33%)	-	5
Health	-	3 (25%)	4 (33,33%)	2 (16,67%)	1 (8,33%)	10
Agriculture and environment	-	2 (16,67%)	-	1 (8,33%)	3 (25%)	6
Cattle Raising and Productivity	-	1 (8,33%)	-	-	2 (16,67%)	3
Waste and collection and treatment system	-	1 (8,33%)	-	-	-	1
Social Assistance	-	-	1 (8,33%)	4 (33,33%)	2 (16,67%)	7
Security	-	-	-	1 (8,33%)	2 (16,67%)	3

Fuente: Censo socioeconómico en el DAA-Piquete Cue. Enero 2020.

Most important recreational and cultural activities at community level

In the DAA, both groups mentioned various recreational and cultural activities such as: Attending local festivities, organizing and attending soccer tournaments for both men and women and in lesser numbers, going fishing, going to mass, birthdays in the community and going to the public spa (“balneario”).

Table 95 – Recreational and cultural activities mostly mentioned

Most important recreational and cultural activities	Amount	Percentage
Patron Saint's Day	11	91,67%
Laceada	5	41,67%

Football tournament (men and women)	4	33,33%
Fishing	2	16,67%
Holy Mass	2	16,67%
Birthdays in the community	2	16,67%
The Spa (balneario - resort area)	1	8,33%
Total		**100%**

Fuente: Censo socioeconómico en el DAA-Piquete Cue. Enero 2020.

Most used media in the area

All the interviewees from the farms and ranches (estancias) mentioned that the most used media is the cell phone through social networks (WhatsApp, Facebook), the most watched TV channel is Telefuturo and one of them mentioned that he uses cable TV. Among the most listened radios are cited: Regional Radio, Aquidaban and Radio Norte. In the case of the people surveyed, the answers are shown in table 96:

Table 96 – Media

Media	**Quantity**
Oficial radio media and alternative radio media (from community). (Teko Pyahu Loreto. Regional 660 AM Concepción. Radio comunitaria Primavera. La Mega)	10
TV: Telefuturo, Cable, Canal 40 de Concepción.	10
Social network: Facebook y WhatsApp	5
Total	**25**

Source: Socioeconomic census in the DAA-Piquete Cue. January 2020.

As can be seen, and unlike the group of interviewees from the estancias, 83.33% (10 out of 12) mentioned that the most used media in the area are: official and alternative (community) radios, as well as TV which was also mentioned by 10 people (83.33%); the minority 41.67% (5 out of 12) responded that the most used media are social networks.

Socio-economic characteristics of DIA - social perception

All 300 people were involved in the DIA in the different consultation spaces already mentioned at the beginning of this section. The following results were obtained from this process:

Table 97 – Economic Activities

Economic Activity	Concepción	Horqueta	Loreto	Belén	Total
Agriculture	66	16	14	7	103
Cattle breeding	76	11	10	10	107
Smaller Cattle	6	1	0	0	7
Trade	73	11	18	19	121
Day laborer/Changa	26	3	2	1	32
Tambo	2	2	1	0	5
Fishing	4	0	0	0	4
Goods and Services	12	0	1	3	16
Civil Service	2	2	4	1	9
Financial	1	1	0	0	2
Industry	7	1	0	18	26
Tourism	2	0	0	4	6
Retired	0	0	1	0	1
Productive Cooperatives	0	2	2	0	4
Construction	1	2	4	1	8

Source: Social work in the field. January and February 2020.

In terms of the main economic activities in the area, the three most important categories in the districts of Concepción, Horqueta and Loreto were agriculture, livestock/cattle farming and trade. In Belén there is a variation considering that industry is registered as the second most mentioned category.

In general terms, it can be observed that the 4th most mentioned factor is the one corresponding to the work by day or "changa", where, those who are inserted in this labor segment are occupied in great measure in the informal sector; receiving a daily remuneration or to piecework. Examples include work on the farms (fencing, carpentry, planting), the sale of fruit and vegetable products at weekly fairs, and the sale of weed remedies, chicken, eggs, milk, cheese and other items on the street.

Agriculture and cattle raising are mostly done on a small scale and for family consumption. As part of the agricultural production are mentioned the cultivation of sesame, corn, cassava, pineapple, tomato, watermelon, cotton and tartar.

Cattle raising has the particularity of being an area that operates as a savings system for families, since the animals are sold or slaughtered according to need or in case of emergencies. To a certain extent, they supply the area's slaughterhouses and most of them slaughter for sale and consumption by the families in the places where they live.

Trade is an activity that has been increasing in recent years. Examples are: gastronomic enterprises (pizzerias, restaurants, food park), hardware stores, distributors, transporters, supermarkets, "bodegas", warehouses and others.

The secondary sector is represented by the cement, lime and slaughtering industries as referred to by the people who participated in the consultation process. These industries are initiatives that generate sources of income for the inhabitants of the area and are highly valued due to the lack of jobs/work.

In this area, the participation of both women and men in the neighborhood courts or sports centers of the largest cities is noteworthy. In addition, it is worth mentioning that there are people of all ages who come to support their teams, so it becomes a collective activity to which several people come as spectators; even more so in the official tournaments of Paraguayan “salonism”.

Another of the aspects mentioned belongs to the cultural environment, highlighting the reference to the Patron Saint's Day by the actors consulted. These are characterized by integrating a strong religious content in which festive acts are merged with beliefs, customs, and traditions.

The third most important factor is the traditional livestock, industrial and commercial event called Expo Norte. It has been held since 1989, organized by the Rural Association of Paraguay (ARP) and the Association of Traders and Industrialists of Concepción (ACIC). It takes place in the first two weeks of September in the Nanawa exhibition field, located at km 2.5 of Route V.

Expo Norte opens its doors to the general population with a wide variety of attractions at the artistic, cultural, sporting and social levels, in addition to the exhibitions presented by the fairground owners from different areas. Another of the activities referred to mainly at the community level is: attendance at spas, streams, pools or rivers that exist locally; and in the field of equestrian sports the competition of ties or "laceada" that takes place in a field called the track where the objective is to link the cattle with a rope or ribbon in the shortest time possible.

Table 98 – Recreational Activities

Zone	Concepción	Horqueta	Loreto	Belén	Total
Patron Saint Festivities	34	8	9	7	58
Founding Party	0	2	0	1	3
Night parties (discos)	6	3	2	1	12
Artistic Festivals	9	4	9	1	23
Motorcycle/running tours	2	1	0	0	3
Football tournaments (indoor, outdoor)	63	22	13	8	106
Volley	10	1	0	0	11
Fishing	1	0	0	0	1
Boat trip	1	0	0	0	1
Skating	1	0	0	0	1
Basket	1	0	0	0	1
Dance	1	1	0	0	2
Swimming	0	1	0	0	1
Painting	1	0	0	0	1
Open spaces (square, parks)	3	0	2	0	5

Spas, streams, river, pool	20	3	4	4	31
Race horse / horseback riding	6	2	1	0	9
Laceada	15	1	1	1	18
Going to Gourmet Sites	2	0	0	0	2
Expo Norte	28	3	1	2	34
Tourism	1	1	0	1	3
Theatre	4	0	0	0	4
Student Parade	11	2	5	14	32
Shopping	0	1	2	1	4
Religious activities	4	2	0	0	6
Youth Group Meeting	1	0	0	0	1
Fundraising activities for social assistance	3	0	0	0	3

Source: Social work in the field. January and February 2020.

Positive aspects of living in the area

Peace of mind, security, people, environment and low car traffic are the five most outstanding positive aspects of living in the area according to the data collected in the four districts of the study area. These elements refer to aspects related to the quality of life of the inhabitants.

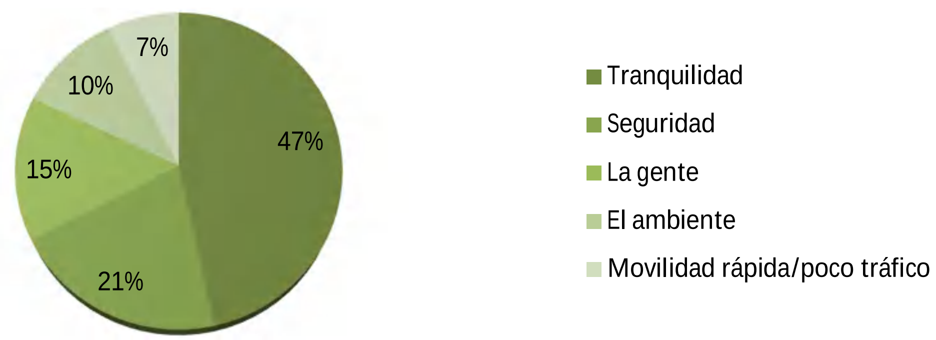


Figure 77 – Assessment of the positive aspects
Source: Social work in the field. January and February 2020.

In addition to the above-mentioned aspects, unity and solidarity are also noted as part of the organizational component, followed by the importance of having land suitable for agricultural and livestock production.

Table 99 – Main positive aspects mentioned about living in the area

Positive aspects	Concepción	Horqueta	Loreto	Belén	Total
Peace of mind	68	29	32	30	159
Security	21	15	11	24	71
Unit/Organization/Solidarity	10	3	2	6	21
Fast mobility/low traffic	9	4	1	11	25
The environment	25	7	2	2	36
The cost of living is lower	4	1	0	1	6
Roots (born tradition)	4	0	0	1	5
Productive zone, Fertile land	12	3	0	1	16
Area close to institutions and communities and access to benefits	9	0	0	0	9
Low rate of drug use	0	1	1	0	2
Investment zone	1	0	0	0	1
The people	33	6	4	7	50
Progress on the road and access	1	0	0	0	1
Industrial development	1	0	0	2	3
Offer of educational institutions	0	1	0	0	1
Freedom of speech	0	1	0	0	1
Little pollution	0	0	2	0	2
Cultural and recreational spaces	2	1	0	0	3
Job offer	4	4	3	2	13
Commercial sector development	1	2	1	1	5
Hotel and Tourism	2	0	0	1	3
Water quality	2	0	0	0	2

Source: Social work in the field. January and February 2020.

Necessary aspects for further development

The results obtained with respect to this item will be presented initially as mentioned by the people consulted through the interviews, including key institutional and community actors.

According to institutional and community stakeholders interviewed: Infrastructure and road safety (17%) considering the importance of improving the condition of roads and local roads, as many communities are isolated in the rainy season. The second factor refers to the need to generate sources of work (16%) in the area of study due to the little or almost no existing labor supply, together with the importance of promoting or developing technical assistance programs (16%) for local initiatives and enterprises, with special emphasis on small and medium producers. Linked to this factor is the importance of strengthening peasant agriculture (5%) accompanied by a market for the commercialization of existing production at fair prices (5%).

The third factor corresponds to the importance of installation and operation of industries (10%), considering that these can contribute to compensate the lack of labor opportunities in the area.

Table 100 – Results about issues needed for development

Development	Concepción	Belén	Loreto	Horqueta	Total	%
Education/training	6	1	0	1	9	5%
Technical assistance for local initiatives	24	1	2	0	29	16%
Strengthen peasant agricultural production		2	2	3	9	5%
Agrarian reform and organization		0	0	1	2	1%
Generation of work sources	19	2	3	3	28	16%
Health	8	0	0	1	10	6%
Market for the trading on production at fair prices	3	2	1	3	10	6%
Industries	10	0	1	5	18	10%
Local investment and new technologies		1	2	2	7	4%
Infrastructure and Road Safety	26	1	1	1	31	17%
Recreational Spaces	1	0	1	0	3	2%
Clean-up politics	1	0	0	0	2	1%
Improvement of local government	1	0	0	0	2	1%
Dynamization of the local and departmental economy.	1	0	0	0	2	1%
Drainage and sanitation.	1	0	0	0	2	1%
Lack of political will.	1	0	0	0	2	1%
Supply market	0	1	0	0	1	1%
Strengthening SMEs.	0	1	0	0	1	1%
Roots	2	0	1	0	3	2%
Strengthen livestock production.	0	0	0	1	1	1%
Transparent competitions to access public positions, eradicating preferential treatment and clientelism.	0	0	0	1	1	1%
Access to basic services	2	0	0	0	2	1%
Access to education	4	0	0	0	4	2%

Source: Social work in the field. January and February 2020.

Necessary aspects for further development according to DIA respondents

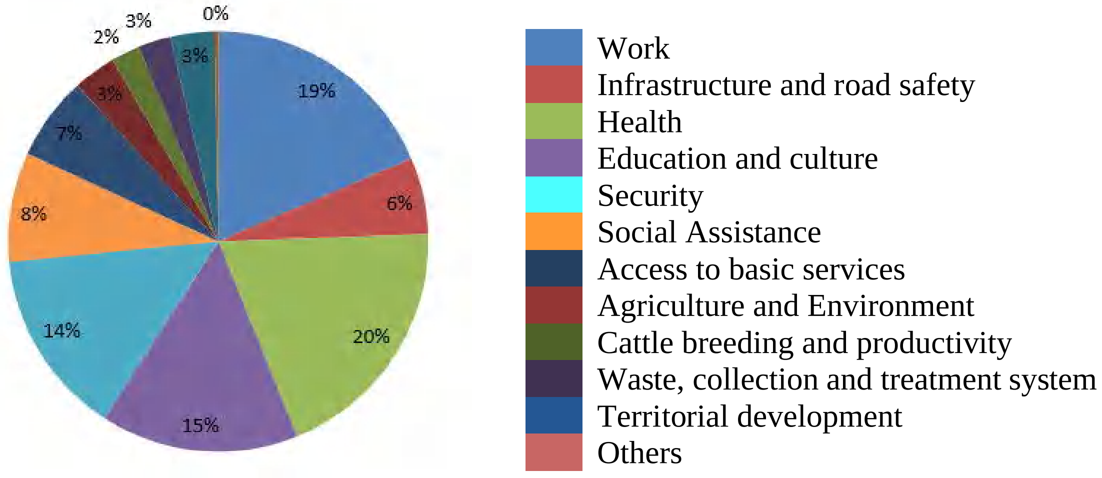


Figure 78 – Priorities for a major development
Source: Social work in the field. January and February 2020.

It can be seen that the priority factors are: Health (20%) related to the need to improve access to quality care, the importance of having health units close to the communities and that these have equipment, infrastructure and basic inputs for adequate care.

The second factor corresponds again to the need for labor supply in the area (19%). It is important to emphasize that the districts have qualified labor that cannot practice their profession due to the lack of jobs/work that is forced to migrate to other cities for greater employment opportunities.

The third factor most frequently mentioned is the priority given to education and culture (15%), linked among other aspects to the possibility of accessing university and improving the educational level of many young people who, due to low family income, are unable to continue their studies.

Social issues

The results that will be presented in this item correspond to the responses of the total number of people who responded to the interviews with institutional and community actors and to the surveys carried out. The analysis is in turn complemented by the conclusions resulting from both the participatory workshop and the focus groups held in the field.

At the level of social problems, the factor "insecurity" was mostly mentioned, that is, by 20% of the total number of interviewees, and the factor "migration" (rural-urban) was reflected by 18%, followed by "lack of work sources" by 14%.

Poverty, cattle ranching and uprooting are the 4th most important factors and the 5th element indicated corresponds to the Emigration of women in their majority to countries such as Argentina and Spain.

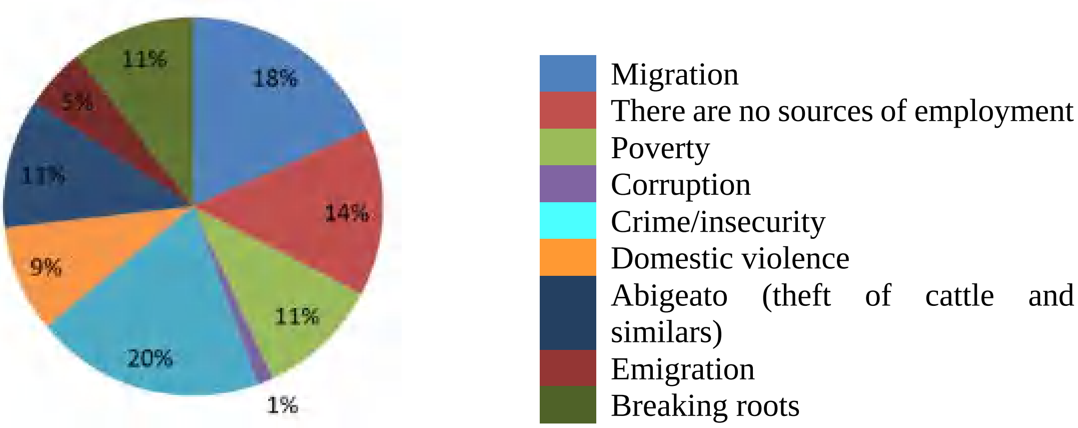


Figure 79 – Results of interviews about social issues

Source: Social work in the field. January and February 2020.

Economic issues

Among the factors most frequently mentioned as part of the results of institutional and community interviews, the first is the lack of work at the local level (27%); followed by the low profitability of agricultural production (22%) associated mainly with the difficulty in moving products for sale, the non-existence of a secure market for marketing and/or the loss of production; and the phenomenon of rural-urban migration (22%).

The third factor mentioned is poverty (12%), followed by uprooting (9%), which in most cases is identified by the people consulted as a consequence of the permanent migration and/or emigration registered in the areas of study.

The fifth element referred to consists of the lack of technical assistance specifically for small and medium-sized producers, both livestock and agricultural, as well as for entrepreneurs in general.

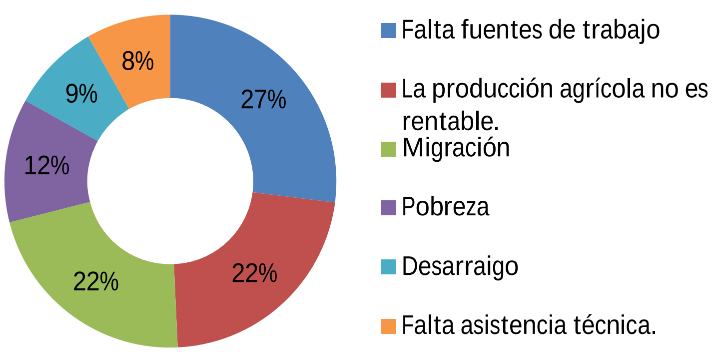


Figure 80 – Results of interviews about economic issues

Source: Social work in the field. January and February 2020.

Problems identified in the district - survey results

Out of a total of 150 respondents in the DIA districts, 9 key factors are mentioned, which are reiterated in the 4 districts; from which 5 central aspects can be visualized which are: the lack of jobs/work (38%), drug use (29%), insecurity (17%), emigration (10%) and migration (6%).

In relation to both social and economic problems, it can be seen that the lack of a source of work is currently a cause for concern in the area, as it was an aspect mentioned by a large number of people, both in the interviews and in the surveys. Insecurity and related issues (drug use, crime, etc.) and migration were also mentioned. However, it should be noted that in many cases these were linked to the lack of employment as the trigger for the other aspects mentioned.

In group spaces such as the participatory workshop with key actors in the city of Concepción, these aspects were reiterated. Likewise, the lack of road access, the little decentralization that leaves the area quite isolated at the political and social level, the fracture between the rural and the urban environment and the lack of training adapted to the local reality should be highlighted as other issues of concern highlighted in that space. It was also possible to access aspects that were highlighted in the community focal groups and that generate concern in the rural area, such as school dropouts, cattle ranching, lack of technical assistance for production, low income and debt, among others.

At the end of this subsection, it is necessary to highlight that, both in the DAA and in the DIA, through the techniques used, it was possible to access the socioeconomic characteristics of these areas, from the viewpoint of the inhabitants of the project's areas of influence, also fulfilling the objective of generating an initial information channel with them. It was possible to demonstrate that beyond belonging to an urban or rural area, there are similar visions regarding issues related to their immediate environment and in general, the main economic / productive activities of the area, also the positive aspects or personal appreciation of the community in which they reside, highlighting the "tranquility", "security" and other factors linked to the way of life in the department, as well as some similarities in aspects related to the common interest such as those that, according to them, should be worked on so that there is greater development in the community / department. However, in this and other items, in addition to the common themes that were mentioned, such as "sources of work" and "road improvement", others were also highlighted that refer to more particular issues depending on the area in which the survey was conducted "access to health services" "access to basic services, especially water".

9.3.5.3 Social perception of the PARACEL Project (pulp mill)

With regard to the social perception of the installation of the PARACEL pulp mill, the general results are presented, including the various techniques used to reach the population, this by district. The population was consulted about their knowledge of the project, the means by which they found out about it, their opinion of an initiative of this magnitude in the area, the positive and negative aspects of it, their expectations, aspects that they think are important to take into account in the construction and operational stages, among others.

As can be seen in the following table, the first item consulted is related to the knowledge about the installation of the plant, to which almost 30% of the interviewees and respondents answered affirmatively, that is, they mentioned having heard of the pulp mill. Of the districts involved, Concepción had 45% of affirmative responses, as opposed to the other districts with less than 20% of affirmative responses in all cases. It can be seen that in the case of the Belén district no one had heard about the venture.

An important aspect to highlight is that, in the DAA, the people surveyed and interviewed already had 100% knowledge about the venture and that through the development of focus groups it could also be noticed that the people living in the micro-territories located on the access road to the plant had greater knowledge than those in more distant districts.

The following table shows the general results related to the above-mentioned item.

Knowledge about the construction of a pulp mill

People who have claimed to have heard about the construction (67) have been consulted about the area in which the construction is planned and, if so, the means by which they found out. More than 80% responded that they had knowledge of the area in which the construction is planned, affirming that most of them had heard about it from friends, neighbors and/or relatives, followed by those who had heard about it through local radio programs.

Table 101 – Results of surveys, community interviews, institutional interviews and census

Have you heard about Pulp mill?	Concepción	Horqueta	Loreto	Belén	Total	Percentage
Yes	57	6	4	0	67	28,63
No	74	29	31	33	167	71,37
Total	131	35	35	33	234	100%

Source: Social work in the field. January and February 2020.

Table 102 – Results of surveys, community interviews, institutional interviews and census

Do you have idea about the area of future Pulp mill?	Concepción	Horqueta	Loreto	Belén	Total	Percentage
Yes	49	3	3	0	55	82,09
No	8	3	1	0	12	17,91
Total	57	6	4	0	67	100%

Source: Social work in the field. January and February 2020.

As can be seen in Table 102, most of the people who have knowledge of where the pulp mill will be built come from the district of Concepción.

Knowledge about what is manufactured and its implications

When asked about what is manufactured and its implications, the results show that in Concepción most of the answers were in the affirmative, however, with very little difference from those who responded not knowing. In the other districts there was a clear lack of knowledge.

Table 103 – Results of surveys, community interviews, institutional interviews and census

Do you know what it is produced and what the implications of its production are?	Concepción	Horqueta	Loreto	Belén	Total	Percentage
Yes	42	2	1	0	45	46,39
No	36	6	5	5	52	53,61
Total	78	8	6	5	97	100%

Source: Social work in the field. January and February 2020.

Opinion about the initiative

As for the opinion of the people involved in the survey regarding the initiative, most of them presented positive opinions. These opinions were linked to the generation of sources of work, to boosting the industrial development of the area and to generating progress and development. In terms of negative connotations, although there is a notable difference in terms of quantity, the most mentioned factor is related to people's fear of the possible damage to the environment that could be caused by the project if the corresponding precautions are not taken.

Table 104 – Result of inquiries

Opinion about the Project/initiative	Concepción	Horqueta	Loreto	Belén	Total
It is expected to be actually implemented (Corruption may create obstacles to the implementation of the initiative)	5				5
It's all about generating jobs	36	3	3	3	45
It is positive if it does not generate environmental damage (compliance with environmental laws on care and protection of the environment, reforestation, among others)	12		2	2	164
It will enhance the industrial development of the area. "Dynamization of the local and departmental economy"	17	6	3	1	27
Roads will be improved	2				2
Compliance with the Working Conditions "It is important that it takes place within the framework of decent working conditions".	4				4
Social Responsibility	4				4

Opinion about the Project/initiative	Concepción	Horqueta	Loreto	Belén	Total
"That they take into account the care of the social environment"					
It can be a good opportunity for local suppliers	4	1	1		6
It is important that they generate a truthful, transparent and articulated communication system with the citizens	1			1	2
Dynamization of the local and departmental economy	1	1	1	1	4
It is important that they consider and comply with safety and impact mitigation measures	1				1
Training and Proficiency	1			1	2
No answer	2				2
Total	90	9	8	9	116

Source: Social work in the field. January and February 2020.

Positive aspects/benefits that it will be able to offer to the community/department/country

Table 105 – Results of community and institutional interviews, census and inquiry responses

Positive aspects/benefits that it will be able to offer to the community/department/country	Concepción	Horqueta	Loreto	Belén	Total
Generation of work sources	91	28	31	25	175
Dynamization of the economy at the local and departmental level	27	4	6	4	41
Access to basic services		1			1
Progress and development	22	7	1	7	37
Enhancing industrial development	5		2	1	8
Improvement of community infrastructure	10	1			11
Social Responsibility	1				1
Additional facilities will be available	1				1
Reforestation	3				3
Generation of opportunities	1				1
Technical assistance to producers in the area	1				1
Consider and comply with safety and impact mitigation measures	1		1		2
Compliance with labor laws	2	1			3
Income generation	5				5
It will help to lower the hazard index		1	1		2

Root	1	1			2
Compliance with environmental care and protection	1				1
Increased income generation for the municipality	1				1
Trainings		1		2	3
No answer	6				6

Source: Social work in the field. January and February 2020.

As indicated in table 105, numerous positive aspects or benefits that an undertaking of this magnitude could offer to the community, cities and country were named. The aspect that prevailed during each of the survey activities, in all the districts, **was the job generation**, later on they mentioned the dynamization of the local and departmental economy, the progress and development and the improvement of the community infrastructure. When the key actors were consulted in the participatory workshop held in the city of Concepción and the community leaders in the different focus groups developed, all of them agreed on the importance of project implementation for the following reasons:

- It will generate direct and indirect jobs (shopkeepers, bricklayers and others);
- It will improve the quality of life in the area. When there is income there is an improvement in the quality of life;
- It will improve the quality of road access;
- Generate genuine income for the municipality; and
- It will contribute to the improvement of community infrastructure.

Negative aspects that could be generated by the project in the community/department/country.

Results of the processing of community and institutional interviews and surveys (In the case of the surveys, this item includes only the 31 cases of people who answered yes to the question "Do you think this project could generate negative impacts for the community" out of the total number of 150 people interviewed).

Although several factors were mentioned that could generate negative impacts according to the people consulted, the answers reveal, above all, their concern regarding the possible damage to the environment that could be caused if the corresponding precautions are not taken, this was the majority in all districts. This aspect was also mentioned in other spaces, such as the focus groups and the participatory workshop with key stakeholders, with the exception of the families registered in the DAA, who responded that they did not see any negative aspects in the implementation of the project.

Aspects mentioned during the interactive workshop and in 5 focus groups

- Environmental impacts/generation of environmental and health damage
- There may be low absorption of local labor due to lack of training and this may generate complications in the area;
- Threat of non-compliance with national and international regulations;

- Many industrial projects wanted to settle and due to political problems did not advance;
- If there is no good communication, it can generate conflict;
- Lack of information that can generate conflict.

Negative aspects that could be generated by the project in the community/department/country	Concepción	Horqueta	Loreto	Belén	Total
Generation of environmental damage	53	7	3	8	71
Low hiring of people from the department	3	0	1	1	5
Don't take care of the social environment	1	0	0	0	1
Non-compliance with working conditions	3	0	0	0	3
Opposition in the city in the case of not coinciding with a group or sector	1	0	0	0	1
Road unsafety	2	0	0	0	2
It does not promote the revitalization of the economy at the local and departmental level	4	0	0	0	4
Increased cost of quality of life	1	0	0	0	1
Control mechanisms for environmental compliance by weak state institutions.	2	0	0	0	2
Non-compliance with environmental conditions/laws	3	0	1	1	5
Non-compliance with protective measures, prevention and mitigation of impacts		0	1		1
Disinterest or lack of accompaniment by political representatives of the government	1	0	0	0	1
The presence of EPP in the area can be a problem	1	0	0	0	1
Concentration of profits in one sector	1	1	0	0	2
Do not answered	5	2	1	1	9

Fuente: Trabajo social en campo. January and February 2020.

Expectations about the project

The answers obtained in terms of expectations in relation to the project are in line with the answers presented in the previous items (opinion, positive and negative aspects) as can be seen in the following table, **the generation of jobs** was named most often, as the main expectation, followed by the **care and protection of the environment, progress and development, promotion of the development of the department and support for the growth of the communities in the area.**

Expectation about the Project	Concepción	Horqueta	Loreto	Belén	Total
Sources of employment, recruitment of local labor and taking into account the young population	73	23	24	27	147
Feasibility of the proposal	6	4	5	5	20
Road Safety	10				10
Compliance with working conditions	8	1			9
Care and protection of the environment	21	3	1	2	27
Progress and development	12	4	8	1	25
Higher economic income	4	4	1	1	10
a truthful, transparent communication system and work articulated with the citizens	8	2			10
It could generate pollution	1	1			2
Adequate infrastructure	1				1
Technical assistance for local farmers	4	1	1		6
Care of the social environment	5	1			6
Consider and comply with safety and impact mitigation measures	4	2		1	7
To promote the development of the department and support the growth of the communities in the area	13	2	2		17
Installation of the plant in the areas; in places where the negative impacts are minor and it is easily accessible	1				1
Selection of qualified and reputable personnel	2		1		3
Training development	5	1			6
Contribute to local suppliers	8	2	2		12
Enhancing industrial development	1				1
relative impact on the local economy	1				1
Do not answered	5			1	6

Fuente: Trabajo social en campo. Enero y febrero de 2020.

Expectations and observations resulting from the collaborative workshop

– Effective communication with regard to the project;
– That society is aware of the implications of the project;
– That the hired labor is local professionals;

- That the project becomes a reality in the area;
- To inform with transparency so that erroneous information does not spread;
- Dissemination and awareness of environmental safety measures;
- Compensation for the natural resources used;
- Promoting synergies with educational institutions on the implementation of training programs;
- Promote synergies with educational institutions on the implementation of training programs; Dissemination within the Department, the clearer the impacts and benefits, the better.

Considering the consultation process related to people's perception of the possible installation of the pulp mill in Concepción, and as mentioned at the beginning of this section, it is considered important to **“UNDERLINE THE POSITIVE ATTITUDE OF PEOPLE IN ALL BUSINESS THAT MAY MEAN DEVELOPMENT AND BETTER LIVING CONDITIONS IN THEIR DEPARTMENT”.** Although institutional actors from the city of Concepción, DAA and micro territorial residents mentioned that they were aware of the initiative, in the other districts where the possibility was raised, even though they were surprised by the consultations, people were interested in knowing more about the implications of the pulp mill since it could mean "NEW SOURCES OF JOB GENERATION", possibility of employment for unemployed local labor, especially in the case of young people who finish even university degrees and not being able to work they migrate to other places to look for better/greater opportunities, they also expressed the importance that the project has as a priority about "**CARE AND PROTECTION OF THE ENVIRONMENT”**.

People interviewed in the districts of Horqueta, LORETO and BELÉN requested that their communities take into account the work force, commenting that, in previous experiences, although the projects meant absorption of labor at the departmental level, at the local level the impact was not "felt". In the micro territories and DAA, through the implementation of the Census, interviews and focus groups, it was possible to record, among other issues, the expectations of the inhabitants, who expressed the hope that the pulp mill would support the **DEVELOPMENT OF THEIR COMMUNITIES**, expressed in technical assistance for farmers, training in general, contribution with local suppliers, road safety, among others. One aspect that stands out in several areas, both in the rural and urban zones, has to do with the fear of the citizens that the project will not be implemented, since they highlighted that **"MANY TIMES THIS TYPE OF OPPORTUNITIES IS DISCUSSED, BUT IT IS NOT CARRIED OUT"** to what in terms of expectation they mentioned as the " feasibility of the project". Likewise, particular opinions were given through which the importance of fluid communication with the population was highlighted, attention was paid to the interference of political parties in the actions and that security measures and impact mitigation be considered and complied with.

ANNEX I

SOCIAL STUDIES – MILL COMPONENT

SOCIAL STUDIES (Industrial Component)

Environmental and Social Impact Assessment (ESIA)

Proyect: Build a pulp mill in the Concepción region of Paraguay - March, 2021

PARACEL

Acronyms and Abbreviations

ACIC	Merchants and Industrial Association Industriales de Concepción
ADA	Directly Affected Area
AID	Direct Influence Area
AII	Indirect Influence Area
ANDE	National Electricity Administration
ANEAES	National Agency for the Evaluation and Accreditation of Higher Education
ANNP	National Administration of Navigation and Ports
ARP	Rural Association of Paraguay
BM	World Bank
BNF	National Bank of Fomento
CAH	Agricultural Enabling Credit
CGT	General Central of Workers
CNT	National Central of Workers
CODENI	Municipal Councils for the Rights of Children and Adolescents
CONATEL	National Telecommunications Commission
COPACO	Paraguayan Communication Company
DEA	Agricultural Education Directorate
DEAg	Directorate of Agricultural and Livestock Extension
DGEEC	General Directorate of Statistics, Surveys and Censuses
DIA	Environmental Impact Declaration or Environmental License
DINAC	National Directorate of Civil Aeronautics
EIAp	Preliminar Environmental Impact Assessment
ESIA	Environmental and Social Impact Assessment
EPH	Permanent Household Survey
ESSAP	Paraguay Sanitary Services Company
EIA	Environmental Impact Evaluation
IAIA	International Association of Environmental Impact
IFC	International Finance Corporation
INDERT	National Institute of Rural and Land Development
INDI	Indigenous People Paraguayan Institute
INFONA	National Forest Institute
IPS	Social Security Institute
LBS	Social Baseline

LPE	Extreme Poverty Line
LPT	Total Poverty Line
MADES	Ministry of Environment and Sustainable Development
MAG	Ministry of Agriculture and Livestock
MEC	Ministry of Education and Sciences
MIC	Ministry of Industry and Commerce
MINA	Ministry of Childhood and Adolescence
MOPC	Ministry of Public Works and Communications
MSPyBS	Ministry of Public Health and Social Welfare
MUVH	Ministry of Urbanism, Housing and Habitat
NBI	Unmet Basic Needs
ND	Performance Standard
ORMIC	Regional Office of the Ministry of Industry and Commerce
OSC	Civil Society Organizations
PDM	Municipal Development Plan
PE	Equator Principles
PEA	Economically Active Population
PEI	Economically Inactive Population
PET	Working Age Population
PGS	Social Management Plan
PLS	Local Health Plan
MDS	Ministry of Social Development
SENACSA	National Service for Animal Health and Quality
SENAVE	National Service for Plant and Seed Quality and Health
SENEPA	National Service for Paludism Eradication
SINAFOCAL	National System for Job Training and Qualification
SNPP	National Service for Professional Promotion
STP	Technical Secretary of Planning
USF	Family Health Unit
UNA	National University of Asunción
UNC	National University of Concepción
VECs	Valued Socio-environmental Components

Index

ACRONYMS AND ABBREVIATIONS **3**
Illustrations index..... 7
Maps index 8
Graphics index..... 8
Charts index 9
1. PRESENTATION **13**
1.1. Objectives and scope of the studies of the social component 14
1.2. International and national linked regulatory framework 14
2. DESCRIPTION OF THE PROJECT AND AREAS OF INFLUENCE **17**
2.1. Project synthesis 17
2.2. Criteria for the definition of the areas of influence 18
2.3. Description of the project's areas of influence 19
3. METHODOLOGY FOR THE DEVELOPMENT OF SOCIAL STUDIES **20**
3.1. Methodological scheme 21
3.2. Information gathering in the field 21
4. CHARACTERIZATION OF THE PROJECT'S AREAS OF INFLUENCE **23**
4.1. Indirect Influence Area (AII) 23
4.1.1. General Description of the Department 23
4.1.2. Demographic Dimension 24
4.1.2.1. Population 24
4.1.2.2. Indigenous Population 26
4.1.2.3. Main Demographic Indicators 27
4.1.2.4. Households, housing 29
4.1.2.5. Poverty, Income Distribution, Unsatisfied Basic Needs (NBI) 31
4.1.2.6. Migration 33
4.1.3. Job 35
4.1.3.1. Summary of the main indicators of the labor market 35
4.1.3.2. Formality in Employment 39
4.1.4. Economy 40
4.1.4.1. Primary Sector 41
4.1.4.2. Secondary and Tertiary Sectors 43
4.1.4.3. Evolution of the economic-productive activity and services in the department of Concepción 43
4.1.5. Services 44
4.1.5.1. Basic Services 44
4.1.5.2. Education 47
4.1.5.3. Health 52
4.1.5.4. Security, justice 54
4.1.5.5. Infrastructure and accessibility 56
4.1.5.6. Means of Transportation 61
4.1.5.7. Technologies of the information and communication (TIC) 63
4.1.5.8. Media 64
4.1.5.9. Tourist Services and Accommodation 66
4.1.5.10. State Presence 67
4.1.6. Land Use 69
4.1.7. Use of Water Resources 72
4.2. Area of Direct Influence (AID) 76
4.2.1. Belén's District 76
4.2.2. Loreto's District 79
4.2.3. Horqueta's District 81
4.2.4. Concepción's District 83
4.2.5. Mapping, Characterization and Analysis of Micro-territories 86

4.2.5.1. Identification and presentation of the micro-territories.......86
4.2.5.2. Characterization of each identified micro-territory.......89
4.2.5.3. Presentation of results generated from the field survey process.......99
4.3. Characterization of the Directly Affected Area (ADA) 115
4.4. Cultural Heritage....... 128
4.4.1. Synthesis of the main findings.......128
4.4.2. Valuation and Methodology.......132
4.4.3. Description and Evaluation of the Cultural Heritage of the Project Area 135
4.4.3.1. Tangible or Material Cultural Heritage.......135
4.4.3.2. Intangible or inmaterial heritage 146
4.4.3.3. Natural Heritage 148
4.4.3.4. The Cultural-natural Heritage.......149
4.4.3.5. Gastronomic/Culinary Heritage 150
4.4.4. Final Thoughts 152
5. SURVEY OF THE SOCIAL PERCEPTION 152
5.1. Presentation of the results of the perception survey....... 152
5.1.1. Social Perception of the Socioeconomic Characteristics of the Area.......157
5.1.1.1. Socioeconomic Characteristics of the ADA – Social Perception 157
5.1.2. Social Perception of Entrepreneurship (the mill) 167
6. EVALUATION OF SOCIAL IMPACTS....... 173
6.1. Presentation 173
6.2. Methodology for the evaluation of social impacts....... 174
6.2.1. Entrepreneurship activities that generate potential impacts versus potentially impacted social factors.......175
6.2.1.1. Entrepreneurship activities that generate potential impacts.......175
6.2.1.2. Potentially Impacted Social Factors 178
6.2.2. Criteria for the impact assessment.......180
6.3. Evaluation of Social Impact....... 182
6.3.1. Social Impact Assessment – project or pre constructive phase 182
6.3.1.1. Perception Results – perception results report 182
6.3.1.2. Environment immediate to the property of the Enterprise – social units closest to the enterprise 185
6.3.2. Evaluation of Social Impacts – Constructive Phase.......188
6.3.2.1. Matrix of Interaction Between Factors of the Social Environment and Social Aspects of the Construction Stage.......188
6.3.3. Social Impacts in the Construction Phase 189
6.4. Social Impact Assessment – Operational Phase 225
6.4.1. Interaction between factors of the social environment and social aspects of the operational stage 225
6.4.2. Social Impacts in the Operational Phase.......226
6.5. Synthesis of Impacts Due to Significant Conditions Created by the Cctivities of the Industrial Component....... 248
6.6. Cumulative Impact Analysis....... 251
6.7. Identification and Analysis of Social Risks....... 252
6.7.1. Definition of Risks and Methodology.......253
6.7.2. Social Risks of the project 255
7. MEASURES AND PROGRAMS....... 257
7.1. Identification and Justification of the Programs/Measures 257
7.2. Social Management Plan (PGS)....... 257
7.2.1. ADA Social Management Program for Communities.......260
7.2.2. Community and Stakeholder Relation Program 261
7.2.3. Local Workforce Development and Linkage Program.......263
7.2.4. Promotion and Development Programa for Local Suppliers.......265
7.2.5. ADA Cultural Heritage Protection and Enhancement Program 266
7.2.6. Road Safety Program for Institutions and Communities of the ADA and AID 267

7.2.7. Awareness and Monitoring Program for Contractors and Workers on Compliance with Regulations 268
7.2.8. Community Health and Safety Program 269
7.2.9. Dissemination and Communication Program....271
7.2.10. Complaints, Claims and Concerns Management Program....273
7.2.11. Internal Management Protocols for Land Affectation (easement)....275
7.2.12. Social Monitoring Program 276
7.2.13. Social Contingency Prevention and Management Program....278
BIBLIOGRAPHY 279
ANNEX 1 Survey tools
ANNEX 2 Activity Log for Social Studies
ANNEX 3 Systematization and registration of the participatory workshop
ANNEX 4 Mapping of actors, plans and programs
ANNEX 5 Equity Report (Concepción)
ANNEX 6 Maps
ANNEX 7 Study of indigenous communities
ANNEX 8 PPT - Paracel. General location and distribution of accommodation
ANNEX 9 Cumulative Impacts

Illustrations index

Illustration 1. Picture of an access road to the city 76
Illustration 2. Picture of the city of Belén, representation of the indigenous culture 78
Illustration 3. Pictures of the access of Loreto 80
Illustration 4. Picture of the City of Loreto 80
Illustration 5. Picture of Horqueta.... 83
Illustration 6. “Nanawa” Bridge, on the Paraguay River, city of Concepción 86
Illustration 7. System of relationships and level of Independence 87
Illustration 8. Reference pictures 97
Illustration 9. Picture took in the micro-territory: Saladillo regarding waste disposal 101
Illustration 10. Pictures of micro-territories in rainy seasons.... 103
Illustration 11. Pictures of the area of the AID 103
Illustration 12. Main economic activities.... 113
Illustration 13. Picture: cattle raising 113
Illustration 14. Pictures of the Curuzu Ñu micro-territory.... 114
Illustration 15. Pictures of the Colony Coronel Mongelós micro-territory.... 114
Illustration 16. Picture of the Co’ê Porâ micro-territory 114
Illustration 17. Pictures of the Pirity Mongelós micro-territory 114
Illustration 18. Picture of the Piquete Cue Access 118
Illustration 19. Access roads to the community.... 119
Illustration 20. Access roads to community.... 119
Illustration 21. Standard houses of the ADA zone 120
Illustration 22. Pictures of the ranches in the zone.... 127
Illustration 23. Pictures of the ranches in the zone.... 128
Illustration 24. Picture of a ranch in the zone.... 128
Illustration 25. Heritage bars present in the city of Concepción with hierarchical symbol.... 136
Illustration 26. Picture: Barracks of the Villa Real de Concepción-1886 139
Illustration 27. Picture: Current facade of the museum. 2020 140
Illustration 28. Picture: Intern gallery of the museum 140

Illustration 29. Picture: Municipal Museum of the Barracks of the Villa Real 141
Illustration 30. Pictures: Cementery, Antique sector – Villa Real of the Concepción 141
Illustration 31. House – typology 142
Illustration 32. Lateral facade of the Church of Belén 143
Illustration 33. Back facade of the Church of Belén 143
Illustration 34. Colonial house with front gallery. Av. Padre Sánchez in the corner with Uruguay 143
Illustration 35. House in a corner with facade cover type 143
Illustration 36. Colonial house with front gallery with details of columns of Jesuit style 144
Illustration 37. Colonial house with frontal gallery with details of columns of Jesuit style 144
Illustration 38. Monument to the Capricorn Tropic. Belén, Concepción 144
Illustration 39. House transformed into a corner with a cover type façade and ciborium on the cornice ... 145
Illustration 40. House in a corner with a cover type façade and ciborium and baluster 145
Illustration 41. House in a corner with cover type facade 146
Illustration 42. House of colonial style with frontal gallery 146
Illustration 43. Monolith María Auxiliadora – main street 148

Maps index

Map 1. Location of the Industrial Mill and relevant related activities 18
Map 2. Influence Areas for social studies 20
Map 3. National Road Network 57
Map 4. National Routes in the Indirect Influence Area 59
Map 5. Road network department of Concepción 59
Map 6. Description of road works and their coordinates in the department of Concepción 60
Map 7. Map of Belén's District 77
Map 8. Map of Loreto's District 79
Map 9. Map of the District of Horqueta 81
Map 10. Map of Concepción's District 84
Map 11. Identified micro-territories 90
Map 12. Geographical localization of interest institutions and places 98
Map 13. Limit of the Directly Affected Area (ADA) 117
Map 14. Map of the Directly Affected Area (ADA) 129
Map 15. Reference zones categorized and presented in layer format with points 129
Map 16. Mapping of historical buildings, inside the old town of Concepción, connection to Paraguay River 138
Map 17. Satellite imagen of the City of Belén 143
Map 18. Satellite image of the city of Horqueta 145
Map 19. Map of the city of Loreto – heritage survey 146
Map 20. Geo reference of hte field survey areas 152
Map 21. Localization of the process of information gathering 154

Graphics index

Graphic 1. Rural urban population projected according to department year 2020, according to projections 25
Graphic 2. Age and Gender Distribution according to projected data 2017. Concepción Department 28
Graphic 3. Age and Gender Distribution according to projected data 2017. San Pedro Department 28

Graphic 4. Age and Gender Distribution according to projected data 2017. Amambay Department........ 29
Graphic 5. Net Migration Rate, projection per department........ 34
Graphic 6. Evolution of the number of intentional homicides per one hundred thousand inhabitants in the departments 55
Graphic 7. Rate of crimes against property per one hundred thousand inhabitants in the departments . 55
Graphic 8. Size of the micro-territories of Concepción in hectares 88
Graphic 9. Main Access Channels 102
Graphic 10. Social Problems 111
Graphic 11. Economical Problems 111
Graphic 12. Valoration of positive aspects 163
Graphic 13. Priorities for further development 165
Graphic 14. Results of the consult about social issues........ 166
Graphic 15. Results of the consult about economic problems........ 166

Charts index

Chart 1. National and international Norm linked to the project........ 15
Chart 2. Standards and performance on environmental and social sustainability IFC........ 16
Chart 3. Equator Principles 16
Chart 4. Projection of total population by gender, regarding department. Year 2017........ 24
Chart 5. Evolution of the population (Projection 2017) 25
Chart 6. Population Density 26
Chart 7. Main demographic indicators, by department. Year 2017........ 27
Chart 8. Indicators contained in the chart 7 27
Chart 9. Houses, legal possession and electrical current, years 2017 and 2018........ 29
Chart 10. Water sources in the houses (%), years 2017 and 2018........ 29
Chart 11. Solid waste disposal and wastewater (%), years 2017 and 2018........ 30
Chart 12. Main used fuel for cooking (%), years 2017 and 2018 31
Chart 13. Possession of durable godos (%), years 2017 and 2018........ 31
Chart 14. Information about poverty lines on 2017........ 32
Chart 15. Total and Extreme Poverty according to department (year 2017) 32
Chart 16. Average and distribution of population's monthly income per capita, according to monthly income quintiles (2017) 32
Chart 17. Houses with UBN, per department and district 33
Chart 18. Population of 10 years and more, pendular migrants per department of residence, according to employment, 2012 34
Chart 19. Main indicators of the working market 37
Chart 20. Working population, according to sector of employment 37
Chart 21. Working according to the years of study, by gender, in the AII (2017)........ 39
Chart 22. Average working income (years 2016 and 2017) 40
Chart 23. Average of the working income, according to department and gender (in thousands of guaraníes) 40
Chart 24. Land according to its usage in amounts of farms, by department on 2008 41
Chart 25. Land according to its number in terms of area, by department on 2008 42
Chart 26. Farms according to soil management and conservation, by department on 2008 42
Chart 27. Forestry Plantations (Eucalyptus and Pine Tree crops), by department on 2008........ 42

Chart 28. Total of economical units. Secondary and Tertiary Sectors, by department. Year 2011 43
Chart 29. Evolution of the economy of Concepción in the last 50 years.. 44
Chart 30. Amount of water systems and connections per lender, by department 45
Chart 31. Average of study years of the population between 15 and 29 years old, by department and gender. Year 2018 47
Chart 32. Main indicators of education of the population in Concepción (% and absolute value) 48
Chart 33. Students enrolled in high school, by department and gender (year 2015)............................. 49
Chart 34. Students enrolled in high school with emphasis, according to department and zone (year 2015).. 49
Chart 35. Universities, district and offered careers.. 50
Chart 36. Careers accredited by the ANEAES, department of Concepción 51
Chart 37. Enrolled in Concepción 51
Chart 38. Number of graduated in Concepción according to the university, school, career years 2013 to 2016 52
Chart 39. Total population, per department, gender and health status (%). Year 2018......................... 52
Chart 40. Main indicators of health of the population of Concepción per year in % and absolute value. 54
Chart 41. Intentional homicide rate per one hundred thousand inhabitants, according to department, years 2010-2017 54
Chart 42. Punishable acts against property, por department, years 2010-2017 55
Chart 43. Road network per department according to type 58
Chart 44. Bridges and roads in the process of improvement in the AII... 60
Chart 45. Infrastructure Works in course in the AID of the project (Dec. 2019) 61
Chart 46. Ground transportation companies from y to Concepción.. 62
Chart 47. Number of vehicles enabled by type, according to department (2017) 63
Chart 48. Population of 10 and more years by gender, according to the use of internet (%)................. 63
Chart 49. Population of 10 and more years who used internet by gender, according to access place (%) 63
Chart 50. Number of radio stations and TV services, per department. Year 2017 64
Chart 51. FM comercial radio stations – department of Concepción 64
Chart 52. AM radio stations – Department of Concepción.. 64
Chart 53. TV Service – Department of Concepción 65
Chart 54. Digital local communication media in the AID... 65
Chart 55. Settlements, romos and beds in the AID, per district 67
Chart 56. Public institutions present in the municipalities.. 67
Chart 57. Instance of citizen participation, with the participation of State representatives 68
Chart 58. Land according to its usage in number of farms, by department on 2008 69
Chart 59. Land according to its number in terms of area, by department on 2008 69
Chart 60. Land distribution by district, department of Concepción... 71
Chart 61. Public colonies formed between 1891 and 2010.. 71
Chart 62. Watering places of the department of Concepción 75
Chart 63. Complementary information about Belén’s District 78
Chart 64. Complementary information about Loreto’s Disctric... 80
Chart 65. Complementary information about Horqueta’s District 82
Chart 66. Complementary information about Concepción’s District 84
Chart 67. Descriptive summary of identified micro-territories.. 91

Chart 68. Registry of recreational places ... 96
Chart 69. Total population in micro-territories of the identified district of Concepción ... 99
Chart 70. Number of houses in the microregion 2 ... 100
Chart 71. Solid waste treatment ... 100
Chart 72. Sanitary and/or storm sewe... 101
Chart 73. Use of technologies ... 104
Chart 74. Health Units ... 105
Chart 75. Educational Institutions ... 106
Chart 76. Prioritization of social problems in the micro-territories of the Concepción's district ... 110
Chart 77. Main economic activities ... 111
Chart 78. Rooting time in the structure ... 120
Chart 79. Number of people in each house ... 121
Chart 80. Number of people by age group ... 121
Chart 81. Arrival of water to the population ... 122
Chart 82. Summary of dwellings of Piquete Cue and their characteristics... 124
Chart 83. Assessment and impacts on the evaluated cultural heritage ... 131
Chart 84. Selection and evaluation criteria for the study of architectural cultural heritage... 134
Chart 85. List of the relevant tangible heritage of the City of Concepción... 136
Chart 86. List of intangible heritage relevant in the AID ... 147
Chart 87. List of relevant Patronal Feasts ... 147
Chart 88. List of relevant natural heritage: Protected areas and reserve in the area of the project/ AID ... 148
Chart 89. List of relevant typical food with local testimony ... 150
Chart 90. Techniques used in the intervention... 155
Chart 91. Main economic activities of the population ... 157
Chart 92. Aspects which population mentioned as positive... 158
Chart 93. Problems identified by censed families... 158
Chart 94. Priority aspects selected by censed people in Piquete Cue (ADA)... 159
Chart 95. Recreational and cultural activities mostly mentioned... 159
Chart 96. Means of Communication... 160
Chart 97. Economic activities... 160
Chart 98. Recreational Activities ... 162
Chart 99. Main positive aspects mentioned of living in the zone ... 163
Chart 100. Results of the consult about necessary aspects for development... 164
Chart 101. Result of the surveys, communitarian interviews, institutional interviews and census ... 168
Chart 102. Result of the survey, communitarian interviews, institutional interviews and census... 168
Chart 103. Result of the surveys, communitarian interviews, institutional interviews and census ... 168
Chart 104. Results of the consult ... 169
Chart 105. Result of the counting of answers to communitarian and institutional interviews, census and survey ... 169
Chart 106. Aspects derived from the activities of the entrepreneurship... 175
Chart 107. Social factors considering for pre constructive, constructive and operative stage ... 178
Chart 108. Nature of the social index... 180
Chart 109. Variables of the social index and their assessment... 181
Chart 110. Social index and impact cathegory... 181

Chart 111. Main expectations/observations/perceptions in relation to the Project and potential associated impacts ... 183
Chart 112. Potential socioeconomic impacts identified ... 186
Chart 113. Matrix of qualitative interaction, social factors and aspects derived from activities in the constructive phase ... 189
Chart 114. Social impacts identified in the constructive stage ... 191
Chart 115. Assessment of social significance of social impacts identified in the construction phase ... 192
Chart 116. Matrix of qualitative interaction, social factors and aspects derived from the activities in the operational phase ... 225
Chart 117. Social impacts identified in the operational stage ... 227
Chart 118. Assessment of the social impact of identified social impacts in the operational phase ... 228
Chart 119. Assessment of probability and consequence of the risks' matrix – Semi-quantitative method (de Deere et al., 2001) ... 254
Chart 120. Description of the Magnitud of a consequence ... 254
Chart 121. Description of the risk class and its assessment ... 254
Chart 122. Main social risks of the project ... 256
Chart 123. Programs and measures ... 258

1. Presentation

This document corresponds to the results of the studies of the social component, developed within the framework of the Preliminary Environmental Impact Study (EIAp), of the Paracel firm's project, for the construction and operation of a pulp mill in the department of Concepción, Paraguay.

This report is developed in accordance with the following sections:

- **Description of the project and the areas of influence**, which contains a brief description of the project, services and related activities, and the implications of its implementation, the proposed phases, including the estimated execution periods and the results that are intended to be achieved, in terms generation of income sources, technological innovation, possible alliances, among others. Likewise, the selection criteria of the Project's Areas of influence: Directly Affected Area (ADA), Direct Influence Area (AID) and Indirect Area of Influence (AII).

- **Methodology for the preparation of social studies,** exposing in detail the work carried out by the team responsible for the preparation of this material, in its different chapters as a baseline and support studies, evaluation and analysis of impacts, measures and programs proposed. The information gathering process in the field, the techniques used, the processing and analysis system, among others, are also described.

- **Social characterization of the project's areas of influence,** a section that describes the economic, social and cultural aspects of the IIA and AID, including variables such as land tenure, income, gender, among others. Initially, a general presentation is made of each area (departmental, district and local) and later its situation in relation to demographics, economy, employment, access to basic services, etc.

- **Survey of social perception**, it is developed as one of the main components of the baseline since it contains information, especially qualitative regarding the perception of the resident population in the ADA and the AID, this in two large categories such as:
  - Socio-economic characteristics of the area in which they reside, and
  - The Build of a Pulp Mill in the department of Concepción.

- **Evaluation and analysis of social impacts**, section that contains the identification and assessment of the impacts and social effects expected by the project, and its services and related activities, as a result of the interaction between its different phases, activities and factors of the social environment, taking in consideration the area of influence of the same. It also contains the analysis of the effects caused both in the pre-construction phase and in the construction and operation phase of the Industrial Mill.

- **Identification and justification of the measures and programs**, which it presents from the analysis of the social baseline (LBS) and the impact assessment; the Social Management Plan (PGS). This Plan contains the objectives, scope and lines of action proposed in each program and/or measure to mitigate and manage the identified social impacts, in order to contribute to local development and to improve people's quality of life. For the development of this and other sections, the analysis of the national legal framework and the international standards that govern and guide the processes of this nature at the international level, of the actions to be implemented from the project, have been continuously considered.

Finally, in the annexes section, information related to the information collection tools, sources of verification resulting from field work, specific studies (Study of the indigenous component) and additional information on the project and related activities provided by the Paracel team.

1.1. Objectives and scope of the studies of the social component

The main objective of the social studies carried out within the framework of the EIAp is to develop a social baseline of the project's area of influence that allows evaluating the impacts of the social environment and consequently developing mitigation measures and social management programs.

An important part of the social studies was devoted to the survey of the perception of the population of the area of influence in relation to their community and the project, as well as to the identification of key actors at the institutional and community level, and the communities residing in the area closer to the mill.

Taking into account the importance of social management in a project of this magnitude, a permanent bidirectional social work was proposed from the beginning, that is, the development of actions that enable on the one hand; collect the first source information, as accurate as possible for the purposes of the project and the EIAp; and on the other hand, to deliver information of interest to the communities from the beginning, generating participatory spaces so that the population is involved from the project design stage.

1.2. International and national linked regulatory framework

The main laws, norms, and principles that have been considered for the development of social studies are listed below. The sustainability policy of the Paracel company takes into account the best international practices, which guide the socio-environmental management of the project.

The normative framework at the national and international level mentioned below has been considered in the different stages of social studies, from the definition of the areas of influence to the criteria for evaluating impacts and developing programs.

At the National Level

Within the framework of the socio-environmental processes of the projects, both public and private, specific studies are carried out framed in Law 294/93 on Environmental Impact Assessment, and its Regulatory Decrees No. 453/13 and 954/13, in which the Environmental Management Plan (PGA) or the Environmental and Social Management Plans (ESMP) are established that will govern the undertaking in its different stages, that is, during design, construction and subsequent operation.

On an International Level

Related international legislation, such as The Equator Principles, the Performance Standards on Environmental and Social Sustainability of the International Finance Corporation (IFC) that guarantee the implementation of projects with social responsibility linked to rigorous environmental management practices, the Objectives of Sustainable Development (ODS), the Guidelines on environment, health and safety of the World Bank, and ILO Convention No. 169, ratified by Law No. 234/93, among others.

Chart 1 presents the legal instruments and principles that govern the project, with an emphasis on social aspects.

Chart 1. National and international Norm linked to the project

Topic	Legal Instrument
National Constitution	▪ Main rule of the Paraguayan State. It establishes the principles of the organization and administration of the country, guaranteeing the protection of fundamental rights. It establishes the principles that define the right to quality of life (Article 6), the right to a healthy environment (Article 7), among others.
Main International Treaties and Conventions	▪ Law No. 1231/1986. That approves and ratifies the Convention on the Protection of the World Cultural and Natural Heritage. ▪ Law No. 2885/2006. Approving the Convention on the Defense of the Archaeological, Historical and Artistic Heritage of the American Nations (San Salvador Convention). ▪ Law No. 2886/2006. Approves the Convention on the Protection of the Underwater Cultural Heritage and Annex. ▪ Instruments derived from the commitment to climate change (National Strategy for Adaptation to CC, National Strategy for CC Mitigation, National Plan for Adaptation to CC). ▪ Law No. 234/93. That approves Convention No. 169[1] on Indigenous and Tribal Peoples in independent countries, adopted during the 76th. International Labor Conference, held in Geneva on June 7, 1989.
Environmental Impact Assessment	▪ Law No. 294/1993. Environmental Impact Assessment. ▪ Law No. 345/1993. That modifies article 5 of Law No. 294/93 on Environmental Impact Assessment.
Institutional Framework with emphasis on environmental, social and territorial issues	▪ Law No. 1561/2000. Creates the National Environment System, the National Environment Council and the Environment Secretariat. ▪ Law No. 6123/2018. That raises the Ministry of the Environment to the rank of Ministry and is renamed the Ministry of the Environment and Sustainable Development. ▪ Law No. 436/1994. Departmental Organic Charter. ▪ Law No. 3966/2010. Municipal Organic. ▪ The National Environmental Policy - PAN. ▪ Law No. 1183/1985 Civil Code. ▪ Law No. 976/1982 by which Law No. 966/1964 creating the ANDE National Administration is expanded. ▪ Law No. 6682/2020 That modifies Article 1 of Law No. 976/1982. ▪ Ordinances of the Municipalities of the area of influence. ▪ Resolutions issued by MADES
Health, Hygiene and Safety	▪ Law No. 836/80 Health Code ▪ Law No. 213/93 Labor Code ▪ Law No. 5552/16, which classifies and categorizes national, departmental and neighborhood routes; ▪ Law No. 5016/14. National Traffic and Road Safety; ▪ Decree No. 14,390 / 1992. General technical regulation of safety, hygiene and medicine at work.
Social, Cultural y patrimonial	▪ Law Nº 3051/2005 “National of Culture”. ▪ Law No. 5621/2016 for the Protection of Cultural Heritage. ▪ Law No. 904/1981 “Statute of Indigenous Communities”. ▪ Law No. 946/1982 for the Protection of Patrimonial Assets. ▪ Law No. 352/1994 on Protected Areas. ▪ Law Nº 4228/2010 By which the Serranía San Luis National Park is declared a Protected Wilderness Area under public domain, within the department of Concepción. ▪ Law No. 4577 on Natural Monuments (Santa Elena, Kamba Hopo Cavern, Tres Cerros, among others.) ▪ Decree No. 1039/2018 "By which the Protocol for the Process of Consultation and Free, Prior and Informed Consent with the Indigenous Peoples living in Paraguay is approved."

1 Although ILO 169 and other Regulations Related to Indigenous Peoples are mentioned, these are the Object of Evaluation in a document independent, and evaluated by specialists hired by Paracel.

Topic	Legal Instrument
Other related norms	▪ Laws that govern the management of Solid Waste (Law No. 3956/2009), Water Resources (Law No. 3239/2007), Air Quality (Law No. 5211/2014), Sound Pollution (Law No. 1100/1997), others

The principles and international performance standards that have guided the elaboration of the baseline and the studies of the social component in the framework of the preparation of the EIAp are presented in detail below.

Chart 2. Standards and performance on environmental and social sustainability IFC

Performance Standards	Description
1. Assessment and management of environmental and social risks and impacts	Attending to the development of a good management system during the different stages of the project requires a comprehensive evaluation of the identification of impacts, risks and opportunities at an environmental and social level. This requires the inclusion of intervening actors as part of participatory processes, as well as the dissemination of pertinent information about the project.
2. Work and working conditions	This principle starts from recognizing and guaranteeing the basic rights of workers by promoting fair, healthy and safe working conditions. Promoting non-discrimination, equality, the protection of workers including the category of vulnerable workers such as children, migrants or workers hired by third parties.
3. Efficiency of resource use and pollution prevention	Increased industrial activity and urbanization can lead to increased levels of pollution. Therefore, this principle describes the approach of the project to avoid or minimize the impacts generated on human health and the environment; integrating pollution prevention and control technologies and practices.
4. Community health and safety	The principle stipulates the need to anticipate and avoid impacts and risks on the health and safety of the communities that are affected by the project activities.
5. Land acquisition and involuntary resettlement	The acquisition of land for project purposes can lead to: physical displacement (relocation or loss of housing) and/or economic displacement (loss of access to resources to generate income or means of subsistence) of individuals or communities. The objective is to avoid physical or economic displacement or minimize the impacts through appropriate measures that are governed by general requirements stipulated in the regulations such as: compensation, community participation, complaint handling mechanism, among others.
6. Conservation of biodiversity and sustainable management of living natural resources	Its objective is the protection and conservation of biodiversity; the sustainable management of natural resources adopting conservation and protection practices.
7. Indigenous People	Guarantee that the development process ensures and fosters full respect for human rights and the dignity of indigenous peoples
8. Cultural Heritage	This principle seeks to protect cultural heritage from the adverse impacts of project activities and to support its conservation, recognizing their importance for current and future generations.

Source: own elaboration based on revised documents

Chart 3. Equator Principles

Principle	Description
Review and categorization	The adhered finantial institution (EPFI)[2] categorizes the project based on levels of risks and environmental and social impacts of the project.
Environmental and Social Assessment.	It refers to the evaluation processes to address the relevant environmental and social risks and impacts of the project; incorporate measures to appropriately minimize, mitigate and compensate for adverse impacts.

2 Equator Principles Financial Entities.

Applicable Environmental and Social Standards.	The evaluation process should address compliance with the host country's laws, regulations, and permits and should demonstrate overall project compliance with applicable standards.
Environmental and social management system and action plan of the EPs.	Projects must have an adequate environmental and social management system. An Environmental and Social Management Plan must be prepared.
Participation of Interest Groups.	The effective and systematic participation of stakeholders must be guaranteed through informed consultation and participation processes in the different phases of the project
Complaints and Claims Mechanism	The operation of a system is due to receive and facilitate the resolution of concerns and problems related to the environmental and social performance of the Project.
Independent review	A review by an external environmental and social consultant is required; for the purposes of evaluating compliance with the principles.
Contractual Commitments	All projects must comply with the current documentation, regulations, environmental and social permits of the host country.
Independent Monitoring and Reporting	Follow-up information must be verified by a qualified external expert.
Reporting and transparency	In addition to the information requirements of principle 5, at least a summary of the Environmental and Social Impact Assessment must be guaranteed; the public presentation of information on the levels of GHG emissions.[3]

Source: own elaboration based on revised documentation

2. Description of the Project and areas of influence

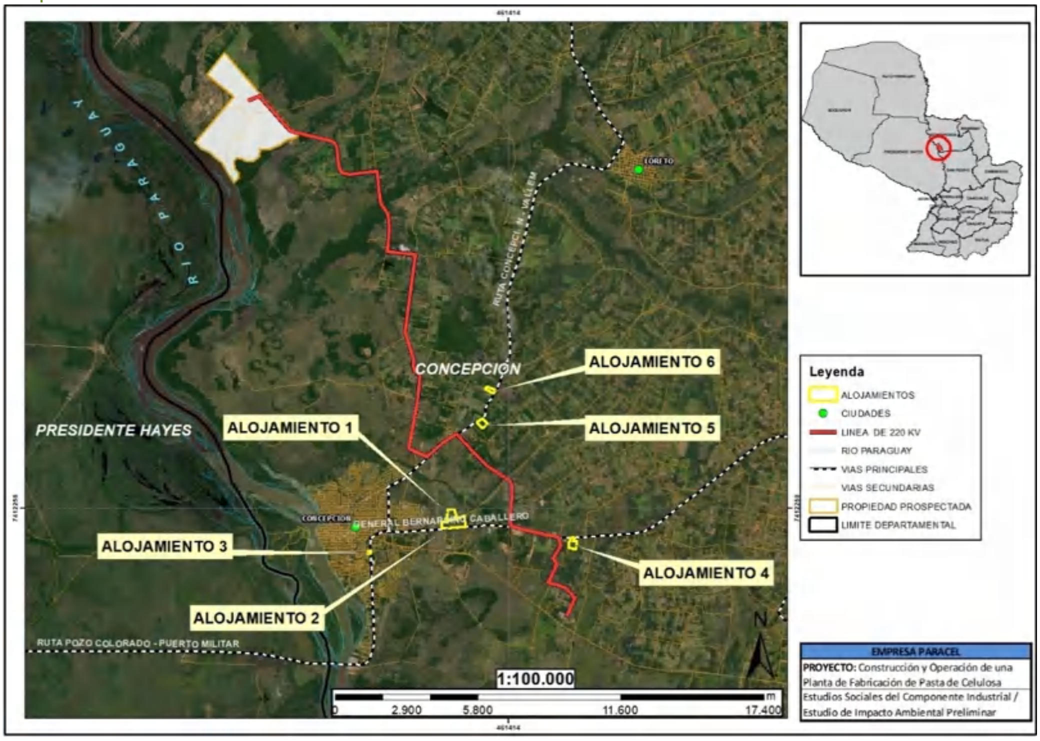
2.1. Project synthesis

Paracel, a Paraguayan national and foreign investment company, plans to build and operate a pulp mill on the coast of the Paraguay River, approximately 15 km north of the city of Concepción, in the department of the same name.

The venture integrates two major components: the industrial and the forestry. The Industrial Mill (industrial component of the Project) will be designed based on the best available technologies and managed in accordance with certified systems; both from the productive point of view, as well as the socio-environmental point of view. In addition, related services (port, exclusive sanitary landfill, others) and other relevant related activities in this component are considered, such as everything related to accommodation for staff in six accommodations[4] to be built for this purpose in the city of Concepción, as well such as the construction of a 220 kV Transmission Line (TL), from the city of Concepción to the mill site itself.

3 Combined emissions of Scope 1 and 2 refered to in Annex A of the Equator Principles.
4 The location might vary in the future

Map 1. Location of the Industrial Mill and relevant related activities



The raw material, consisting of *Eucalyptus sp*. wood, will come from our own plantations, with certified afforestation, located almost entirely in the department of Concepción (forestry component of the Project), although is expected during the first years of operation a supply from Mato Grosso do Sul (Brazil) and, to a lesser extent, from northern Argentina.

The estimated times for each component are:

Study Phase:	For de study phase (engineering, forestry, environmental, social, among others) which started on 2019, an approximate duration of 2 years is expected.
Planting Phase:	5 - 7 years
Construction Phase:	2 - 3 years

It is estimated that the project will generate direct quality jobs: between 5,000 - 8,000 during the construction phase, and 500 - 800 during operation. In addition, the generation of indirect jobs of between 10,000 - 30,000 is projected, with entrepreneurship being a potential booster of the local and national economy. Having as a priority the absorption of local labor, the company will seek to create alliances with local and national educational institutions, to stimulate education and training according to the required profiles.

For the care of the environment, the project will be governed by national regulations (water and effluent quality standards, zero deforestation, among others). With the highest international standards, which require permanent monitoring of environmental impacts, and the public dissemination of the results.

2.2. Criteria for the definition of the areas of influence

For the delimitation of the areas of influence in the framework of social studies, the following criteria were taken into consideration:

- IFC Performance Standard No. 1, on the delimitation of the project's area of influence[5],
- the phases of the project (design, construction and operation), its components (industrial and forestry[6]), possible impacts, and
- the social and cultural aspects studied.

Based on the analysis of these aspects and the initial recognition of the area, three areas of influence of the project were established, for which a particular methodology of work with the resident population has been defined, taking into account the different aspects studied about it.

The three areas were named as follows:

- Indirect Influence Area (AII)
- Direct Influence Area (AID)
- Directly Affected Area (ADA)

2.3. Description of the project’s areas of influence

Indirect Area of Influence (AII): It includes the three northern departments of the Eastern Region of the country: Concepción, San Pedro and Amambay; which were taken into account since they could represent, given their proximity, areas of possible migratory flows, especially in the context of the construction stage. In addition, as a result of the review of secondary sources and field work, it was possible to verify the internal migratory dynamics of these three departments, and their own and common characteristics such as the northern area (economy, population, road connection, etc.).[7]

Area of Direct Influence (AID): The district of Concepción (belonging to the department of the same name), was integrated into the area of direct influence of the project, as it is the closest and most populated urban area to the project, important because it is also the capital from the Department. Especially within this district, an area of approximately 5 km was initially considered around the prospected area for the construction of the mill, as well as the access roads to it, including the Paraguay River in said area. In this area, 18 interconnected localities were identified through local roads. Considering this aspect, it was decided to extend the initial range to a radius of 13 km around the surveyed area. Likewise, the districts close to the surveyed area were included, such as Belén (54 km), Horqueta (66 km) and Loreto (26 km)[8]. Furthermore, this area of influence (AID) also integrates the related activities of the project (accommodation and TL 220 kV)[9].

In relation to the population in the area of direct influence on the side of the department of Pdte. Hayes, after observation in the field and the data from secondary sources surveyed, it was verified that there is no settled population near the factory. The western region in this area has a very low population density, with the most

5 The area that is likely to be affected by: (i) the project and by activities and facilities that are directly owned or operated or managed by the client (including through contractors) and that are components of the project; (ii) the impacts of unscheduled but foreseeable events caused by the project, which may occur subsequently or elsewhere, or (iii) the indirect impacts of the project on biodiversity or on the ecosystem services on which the affected communities depend for get your livelihood. Related facilities, which are facilities not funded as part of the project, that would not have been built or expanded had the project not existed, and without which the project would not be viable. Cumulative impacts (resulting from the incremental impact) on areas or resources used or directly affected by the project, produced by other existing, planned or reasonably defined constructions at the time of carrying out the risk and impact identification process. Performance standard 1 evaluation and management of environmental and social risks and impacts. IFC. 2012. P. 9.

6 Although the characterization does not include the development of the baseline and the evaluation of impacts for the forestry component, it will be taken into account in the framework of the proposed social work.

7 With respect to Pdte. Hayes, although the geographical proximity could indicate that it is part of the IIA, the analysis carried out based on social criteria and in accordance with the results presented in this baseline, shows that the migratory relationship between the North Zone and Pdte. Hayes has a greater number of inhabitants of Concepción who travel to the Chaco for work (for example, to Farms in Pdte. Hayes), than the other way around (from Pdte. Hayes to Concepción). In addition, the populated areas of Pdte. Hayes are far from the surveyed area.

8 Road distances.

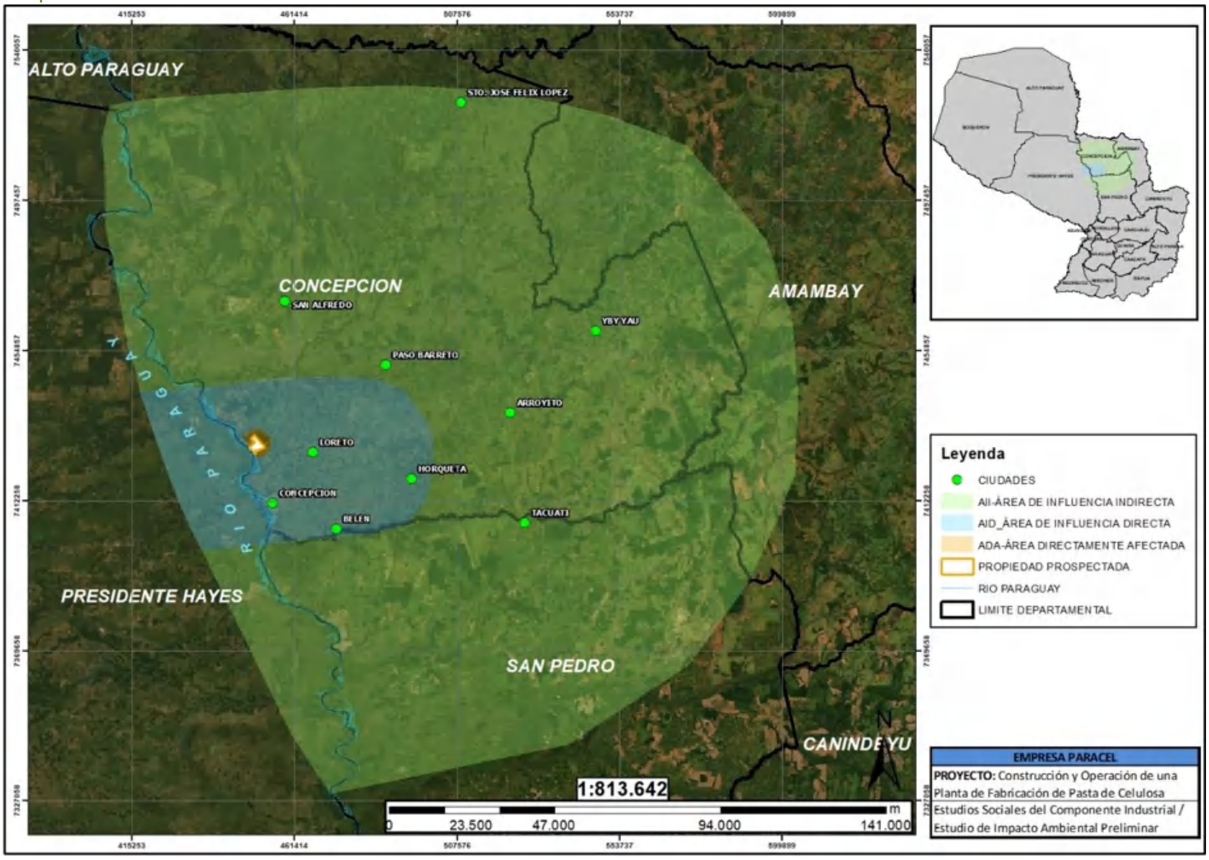
9 The update of this document includes more precise information in relation to the related activities of the project than the initial version (April 2020), because at that time there was no defined location of the accommodation sites and other related aspects.

populated urban centers being very far from the intervention zone (Puerto Pinasco, Benjamín Aceval, Villa Hayes, among others).

Directly Affected Area (ADA): In this area were included the social units (properties, building infrastructures, dwellings, etc.) located in the immediate surroundings of the area surveyed for the installation of the mill, settled within a radius of 1 km from distance.

The scope of the areas of influence is described below:

Map 2. Influence Areas for social studies



It should be clarified that, for the purposes of the EIAp and considering the requirements of the indigenous population, a specific study independent of this document has been developed. Said study, carried out by the Natán Foundation, is presented in the annexes section of this document. The delimitation of areas of influence for said study was carried out according to specific criteria that take into account the particularities and sociocultural dynamics of the communities.

3. Methodology for the development of social studies

For the elaboration of the social studies referring to the industrial component of the project, the following actions have been developed:

- **Formation o fan interdisciplinary team** of professionals and social technicians in charge of carrying out the necessary process for the preparation of the studies. The collection, processing and analysis of information was carried out according to the different study topics developed in each section.
-

- **Survey and analysis of information** obtained through secondary and primary sources, including the use of different selected techniques, which has allowed, in the case of field work, access to the perception of residents regarding the socioeconomic characteristics of their community and the implementation of the project in those areas.

- **Identification and direct communication** with key actors in the areas involved in the project, departmental, municipal and community referents, in order to have their participation and involvement during all stages of the work carried out.

3.1. Methodological scheme

Considering the objectives of preparing this document, a work methodological scheme was defined that was based on the steps described below:

- **Review of secondary sources:** To access information regarding the socioeconomic characteristics of the project's areas of influence, including their cultural heritage; and for the elaboration of the impact assessment carried out, it was necessary to review and analyze pertinent documentation such as censuses, statistical databases, development plans, specific studies, land use plans, periodic reports from public institutions, regional investigations, reports local programs for socioeconomic development, among others.

  Information from the departmental and district level was considered, however, there were difficulties in accessing official data on the local level, in response to which information generated thanks to field work was used, including consultations made to reference bodies such as the Government of Concepción, Municipalities involved and other public institutions in the area.

  Both the national and international regulations, mentioned above, have constituted the guiding basis for the preparation of the different sections that make up this document.

- **Access to information through primary sources/field work:** Various information gathering activities were carried out in the field, through the application of pre-designed tools in order to obtain the necessary data for each study and deliver information to the population involved. These will be described in detail in item 3.2. Information gathering in the field.

- **Access to Project-specific information**: Obtained through work meetings with Paracel's environmental and social sustainability team, who provided complementary and additional data (information on related activities, ongoing social management plans, among other topics) in the period development of this document. In addition to information and documentation available on the project website (https://paracel.com.py).

- **Processing of collected data:** Once collected, the information has been processed with the aim of generating a unique database, taking into account each technique used, so that it is available for the following actions to be developed within the framework of the draft.

3.2. Information gathering in the field

As previously mentioned, for social work in general and in particular for field surveys, the importance of constantly carrying out a bidirectional process was raised; developing actions that made possible; on the one hand, to collect the information from the first source, as accurate as possible and necessary for the purposes of the project and the EIAp; and on the other hand, to deliver information of interest to the communities from the beginning, generating participatory spaces so that the population is involved from the project design stage.

Through this work, baseline studies have been developed, contributing information (especially qualitative) regarding the resident population in the areas involved in the project.

The field survey was structured taking into account the different areas of influence of the project, which has also required the use of different data collection techniques (qualitative and quantitative). The steps carried out during the data collection process are described below:

- **Direct Observation:** Initially, an in-situ reconnaissance tour was carried out and the important aspects of the zones were recorded for the final delimitation of the project's areas of influence; in addition to making the first contacts with key players in the departmental capital.
- **Population residing in the Directly Affected Area (ADA)** units closest to the mill area; with whom the following activities were developed:
    - **Socio-economic census** with the application of a previously designed census form, to families identified in the Piquete Cue community, located in the vicinity of the entrance to the prospective area of the Mill's installation and;
    - **Semi-structured interviews** to owners and administrators/managers of mostly livestock establishments (ranches) located in said area.
- **Population residing in the Area of Direct Influence (AID)** with whom survey activities were carried out, taking into account the district (Concepción, Horqueta; Loreto and Belén) and local level, involving 18 localities or micro-territories, located on the access roads to the mill area, carrying out the following activities:
    - **Interviews to Institutional Actors** in coordination with focal points of the municipalities and the Concepción Government, as well as other referents with whom they had contact during the field work.
    - **Community Interviews,** work that initially implied the identification of key informants, which made it possible to involve referents from community organizations, women's committees, members of water and sanitation boards, educators, pantries, former residents, among others.
    - **Participation Workshop** with institutional actors in the city of Concepción, including referents from public and educational institutions, the private sector, civil society organizations and other key actors in the area.
    - **Focus Groups** with representatives from community organizations, producers, neighborhood commissions, water and sanitation boards, educational institutions, among others. These were implemented by areas that bring together several localities, in addition to communities in the districts of Loreto, Horqueta and Belén.
    - **Perception Surveys** in strategic points of agglutination of people such as supermarkets; educational supervisions; Public hospitals; private sanatoriums and pharmacies; transport and tourism houses; Hotels; small, medium and large businesses; Churches; plazas; etc. In the urban area of the districts involved in the project, taking into account profiles such as: university students; merchants and shop users; people who frequent religious spaces; organizational and recreational; teachers; directors of educational institutions; health care providers; among others.

Finally, it is important to consider the following points related to the work methodology:

- Information gathering tools were designed with special emphasis on identifying the socioeconomic characteristics of each area and the existing capacities and/or needs from the perspective of the stakeholders involved.

- The survey of the perception of the population regarding the socioeconomic characteristics of their community and the installation of the mill, was carried out in a transversal way, to all the people involved in each of the activities, so that there is the necessary inputs to carry out the corresponding monitoring during other stages of the project.
- The survey work in the field (primary sources) was considered a priority since through this it was possible to have valuable information for the development of the studies that make up this document, especially the sections of characterization of the districts and localities of the AID in the absence of specific data related to these.

4. Characterization of the project's areas of influence

4.1. Indirect Influence Area (AII)

Taking into account the information available from official sources, this socioeconomic characterization contains data related to the three departments involved in the IIA (Concepción, San Pedro and Amambay), with emphasis on Concepción. Likewise, with reference to the four AID districts, quantitative data that were available are presented in a complementary manner in this section. As explained in Chapter 3. Methodology for the development of social studies; For the characterization of the AID, and due to the lack of official data at the district level, the information has been complemented with the survey work carried out in each of the districts, and which is presented in item 4.2.

The information is presented in sub-chapters by topics of interest, grouped by department and district (where available). Taking into account the diversity of data sources and the differences in the periods for which the information was available. A comparative analysis between departments was integrated, where possible.

Regarding statistical data, it is worth mentioning:

- The use of the most recent publications and databases that were delivered by the General Directorate of Statistics, Surveys and Censuses (DGEEC) was privileged.
- Although certain types of information could only be obtained from the different Censuses carried out: National Census (2012), Agricultural Census (2008), Economic Census (2011), a valuable amount of information could be collected from the Permanent Household Survey 2017 (and earlier).
- For uniformity of criteria, in population projections and related data those corresponding to the year 2017 were used.
- On December 2019, the DGEEC presented departmental results of the Continuous Permanent Household Survey (EPHC) 2017 and 2018, a publication that presents average annual estimates at the departmental level. Where possible, these data were incorporated. However, taking into account the change in methodology, a comparative analysis was not always possible.

4.1.1. General Description of the Department

The **department of Concepción** is located to the north of the Eastern Region. To the north, it borders the Apa river, to the south with the department of San Pedro, to the west with the Paraguay river and to the east with the department of Amambay. Numerous rivers and streams cross it; and the main river communication route is the Paraguay River.

The department has an **area of 18,051 km^2** and ranks second in the region in terms of area. According to data from 2017, the current population amounts to **244,071 inhabitants**, of which 48.58% are women, with a population density of 13.51 people per km^2. In this department the population is young, with a large majority under 35 years of age (72%); and with an average of 7.61 years of studies. Concepción is divided into **twelve**

districts: Concepción, Belén, Horqueta, Loreto, San Carlos del Apa, San Lázaro, Yby Yaú, Azotey, Sergeant José Félix López, San Alfredo, Paso Barreto and Arroyito[10]; and the city of Concepción is the capital of the department

Although the main economic activity historically was agriculture and extensive livestock[11], in recent years, large companies such as refrigerators and cement plants have been installed, with cutting-edge technology. Likewise, important service provider companies have developed; and, in the district of Azotey there is a milk processing plant (Lácteos Norte) that has developed the milk basin in the districts of Azotey, Tacuati, Yby Yaú and Horqueta[12]. These companies created new jobs for skilled and unskilled people, and fueled economic growth in the department.

The **department of San Pedro** borders Concepción to the south and has an **area of 20,002 km²**. Its population reaches **419,629 inhabitants** (2017 projection data) and has a population density of 21 inhabitants/km². A little more than half of the population is made up of men and they are predominantly young: 70% of the inhabitants are under 35 years of age; with an average of 7.21 years of studies. The main economic activity is agriculture and livestock. The department is divided into **21 districts**: Antequera, Capiibary, Choré, General Aquino, General Resquín, Guayaibi, Itacurubí del Rosario, Liberación, Lima, Nueva Germania, San Estanislao, San Pablo, San Pedro, Santa Rosa del Aguaray, San Vicente, Tacuatí, Unión, 25 de Diciembre, Yataity del Norte, Yrybycuá and Villa del Rosario. The departmental capital is the city of San Pedro del Ykuamandiyú

The **department of Amambay** borders Concepción to the west. It has an area of **12,933 km²**, its population is **164,462 inhabitants** (2017 data) and the population density is 12.7 inhabitants/km². In this department, there are almost equal numbers of men and women and most of the population is under 35 years old (68%); and with an average of 8.48 years of studies. The department is divided into **5 districts**: Pedro Juan Caballero, Bella Vista, Capitán Bado, Zanja Pyta and Karapai; the capital is Pedro Juan Caballero

4.1.2. Demographic Dimension

Next, statistical information related to the population of the Area of Indirect Influence and its evolution, age and gender distribution, households, housing, poverty levels, among others is presented. Likewise, data related to the migration patterns that occurred in the departments are included, with emphasis on the department of Concepción. Where available, data are presented for districts in the Area of Direct Influence.

4.1.2.1. Population

According to data from the General Directorate of Statistics, Surveys and Census (DGEEC)[13], the total population of the department of Concepción is 244,071 inhabitants (2017 projection); which represents 3.5% of the Total Population of Paraguay (6,953,646 inhabitants, 2017 Projection). It is the ninth most populated department in the country, while San Pedro ranks sixth and Amambay ranks thirteenth.

Chart 4. Projection of total population by gender, regarding department. Year 2017

	Concepción	San Pedro	Amambay	Total All
Men	125,490	219,509	82,173	427,172
Women	118,581	200,119	82,289	400,989
Total (both genders)	244,071	419,629	164,462	828,162

10 The municipality of Arroyito was created by Law No. 5742/16 "which creates the municipality of Arroyito in the department of Concepción and a municipality based in the town of Arroyito", disaffected the district of Horqueta. For this report, although the most recent information was included, it was relieved from the official reports that still do not include this disaffection; that is, in all the mentions of Horqueta, Arroyito is included.

11 Plan of Development and Departmental Diagnose. I Concepción Department. STP. 2011.

12 https://www.abc.com.py/edicion-impresa/economia/fomentan-produccion-lechera-en-distritos-del-dpto-de-concepcion-1594334.html

13 DGEEC. Statistic Yearbook of Paraguay, 2017, p. 47.

% Total Population of Paraguay	3.5%	6.03%	2.37%	11.1%

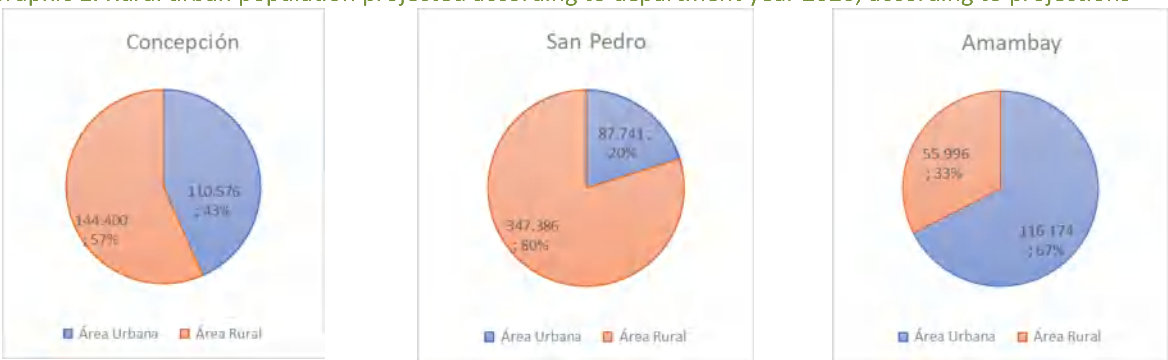
Source: DGEEC. Statistic Yearbook of Paraguay, 2017.

48.58% of the inhabitants of Concepción are women, while in San Pedro less than half of the population is made up of women (47.39%) and in Amambay approximately half are women (50.77%). The total population of the three AII departments totals 828,162 inhabitants, which is estimated to represent 11.91% of the country's population, and of which 400,989 are women (48.41%).

With respect to the population living in rural and urban areas, Figure 1 presents estimates made for each department[14].

Chart 5 presents Population Projection data, revision 2015, in the three departments of the Area of Indirect Influence, and also for the studied districts. Likewise, an estimate of the AII population projection has been made.

Graphic 1. Rural urban population projected according to department year 2020, according to projections[15]



Source: Own elaboration based on data provided by STP/DGEEC. February 2020

Chart 5. Evolution of the population (Projection 2017)

Department/distrcit	2015	2016	2017	2018	2019	2020
Total AII	805,603	816,68	828,161	839,499	850,887	862,272
CONCEPCIÓN	236,959	240,495	244,071	247,675	251,314	254,976
Concepción	80,622	81,917	83,226	84,545	85,876	87,215
Belén	12,223	12,418	12,615	12,814	13,014	13,215
Horqueta	59,374	60,031	60,691	61,349	62,008	62,664
Loreto	18,419	18,514	18,608	18,701	18,791	18,879
SAN PEDRO	40,381	414,503	419,629	424,774	429,957	435,126
AMAMBAY	159,263	161,869	164,462	167,050	169,615	172,169

Source: DGEEC. Paraguay. Proyección de la Población Nacional. Revisión 2015. Own elaboration

Regarding population density, the department of Concepción shows a density of 13.5 inhabitants per km^2, while San Pedro has 21 and Amambay 12.7. On average, then, a population density of 16.2 inhabitants per km^2 can be estimated in the Area of Indirect Influence. Chart 6 summarizes these data.

14 For the estimates, according to the methodology indicated by the DGEEC, the data from a report specifically prepared by said institution were used; For each department the projected population for the year 2020 was used and the proportions were applied according to observations from the 2012 National Census.

15 Sources: STP/DGEEC. Paraguay. Projection of the population by gender and age, according to department, 2000-2025. Revision 2015 and STP/DGEEC. National Population and Housing Census 2012.

Chart 6. Population Density

	Concepción	San Pedro	Amambay	Total All
Area (Km^2)	18,051	20,002	12,933	50,986
Total Population (Projection 2017)	244,071	419,629	164,462	828,162
Population Density (inhabitants/km^2)	13.5	21.0	12.7	16.2

Source: DGEEC. Statistic Yearbook of Paraguay, 2017. Own elaboration.

4.1.2.2. Indigenous Population

As mentioned in chapter 2, as well as in chapter 3: Methodology for the preparation of social studies, for the purposes of the EIAp and considering the requirements of the indigenous population, a specific independent study has been developed. Said study, carried out by the Natán Foundation, is presented in the annexes section of this document.

In the same way, general data in this regard are presented below.

According to the report of the III National Census of Population and Housing for Indigenous Peoples 2012[16], at the country level, the total indigenous population corresponds to 117,150, thus being 1.8% of the total population (6,435,218) of the country. 52% live in the Eastern Region and 48% in the Western Region. Being the majority, 91.3% (103,396) live in rural areas and 8.7% (9,858) live in urban areas.

In the Department of Concepción, 3.5% (3,998) of the indigenous population is concentrated, these are divided according to linguistic family and indigenous people; Among them are the Guaraní linguistic family and people (3,495), which in turn are subdivided as follows: Western Guaraní (3); Ava Guaraní (1); Mbya Guaraní (1234); Paí Tavytera (2,254) and Guaraní Ñamdéva (3). Lengua Masloy (469), corresponds to Toba Maskoy (22); Enlhet North (185); Enxet South (21); Sanapaná (61); Angaité (79) and Guaná (101). Mataco Mataguayo (4) that concerns Maká (4). Zamuco (9), divided into Ybytoso (8) and Tomáraho (1). Guaicuru (2), belongs to Qom (2). Non-indigenous (19), referring to the non-indigenous population living in the communities.

Taking into account the areas linked to the project, the identified communities are presented below, with the exception of the Loreto district in which, according to the source consulted, there is no indigenous population. Of the total indigenous population residing in these areas, 9.5% (381 people) reside in urban areas, in the district of Concepción and 90.5% (3,617 people) in rural areas, including Concepción, Belén and Horqueta.

Concepción

Urban Zone

In Redención there is a total of 150 families with approximately 700 people[17]. According to the DGEEC, in the 2012 National Population and Housing Census for indigenous peoples, the community is made up of the Enlhet Norte/Angaité/Sanapaná/Toba Maskoy/Enset Sur/Guaná/Ybytoso/Maká/Qom/Western Guaraní peoples.

Rural Zone

Nucleus of families Calería Itakua of the Angaité People (13 - 8 men and 5 women), with 3 private and collective dwellings. Vy´a Renda Boquerón Community of the Mbya Guaraní People (235 - 123 men and 112 women),

16 DGEEC. III National Census of Population and Housing for Indigenous People, 2012.
17 Report “Study on indigenous communities of the departments of Concepción and San Pedro. Area of influence of the pulp mill installation project ”. Consulting for the firm PARACEL S.A. Year 2020.

with 54 private and collective dwellings. Jeguahaty Community of the Paí Tavytera People (145 - 75 men and 70 women), with 38 private and collective dwellings.

Belén District

Yvu Pora Community of the Mbya Guraní People (73 - 39 men and 34 women), with 17 private and community dwellings.

Horqueta District

Isla Saka Yaka´i Community of the Mbya Guraní People (33 - 18 males 15 females), with 8 private and community dwellings. Korai Punta Suerte Community of the Mbya Guaraní People (152 - 65 men and 87 women), with 31 private and community dwellings. Ñande Yvy Pave Community of the Paí Tavytera/Sanapaná People (32 - 17 men and 15 women), with 9 private and community dwellings. Paso Ita community of the Mbya Guaraní People (122 - 62 men and 60 women), with 27 private and community dwellings.

4.1.2.3. Main Demographic Indicators

In this section, the main demographic indicators related to the three departments of the IIA are presented. The data used were collected in publications of the General Directorate of Statistics and Censuses[18] and correspond to the year 2017.

Chart 7. Main demographic indicators, by department. Year 2017

Indicators	CONCEPCIÓN	SAN PEDRO	AMAMBAY
Global Fertility Rate	3.02	2.97	2.62
Birth Rate (per thousand)	24.7	23.38	22.31
Mortality Rate (per thousand)	5.31	5.53	5.36
Life expectancy at birth	74.12	73.73	73.76
Men	71.3	70.88	70.91
Women	77.09	76.72	76.76
Ratio for Gender	105.8	109.7	99.9
Middle age	22.5	23.2	24.3
Total dependency ratio	66.9	64.5	59.3
Children dependency ratio	57.6	55	50.7
Senior dependency ratio	9.3	9.5	8.6
Aging index	16.2	17.2	17
Percentage of the female population of reproductive age	49.7	49.9	52.5
Percentage of male population of household starting age	27.6	26.2	25.9
Index of availability of care for the elderly	26.2	24.3	20.9

The definitions provided by the DGEEC[19] for the indicators contained in the preceding chart are transcribed below.

Chart 8. Indicators contained in the chart 7

Ratio for gender	It is the ratio between the number of men and the number of women, expressed as the number of men for every 100 women.
Middle age	Age that indicates exactly when half of the population is older and the other half is younger.

18 DGEEC. Paraguay, Projection of the Population by Gender and Age, according to Department, 2000-2025. Revision 2015.
19 DGEEC. Paraguay, Projection of the Population by Age and Gender, per Department, 2000-2025. Revision 2015.

Age dependency ratio	It is the ratio of people of ages that generally depend on (people under 15 and over 64 years of age) and people of economically productive ages (between 15 and 64 years of age).
Aging index	Relates the older population (65 years and over) with the young (0 to 15 years), indicating the number of older adults for every 100 children. This indicator clearly shows how the aging of the population is progressing in coherence with the two previous indicators.
Percentage of male population of household starting age	It is an approximate indicator of the demand for housing.
Index of availability of care for the elderly	Ratio between adults over 80 years old, who, for the most part, have lost their autonomy, and the female population between 50 and 64 years old, which would correspond approximately to their daughters. This measure roughly indicates the number of elderlies for every 100 potential caregivers.

Source: DGEEC.

In the department of Concepción, the age and gender distribution are presented as illustrated in figure 2.

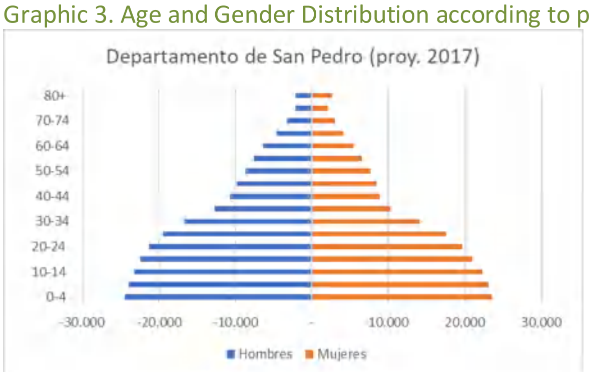
The age and gender distribution of the departments of San Pedro and Amambay can be seen in the following graphs 2 and 3[20]:

In the three departments, the population is eminently young: in Concepción 72% of the total population is under 35 years old, while in San Pedro and Amambay, the data is 70% and 68% respectively.

Graphic 2. Age and Gender Distribution according to projected data 2017. Concepción Department[21]

Source: DGEEC. Own elaboration.

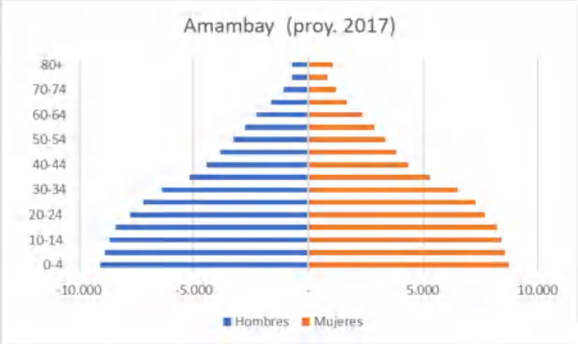
Graphic 3. Age and Gender Distribution according to projected data 2017. San Pedro Department



Source: DGEEC. Own elaboration.

20 DGEEC. Paraguay, Projection of the Population by Age and Gender, per Department, 2000-2025. Revision 2015.
21 DGEEC. Paraguay, Projection of the Population by Age and Gender, per Department, 2000-2025. Revision 2015.

Graphic 4. Age and Gender Distribution according to projected data 2017. Amambay Department



Source: DGEEC. Own elaboration.

4.1.2.4. Households, housing

Throughout this section, data are presented from the Permanent Household Survey, year 2017; complemented with the data included in the Continuous Permanent Household Survey, years 2017-2018. Due to differences in the methodology of each Survey, it is possible that the data cannot be compared at this time, but will serve as a baseline for comparisons with future surveys.

In the Concepción department, there are 60,157 households (EPH 2017)[22]; while, in San Pedro, 103,024 households are registered (EPH 2017)[23]; and in Amambay 43,100 households (EPH, 2017)[24]. In the data listed in chart 9, it can be seen that a large percentage of the homes in the three departments are owned or are in the process of purchasing in installments, and have electricity.

In both Concepción and San Pedro, in 2017, the highest percentage of household water came from SENASA or the local Sanitation Board, while in Amambay most households obtained water from a community network, as shown in Chart 10.

Chart 9. Houses, legal possession and electrical current, years 2017 and 2018

	CONCEPCION		SAN PEDRO		AMAMBAY	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
Total Houses (Númber)	**60,157**	**62,476**	**103,024**	**109,443**	**43,100**	**44,719**
Legal Possession (%)						
- own or paying in installments	83.65	85.7	86.25	87.6	73.86	68.6
- loaned	11.33	8.1	10.91	9	13.08	12.1
- rented	(*)		(*)	3.5	13.06	19.3
Electricity possession (%)	97.79	98.6	99.24	99.4	98.54	98.4

Source: DGGEC. Own elaboration based on data of the DGEEC
(1) DGEEC. Data EPH 2017
(2) DGEEC. Data EPHC 2017-2018
(*) Insufficient sample, less than 30 cases.

Chart 10. Water sources in the houses (%), years 2017 and 2018

Water Sources (%)	CONCEPCION		SAN PEDRO		AMAMBAY	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
- SENASA/Sanitation Board	48.79	29.6	58.29	69	8.13	10.8
- Communitary Network	27.85	37.7	25.76	16.9	33.57	32.3

22 DGEEC. Triptych Concepción Department. EPH 2017. August 2018.
23 DGEEC. Triptych San Pedro Department. EPH 2017. August 2018.
24 DGEEC. Triptych Amambay Department. EPH 2017. August 2018.

- ESSAP	11.28	18.8	(*)	2.8	17.89	20.8
- Artesian Well	(*)		(*)	3.4	10.9	8.9
- Well with or without pump	9.88	7.9			18.36	14.3
- Others (3)	(*)		6.09	7.8	8.33	3.6

Source: DGGEC. Own elaboration based on data of the DGEEC
(1) DGEEC. Data EPH 2017
(2) DGEEC. Data EPHC 2017-2018
(*)Insufficient sample, less than 30 cases.
(3) Others: include spring, cutwater, river or stream

Regarding solid waste disposal, the vast majority of households' resort to burning in Concepción and San Pedro, and public/private collection services in Amambay. It is worth mentioning that one third of the population of Concepción has access to garbage collection services.

Likewise, for the disposal of wastewater (sewage), only 6.55% of the dwellings have access to the sanitary sewer network (sewer) in Concepción (1.03% in San Pedro and 4.14% in Amambay).

Almost 30% of households use a manhole with a septic chamber, and a similar percentage use a manhole without a septic chamber in Concepción and San Pedro, while in Amambay these percentages amount to more than 40% in both cases. In addition, a very important percentage of households (35.47% in Concepción, 37.38% in San Pedro) still use a common latrine with or without a roof or door, a ventilated latrine with a dry pit or the surface of the land, stream, river and others. While in Amambay this percentage is reduced to 8.23%. The corresponding data are found in Chart 11.

Chart 11. Solid waste disposal and wastewater (%), years 2017 and 2018

Solid Waste Disposal and Wastewater (%)	CONCEPCION		SAN PEDRO		AMAMBAY	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
Solid waste disposal (%)						
- Burning	61.44	52.3	75.7	72.2	29.84	30.5
- Public/private collection	30.32	33.1	8.18	13.4	63.12	62.8
- Throws it in a hole			12.73	11		
- Others (3)	8.24	14.6	(*)	3.3	7.05	6.7
Waterwaste disposal (%)						
- Sanitary sewer network (sewer)	6.55	6.8	1.03	2.2	4.14	6.1
- Septic chamber and cesspool	29.8	35.8	29.08	34.4	46.39	47
- Manhole without septic chamber	27.81	23.5	31.38	25	41.24	35.2
- Common latrine without roof or door	27.79	25.7	26.93	29	4.57	9.9
- Common dry pit latrine (with slab, roof, walls and doors)	6.01	6.4	8.79	7	2.63	1.1
- Ventilated dry pit latrine (common with ventilation tube)	1.29	0.3	1.26		1.03	
- Land surface, open hole, ditch, stream, river	0.38	1.4	0.40	1		0.4

Source: DGGEC. Own elaboration based on data provided by DGEEC
(1) DGEEC. Data EPH 2017
(2) DGEEC. Data EPHC 2017-2018
(*) Insufficienct sample, less than 30 cases.
(3) Others: includes Throwing in the municipal dump, hole, backyard, wasteland, street, farm.

In the homes of Concepción, the most used fuel for cooking continues to be firewood (46.49%), followed by gas (31.87%), coal (9.57%) and electricity (8.69%), as well as than in San Pedro. However, in Amambay, the statistical data indicate a strong predominance of gas use, as can be seen in Chart 12.

Chart 12. Main used fuel for cooking (%), years 2017 and 2018

Main fuel used for cooking (%)	CONCEPCION		SAN PEDRO		AMAMBAY	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
- Firewood	46.49	44.2	59.76	55.3	12.76	83.1
- Gas	31.87	38.7	21.31	23	82.74	11.2
- Coal	9.57	6.5	8.07	5.6	(*)	(*)
- Electricity	8.69	9	9.31	13.8	(*)	(*)
- Does not cook	(*)		(*)		(*)	(*)

Source: DGGEC. Own elaboration based on data provided by DGEEC
(1) DGEEC. Data EPH 2017 | (2) DGEEC. Data EPHC 2017-2018 | (*) Insufficienct sample, less than 30 cases.

With reference to durable goods in households, in the three departments it can be observed that the same five types of goods have higher ownership percentages; and the possession of mobile phones is greater. In second place, the possession of motorcycles is located in Concepción, while the households of San Pedro and Amambay give preference to the possession of electrical appliances (refrigerators, televisions and washing machines), as can be seen in Chart 13.

Chart 13. Possession of durable godos (%), years 2017 and 2018

Possession of Durable Goods (%)	CONCEPCION		SAN PEDRO		AMAMBAY	
	2017 (1)	2018 (2)	2017 (1)	2018 (2)	2017 (1)	2018 (2)
- Mobile phone	96.63	95.9	95.97	96.2	98.46	96.5
- Motorcycle	86.58	82.2	71.88	76.2	74.57	74.1
- Regrigerator	83.25	85	84.69	86.9	92.41	90.3
- Television	81.24	86.8	79.98	81.1	89.39	86.9
- Washing machine	69.57	76.1	71.62	76.7	83.07	82.7

Source: DGGEC. Own elaboration based on data provided by DGEEC
(1) DGEEC. Data EPH 2017
(2) DGEEC. Data EPHC 2017-2018

4.1.2.5. Poverty, Income Distribution, Unsatisfied Basic Needs (NBI)

Poverty

In Paraguay, the method used to measure poverty is the Poverty Line method. Among other indicators, the DGEEC carries out calculations to estimate the incidence of total poverty and extreme poverty (percentage of poor and extremely poor), defined as "Proportion of the population with an income below the total poverty and poverty lines extreme"[25]. That is, it measures the percentage of people in a situation of Total Poverty[26] and in a situation of Extreme Poverty[27]. Considering the cultural and consumption characteristics of the population in urban and rural areas, Total Poverty Line and Extreme Poverty Line values are calculated for urban and rural areas.

For the year 2017, the values of the poverty lines are the following[28]:

25 DGEEC. Main Results of Poverty and Income Distribution. EPH 2017. March 2018.
26 The percentage of inhabitants living in poverty is calculated by comparing the per capita income with the cost of the basic consumption basket (Total Poverty Line), considering in addition to food other non-food expenses such as: housing, education, health, transportation, communication, entertainment, etc. (DGEEC. Summary of the Estimation of Poverty Lines).
27 The percentage of inhabitants living in extreme poverty is determined by comparing the per capita income of households with the cost of the basic food basket or the Extreme Poverty Line. (DGEEC. Summary of the Estimation of Poverty Lines).
28 DGEEC. Main Results of Poverty and Income Distribution. EPH 2017. March 2018.

Chart 14. Information about poverty lines on 2017

	Urban Area (Gs.)	Rural Area (Gs)
Total Poverty Line (LPT)	664,297	473,601
Extreme Poverty Line (LPE)	256,881	234,592

Source: DGEEC. Permanent Household Survey 2017.

As can be seen in the data from the Permanent Household Survey[29], 43.97% of the population of Concepción is in a situation of poverty, that is, around 107,097 people have per capita income lower than the cost of a basic consumption basket (LPT). Of these people, 15,911 (6.53%) have per capita monthly income below a minimum food consumption basket, that is, they cannot cover the cost of the minimum amount of food. In San Pedro, the percentage of total poverty is similar to that of Concepción; however, the percentage of people living in extreme poverty is higher. Amambay is the department with the lowest poverty rates in the IIA, and this result is aligned with the other indicators contained in other sections of this report. Chart 15 summarizes the main data obtained.

Chart 15. Total and Extreme Poverty according to department (year 2017)

Department	Total Population(1)	Total Poor Population(2)		Extremely Poor Population	
		Absolut (quantity)	Relative (%)	Absolut (quantity)	Relative (%)
Concepción	243,560	107,097	43.97	15,911	6.53
San Pedro	418,851	182,567	43.59	33,894	8.09
Amambay	164,254	25,026	15.24	5,390	3.28

Source: DGEEC. Permanent Household Survey 2017.
(1) Does not include domestic employee without retirement.
(2) Includes extreme and not extreme poor people

Income Distribution

According to available data, in 2017, the average per capita income in Concepción reached approximately Gs. 896,026[30], which represents 8.7% less than that of San Pedro and is 41.47% less than that of Amambay. In the three departments of the IIA, the richest quintile is more than 50% of the population. There is a marked inequality both between per capita income in each department and between quintiles. By way of illustration, in Concepción, the poorest 20% earn 11.74% of what the richest 20% earn, a relationship similar to that of Amambay (11.50); while, in San Pedro, the ratio drops to 8.55%. However, when comparing the absolute values in the same quintile, the average income in Concepción is almost 40% lower than in Amambay and 7.45% higher than in San Pedro. The data collected can be seen in Chart 16.

Chart 16. Average and distribution of population's monthly income per capita, according to monthly income quintiles (2017)

	CONCEPCION		SAN PEDRO		AMAMBAY	
Per capita income quintiles	Average (Gs)	Percentual distribution	Average (Gs)	Percentual distribution	Average (Gs)	Percentual distribution
Total	896,026	100	981,516	100	1,530,906	100
20% poorer	265,696	5.93	245,836	4.97	440,099	5.71
20% following	433,258	9.67	397,922	8.16	754,516	9.9
20% following	605,317	13.43	550,863	11.29	1,069,846	13.93
20% following	911,518	20.48	832,589	16.86	1,553,616	20.34
20% richer	2,262,201	50.5	2,876,140	58.72	3,824,094	50.12

Source: DGEEC. Permanent Household Survey 2017. Own elaboration.

29 DGEEC. Encuesta Permanente de Hogares 2017.
30 DGEEC. Boletín - Principales Resultados de pobreza y Distribución de Ingreso. EPH 2017. Concepción.

Unmet Basic Needs (UBN)

According to data from the 2012 Census, in Concepción, more than half of the households (56.2%) have at least one UBN. In the three departments, the highest percentage occurs in access to health infrastructure, as is also the case, if we compare, with the total (country). It is worth mentioning that all the percentages are higher than those registered at the country level (except access to subsistence capacity in Amambay), indicating that the departments and districts are in worse conditions than the national average.

Regarding the districts studied for the AID, Concepción presents the lowest percentages in each surveyed indicator, denoting better access in general compared to other districts, while in Loreto there is the highest percentage of homes with at least 1 UBN, in addition of the highest percentages in each type of UBN, except access to education. Chart 17 presents data for the 3 departments and 4 districts.

Chart 17. Houses with UBN, per department and district

Department and district	TOTAL HOUSES	Houses with Unsatisfied Basic Needs (UBN) (%)				
		At least 1 NBI	Type of UBN			
			UBN in the quality of the house	UBN in the sanitary infrastructure	UBN in access to education	UBN in subsistence capacity
Total (country)	**1,232,496**	**43.0**	**12.6**	**20.8**	**15.7**	**14.9**
CONCEPCIÓN	**42,638**	**56.2**	**19.0**	**29.7**	**20.3**	**19.8**
Concepción	14,973	46.6	16.4	20.5	15.2	15.8
Belén	2,165	57.9	20.8	26.7	18.1	20.5
Horqueta	10,784	59.4	17.5	32.5	21.9	20.1
Loreto	3,317	60.0	21.7	32.6	16.1	21.2
SAN PEDRO	**78,742**	**57.6**	**19.1**	**24.8**	**21.2**	**23.3**
AMAMBAY	**27,047**	**48.3**	**18.6**	**26.5**	**25.9**	**14.7**

Source: DGEEC. Unsatisfied Basic Needs Triptych (UBN) 2012. Paraguay based on STP-DGEEC. National Census of Population and Housing 2012.

4.1.2.6. Migration

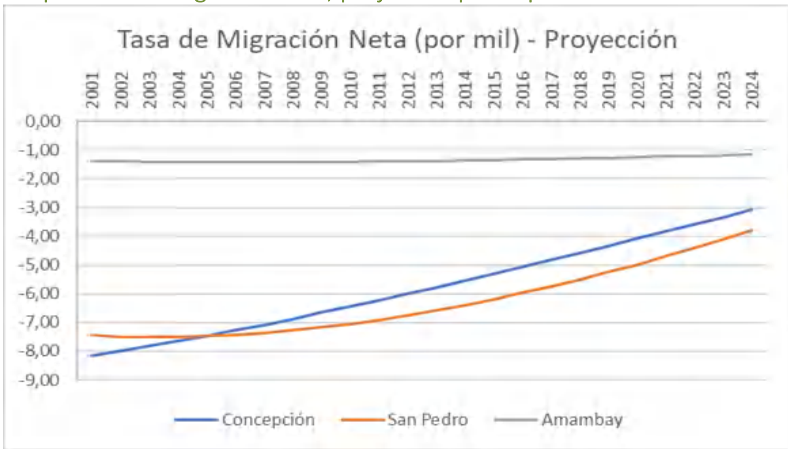
Like other countries, in Paraguay, there are significant difficulties in determining migration, and even more so in predicting it. This situation is exacerbated by the lack of internal migration statistics at the interdepartmental level[31]. Considering these limitations, in this section, the Population Projection data published by the DGEEC has been used, where data are presented that allow their analysis.

Migration can be defined as "permanent or semi-permanent transfer of people and families between geopolitical units, with the consequent change of residence"[32].

In Paraguay, for the years 2001 to 2024, migration rates are negative in all departments, except in the Central department, where a high immigration rate is observed[33]. These data suggest a significant migratory movement from the interior of the country to the cities surrounding the capital.

31 DGEEC-STP. Paraguay. Projection of the Population by Gender and Age, per Department. 2000-2025. Revision 2015
32 DGEEC. Pendular Migration in Paraguay, 2012.
33 Including Asunción.

Graphic 5. Net Migration Rate, projection per department



Source: Own laboration based on Population Projection (DGEEC).

Graph 5 presents the Net Migration Rate for the years 2001-2024 corresponding to the three departments of the IIA. As can be seen, in Concepción and San Pedro, the net rates are negative (emigration) with a tendency to decrease. In Amambay, although they are also negative, the trend remains relatively stable.

According to Pereira, in his text *"Department of Concepción. Wealth and social inequality"*, based on official data from the 2002 Population and Housing Census, 40% of the people migrated to the central department, 16% to Asunción and 12% to the Amambay department. Likewise, he relates that in that period *"emigration from the department of Concepción has the face of a woman. Fifty-seven out of every 100 migrants… were women"*[34]. It is possible that this statement is still valid as of 2017, however, no data has been found in this regard.

Pendular Migration.

Pendulum migration is migration "of a periodic nature and does not translate into a change of residence"[35]. It refers to people who periodically move to another country, department or even district, for work reasons. In this section, data will be used from the Population aged 10 years and over, employed in the same department, but a different district, a different department, another country or without a fixed district to which they reside, according to data from the 2012 Census.

Chart 18. Population of 10 years and more, pendular migrants per department of residence, according to employment, 2012

	Department of Residence		
Place of Employment	Concepción	San Pedro	Amambay
Asunción	113	272	29
Concepción	666	118	69
San Pedro	133	1020	16
Amambay	261	110	131
Cordillera	5	18	0
Guairá	0	25	5
Caaguazú	13	73	1
Caazapá	3	6	2
Itapúa	3	7	0
Misiones	2	6	0
Paraguarí	1	8	0

34 Pereira, Hugo. *"Department of Concepción. Wealth and social inequality"*. Available at:https://revistascientificas.una.py/index.php/RE/article/view/714

35 DGEEC. Pendular Migration in Paraguay, 2012.

	Department of Residence		
Place of Employment	Concepción	San Pedro	Amambay
Alto Paraná	23	83	9
Central	43	121	4
Ñeembucú	3	4	0
Canindeyú	2	101	6
Presidente Hayes	401	168	5
Boquerón	659	114	6
Alto Paraguay	357	60	9
Other country	104	122	2346
Does not have a fixed district	346	441	148
Total pendular migrant population	**3139**	**2875**	**2786**

Source: DGGEC. Pendular Migrant in Paraguay. Own elaboration.

As can be seen in chart 18, a large part of the pendular migration from Concepción and San Pedro occurs as intradepartmental migration: 21.2% and 35.5% respectively, which indicates that, although a significant number of people mobilize outside their area of residence to work, the vast majority do it relatively close and stay in the same department.

On the other hand, it should be noted that a very significant proportion of inhabitants of Concepción work in the Chaco: 45% in the three Chaco departments[36], with easy access through the Nanawa bridge that connects the Western and Eastern regions, which is not reported in the department of San Pedro. With regard to Amambay, 84.2% of the pendular migrant population moves to another country (probably Brazil due to the geographic location of the department) and the lowest percentage of people move to Concepción (4.7%), although important numbers of interdepartmental pendulum migration are not register.

Going deeper into the analysis, and based on the data included in other sections of this document[37], it is possible to observe that the industrial sector in San Pedro is better paid than the industrial sector in Concepción. For this reason, it is probable that the migratory influx is of unskilled labor and probably also coming from the primary sector.

Based on the information presented in this document, the migratory influx from Amambay to Concepción is unlikely, considering that the department of Amambay presents much better ratios than the other two departments of the IIA, so the flow could be unlikely.

4.1.3. Job

In the first part of this section, the main statistical data related to the Working Age Population (PET), Economically Active Population (EAP), Unemployment, underemployment and others are presented. Where available, gender-disaggregated data was included.

In the second part, information is presented on the formality of employment in the 3 departments of the IIA, and on the average labor income.

4.1.3.1. Summary of the main indicators of the labor market

Where possible, data and information have been compiled and total values calculated for the three departments. The data used were extracted from reports prepared by the DGEEC, according to data from the Permanent Household Survey (2017).

36 On the contrary, the total number of people who migrate from the Chaco to Concepción temporarily to work is low, being 101 people, which represents 1.57% of the total number of Chaco people with pendular migration.

37 Items Employment and Economy.

Chart 19 systematizes the main indicators of the Labor Market, and Chart 20 provides data on the Employed Population, according to different segmentation criteria.

In Concepción, there is a Working Age Population (WAP) of 186,627 people (53.53% are women), of which 58.33% are Economically Active (108,860 people, of which 41.33% are women). The department's activity rate is 58.33%, a figure lower than the national activity rate (63.09%)[38]. For women, an activity rate of 45.04% was registered, while for men this figure reached 73.64%, in line with the rates registered at the national level of 50.91% and 75.24% respectively.

The figures recorded for the other two departments are close to the national figures. In San Pedro, the Activity Rate was 63.11% (47.33% for women and 77.63% for men). While in Amambay it reached 64.03% (54.07% for women and 74.55% for men).

In 2017, Concepción's open unemployment rate was 6.66% and Amambay's was 5.48%. In other words, some 7,247 people from Concepción and another 4,490 from Amambay were unemployed[39]. The country's unemployment rate was 5.20%, a figure lower than any of those mentioned.

The Permanent Household Survey also measures the number of "people who worked less than 30 hours in the week and want to work more hours and are available to do so"[40], that is, underemployment due to insufficient working time (or visible underemployment). In Concepción, the visible underemployment rate reached 8.25% (13.55% of women), while in San Pedro it was 6.41% (10.8% of women) and in Amambay it was 5.63% (10.27% of women). It is worth mentioning that the country's visible underemployment rate stands at 5.43%, below those registered in the three departments.

With regard to occupation by economic sectors, 47% of the economically active population of Concepción is engaged in tertiary sector activities (commerce and services), a sector that absorbs two thirds of the female workforce and one third of the male; while the primary sector occupies 36.2% of the EAP and the Secondary Sector 16.63%. A similar situation occurs in Amambay where 70% of the EAP works in the tertiary sector, which occupies 88% of the female EAP and 57% of the male. In San Pedro; however, the vast majority of the EAP is working in the primary sector (56.35%), which occupies 60% of the male population and 49% of the female population.

38 DGEEC. Main Employment indicators. Permanent Household Survey 2017.
39 DGEEC. EPH 2017. Without data about San Pedro.
40 DGEEC. Main indicators of employment. Permanent Household Survey 2017.

Chart 19. Main indicators of the working market

	CONCEPCION			SAN PEDRO			AMAMBAY			TOTAL		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
Total population	244,097	114,152	129,945	419,617	220,754	198,863	164,483	80,975	83,508	828,197	415,881	412,316
Working Age Population (PET)	186,627	86,734	99,893	330,995	172,399	158,596	127,915	62,230	65,685	645,537	321,363	324,174
Economically Active Population (EAP)	108,860	63,869	44,991	208,902	133,841	75,061	81,908	46,391	35,517	399,670	244,101	155,569
Economically Inactive Population (PEI)	77,767	22,865	54,902	122,093	38,558	83,535	46,007	15,839	30,168	245,867	77,262	168,605
Working population	101,613	59,780	41,833	203,463	131,579	71,884	77,418	44,197	33,221	382,494	235,556	146,938
Open Unemployment	7,247	(*)	(*)	(*)	(*)	(*)	4,490	(*)	(*)			
Under-employed population due to insufficient working time (visible underemployment)	8,981	(*)	6,097	13,398	5,292	8,106	4,611	(*)	3,646	26,990	S/D	S/D

Source: DGEEC, Permanent Household Survey – Year 2017. Own elaboration
(*) Insufficient sample, less than 30 cases.

Chart 20. Working population, according to sector of employment

	CONCEPCION			SAN PEDRO			AMAMBAY		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Working by Economical Sector (%) [1]	101,613	59,780	41,833	203,463	131,579	71,884	77,418	44,197	33,221
Primary	36.2	41.78	28.22	56.35	60.48	48.8	11.27	17.13	(*)
Secondary	16.63	24.5	(*)	11.55	14.72	(*)	18.74	26.12	(*)
Terciary	47.17	33.72	66.39	32.1	24.79	45.46	69.98	56.76	87.58
Working by Employment Cathegory (%)	101,613	59,780	41,833	203,463	131,579	71,884	77,418	44,197	33,221
Public employee / worker	8.37	(*)	11.12	6.38	5.7	7.62	7.82	(*)	10.35
Employee / private worker	27.42	36.61	14.28	18.26	23.01	9.56	43.93	55.13	29.02
Employer or employer	5.07	(*)	(*)	3.28	(*)	(*)	7.07	9.72	(*)
Self-employed	38.92	40.19	37.11	44.32	46.97	39.46	25.96	22.84	30.11
Unpaid family worker	13.03	9.8	17.64	24.86	19.8	34.12	6.09	6.08	(*)
Domestic employee	7.19	(*)	16.86	2.9	(*)	(*)	9.14	(*)	20.88

	CONCEPCION			SAN PEDRO			AMAMBAY		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Working according to Size of the Company (%)	101,613	59,780	41,833	203,463	131,579	71,884	77,418	44,197	33,221
Alone	27.57	25.88	29.98	27.06	26.59	27.94	19.88	16.27	24.68
2 to 5 people	42.97	49.34	33.87	54.28	55.36	52.3	36.26	44.91	24.75
6 to 10 people	7.21	8.66	(*)	15.28	17.05	12.04	9.39	11.38	(*)
More than 10 people	14.2	14.91	13.18				23.18	24.48	21.45
Domestic employee	7.19	(*)	16.86	2.9	(*)	(*)	9.14	(*)	20.88
Does not know	0.87	0.78	0.98	0.47	0.6	0.24	2.03	2.64	1.21
Working according to Years of Study (%)	101,613	59,780	41,833	203,463	131,579	71,884	77,418	44,197	33,221
Without instruction [2]	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
From 1 to 6	42.04	41.38	43	50.35	48.69	53.4	34.36	37.91	29.63
From 7 to 12	38.47	43.33	31.53	34.97	39.72	26.27	41.25	42.14	40.07
From 13 to 18	16.97	12.28	23.67	12.31	9.73	17.02	22.58	18.06	28.59
Not available							0.14	- -	0.32

Source: DGEEC, Permanent Household Survey – Year 2017. Own elaboration
[1] Primary Sector: Includes Agriculture, Livestock, Hunting and Fishing.
Secondary Sector: Includes Manufacturing Industries, Construction, Mines and Quarries.
Tertiary Sector: Includes Electricity and Water, Commerce, Financial Establishments, Community and Personal Services.
[2] Includes: Pre-Primary
(*) Insufficient sample, less than 30 cases

In the three departments, the highest proportion of people who work do so in MSMEs/Establishments with 1 to 5 employees (Concepción: 70.54%; San Pedro: 81.34%; Amambay: 45.14%). On the other hand, analyzing the data provided by occupation category, it is possible to conclude that, both in Concepción and San Pedro, the population works mainly independently (Concepción: 57.02%; San Pedro: 72.46%) while that in Amambay most of the population works as an employee of private companies (43.93%) compared to 39.12% of independent workers.

4.1.3.2. Formality in Employment

One of the main criteria to define the formality or informality in the employment of salaried persons is constituted by the registration and contributions to a retirement system. In Paraguay, although there are various types of retirement depending on the business union, the main mandatory retirement system for salaried workers who work in a situation of dependency is the Social Security Institute.

In 2017, a little more than a third of the employed salaried population of the three departments was registered and made contributions to a retirement system: 13,969 people from the department of Concepción made contributions to a retirement system, this is 38.41% of the employed salaried population; in San Pedro, there were 19,171 contributors (38.24%) while in Amambay there were 14,167 people (35.36%).

Additionally, taking into account that, in general, people who were able to carry out higher education levels have better access to better paid jobs with a higher degree of formality, an indicator to consider is the salaried employed population according to years of studies. Chart 21 provides data in this regard:

Chart 21. Working according to the years of study, by gender, in the AII (2017)

	CONCEPCION			SAN PEDRO			AMAMBAY		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Working by Years of Study (%)	101,613	59,780	41,833	203,463	131,579	71,884	77,418	44,197	33,221
Without Instruction (1)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
From 1 to 6	42.04	41.38	43.00	50.35	48.69	53.40	34.36	37.91	29.63
From 7 to 12	38.47	43.33	31.53	34.97	39.72	26.27	41.25	42.14	40.07
From 13 to 18	16.97	12.28	23.67	12.31	9.73	17.02	22.58	18.06	28.59
Not available							0.14	- -	0.32

Source: DGEEC, Permanent Household Survey - Year 2017. Own elaboration
(1) Pre-primary
(*) Insufficient sample, less than 30 cases

In chart 21; It can be observed that, in Concepción, the majority of the employed population has a maximum of 6 years of studies (that is, 42.04% have primary education), a smaller percentage (38.47%) have secondary studies; and only 16.97% attended tertiary studies (7,340 men and 9,900 women). In San Pedro, approximately half of the EAP has primary studies, while almost 35% have secondary studies and only 12% have completed tertiary studies. In Amambay, the majority have secondary studies (41.25% compared to 34.36% with primary studies); and there is also a higher percentage of PEA with tertiary studies (22.58%). It is worth mentioning that, in the three departments, there were a greater number of women (percentage) who attended tertiary studies.

Current Legal Minimum Salary

In recent years, the legal minimum wage has been gradually increasing. From March 2014 to November 2016 it was Gs. 1,824,055; on that date it increased to Gs. 1,964,507 and in July 2017 it increased to 2,041,123. Finally, in July 2018, it was increased to Gs. 2,112,562, to date.

Average Earned Income

As can be seen in the data from the Permanent Household Survey, until 2016, the department with the lowest general average of labor income was San Pedro. While the one with the best average income was Amambay, in correspondence with the number of years of studies of the population. In 2017, the average labor income fell by almost 14% in Concepción, placing this department in last place. It is worth mentioning that, in 2017, the average labor income was higher than the legal minimum wage in force only in the department of Amambay.

Chart 22 details the Average monthly income (in thousands of guaraníes) in the main occupation of the employed population aged 15 and over per year, by department and sex, for the years 2017 and 2018.

Chart 22. Average working income (years 2016 and 2017)

	CONCEPCION		SAN PEDRO		AMAMBAY	
	2016	2017	2016	2017	2016	2017
Average Labor Income (in thousands of guaraníes) of the main occupation (1)	1,763	1,518	1,537	1,747	2,580	2,422
Average Labor Income (in thousands of guaraníes) of the population of Q1 (1) and Q2 (1)	738	704	494	665	1,110	1,350
Average Labor Income (in thousands of guaraníes) of the population of Q1 (1)	562	497	389	512	887	1,082
Average Labor Income (in thousands of guaraníes) of the population of Q2 (1)	853	865	579	795	1,264	1,554

Source: DGEEC. Permanent Household Survey term 2016-2017

(1) Corresponds to the usual monthly income of those employed in the main occupation at constant prices 2017

As can be seen, the average income is significantly higher in Amambay, when we compare data from the three departments. On the other hand, in all three departments, there is a significant pay gap between women and men. In Concepción, women have 25% lower incomes than men, on average, while the gap is 15% in San Pedro and 22% in Amambay.

Chart 23. Average of the working income, according to department and gender (in thousands of guaraníes)

Department	2017	2018
Concepción		
Total	1,511	1,735
Man	1,682	1,920
Woman	1,259	1,439
San Pedro		
Total	1,506	1,885
Man	1,594	1,977
Woman	1,317	1,672
Amambay		
Total	2,249	2,346
Man	2,466	2,581
Woman	1,932	2,016

Source: DGEEC. Annual Departmental Results EPHC 2017-2018

4.1.4. Economy

By way of introduction, we tried to present comparative information of the different economic sectors: primary, secondary and tertiary for the three departments. However, it was only possible to do it for the Secondary (Industry) and Tertiary (Commerce and Services) sectors due to the type of data available[41].

Consequently, the first section presents data related to the Primary Sector and then data from the Secondary and Tertiary sectors of the IIA. Finally, an analysis is presented on the evolution of the economy in the department of Concepción.

4.1.4.1. Primary Sector

In the three departments, 68,047 farms are registered with a total area of 4,575,725[42] hectares dedicated to the sector. The area dedicated to livestock reaches 2,935,287 hectares (65.2% of the total), while that used for agriculture is 527,512 hectares (11.5%), and the area with cultivated natural and forest forests is 734,741 hectares (16.1%).

Comparing the data corresponding to the three departments, there is a greater number of farms in the department of San Pedro, which shows the greater occurrence of small agricultural farms, more agricultural than livestock, as can be seen in Chart 24.

Chart 24. Land according to its usage in amounts of farms, by department on 2008

Department	Amount of farms with lands	Farms with temporary, permanente crops and vegetables	Farms with natural or cultivated pasture	Farms with natural forests or forest plantations.	Farms with fallow land	Farms with land destined for other uses
Concepción	17,377	15,285	10,071	6,414	7,485	15,583
San Pedro	45,875	42,889	23,866	18,468	24,154	40,784
Amambay	4,795	3,969	2,726	2,454	1,745	3,261
TOTAL, ESTIMATED AII	**68,047**	**62,143**	**36,663**	**27,336**	**33,384**	**59,628**

Source: National Agricultural Census 2008. Own elaboration

On the other hand, the department of Concepción is the one that dedicates a notorious higher percentage of its surface to livestock activity in relation to agriculture, in comparison with the other departments of the IIA.

With a total of 17,377[43] farms covering an area of 1,619,416 hectares where farm management by a single producer reaches 16,809 farms, associated producers 431 legitimately constituted farms, companies or societies 115, the State 4 and others not defined 8. Livestock is large landowners and smallholder agriculture.

The cultivated area reaches 464,267 ha, the composition of the workforce is dominated by the national with 16,512 national producers and the international workforce is dominated by the Brazilian with 261, and only 36 from other nationalities.

41 That is to say, we only have data from the primary sector for 2008 (collected by the National Agricultural Census of 2008, with some annual projections using sampling techniques in non-continuous years), and from the other 2 sectors for 2011 (collected by the National Economic Census of 2011, applied by the DGEEC, was unique in its class so the data presented correspond to an observation). The provision of projections from a single observation lacks statistical robustness, since its preparation is carried out through indirect methods, using series of other observations or determinations taken periodically or regularly over time, such as the Permanent Survey of Households (EPH), the Consumer Price Index (CPI), among others.

42 DGEEC. Agricultural Census

43 DGEEC. Agricultural Census

The education of the agricultural producer in the department of Concepción is distributed in 1,108 producers with no educational training; 5,066 with basic school training (from 1st to 3rd completed); 7,668 with basic school training (from 4th to 6th completed); 1,422 with basic school training (from 7th to 9th); 1,058 with completed secondary education and 173 agricultural technical high school graduates (B.T.A.), while 404 are those with non-university higher education.

Chart 25. Land according to its number in terms of area, by department on 2008

Department	Total área (Ha).	Area with permanent temporary crops and vegetables	Area with natural and cultivated pasture	Area with cultivated natural and forestall forests	Fallow area	Area under other uses
Concepción	1,619,416	71,431	1,218,911	233,300	50,394	4,538
San Pedro	1,739,232	321,156	909,500	276,656	81,091	150,828
Amambay	1,217,077	134,925	806,876	224,785	28,567	21,924
TOTAL, ESTIMATED AII	**4,575,725**	**527,512**	**2,935,287**	**734,741**	**160,052**	**177,290**

Source: Censo Agropecuario Nacional 2008. Own elaboration

As shown in chart 26, with respect to soil management and conservation, San Pedro presents clear leadership in conservation techniques, which could be connected to its link with international cooperation development programs, since this department has historically shown high levels of poverty and inequality.

Chart 26. Farms according to soil management and conservation, by department on 2008

	Number of farms with soil management	Soil management and conservation					
		Level curve	Crop rotation	Green manure	Plots with organic production certification	Direct sowing	Others
Concepción	10,390	232	9,176	178	273	596	1,196
San Pedro	28,598	998	23,592	297	393	3,669	3,792
Amambay	1,715	307	1,123	10	39	740	241

Source: National Agricultural Census 2008

Regarding the existing forest plantations in the three departments, it is also possible to see a clear leadership of the department of San Pedro in number of trees. However, Amambay has fewer farms containing more trees per unit area. The department of Concepción presents a lower efficiency among the three, per unit area. This could be due to less efficient or less aggressive planting and management techniques. The corresponding information is included in chart 27.

Chart 27. Forestry Plantations (Eucalyptus and Pine Tree crops), by department on 2008

	Compact Forestry Crops		Eucalyptus Crops			Pine Tree Crops		
	Number of farms	Total Area	Number of farms	Cultivated Area	Number of trees	Number of farms	Cultivated Area	Number of trees

Concepción	1,451	4,209	573	1,269	2,254,095	19	60	113,387
San Pedro	2,994	11,022	740	4,431	6,315,778	29	332	556,676
Amambay	222	6,716	87	3,126	5,986,820	6	7	12,787

Source: Censo Agropecuario Nacional 2008

4.1.4.2. Secondary and Tertiary Sectors

Data from the Secondary and Tertiary sectors of the departments of the Project IIA are presented below, seeking to size part of the economic activity in the area. The data used were extracted from the 2011 Economic Census, which did not include the primary sector.

In Concepción, there are 5,242 economic units that employ 13,682 people (44.55% are women) and generate income of Gs. 1,444,284,575,000. San Pedro presents data of high similarity with Concepción, while there is a lesser coincidence with Amambay, where all the registered data are of greater magnitude; for example, income that reaches Gs. 5,112,545,870,000. This is due to the exposure of the department of Amambay to Brazil, where trade with the neighboring country is one of the highest in the country after Alto Paraná.

In fact, the Commerce subsector is the most developed of the three subsectors in the IIA, it is the one that occupies the largest number of Economic Units and people, and generates the largest amount of income. The following chart 28 presents a summary of the Secondary and Tertiary sectors of the three departments of the Area of Indirect Influence of the Project.

Chart 28. Total of economical units. Secondary and Tertiary Sectors, by department. Year 2011

Department and sector of economic activity	Economical Units	Busy Staff			Total Remuneration	Expenses for purchases of goods and services	Income from supply of goods and services
		Total	Man	Woman	(In thousands of Gs)	(In thousands of Gs)	(In thousands of Gs)
CONCEPCIÓN	**5,242**	**13,682**	**7,586**	**6,096**	**88,154,610**	**1,079,862,460**	**1,444,284,575**
Industry	572	1,877	1,604	273	12,397,928	109,362,370	151,834,489
Commerce	3,032	7,136	3,757	3,379	39,053,593	857,146,675	1,069,238,665
Services	1,638	4,669	2,225	2,444	36,703,089	113,353,416	223,211,421
SAN PEDRO	**5,448**	**13,801**	**7,786**	**6,015**	**89,635,307**	**1,151,030,240**	**1,530,882,702**
Industry	493	1,641	1,385	256	15,239,236	92,135,588	131,524,254
Commerce	3,416	7,481	3,986	3,495	44,082,621	934,217,439	1,207,312,984
Services	1,539	4,679	2,415	2,264	30,313,450	124,677,213	192,045,463
AMAMBAY	**6,249**	**18,502**	**11,071**	**7,431**	**188,575,177**	**4,236,320,036**	**5,112,542,870**
Industry	540	1,869	1,504	365	24,544,937	148,327,137	214,828,806
Commerce	3,868	10,663	6,310	4,353	100,170,416	3,721,163,117	4,347,214,366
Services	1,841	5,970	3,257	2,713	63,859,823	366,829,782	550,499,699

Source: DGEEC. Economical Census of Paraguay, 2011

4.1.4.3. Evolution of the economic-productive activity and services in the department of Concepción

The economic-productive activity in the department of Concepción, in general, has been increasing in the last 50 years.

There are no available and detailed time series to perform a consistent and evolutionary analysis in a timely manner, however, it is possible to analyze aggregate data such as those shown in chart 29, including macro trends at the regional level.

In Chart 29, the decrease in the EAP can be observed, which is due to the interdepartmental migration that occurs towards the Chaco, as well as towards the capital Asunción and the Metropolitan Area. This also affects the EAP of the primary sector as can be seen in the corresponding section in the same chart.

The data from the EPH for 2015 show an unemployment rate for Concepción of about 16%, which is inconsistent with the results of chart 29, which has the same institution as a source. This is mainly due to the modification of methodologies in determining the occupancy percentages that occurred in the same year.

Chart 29. Evolution of the economy of Concepción in the last 50 years

Years	1962	1972	1982	1992	2002	2012	2017
Concepción's Population	**85,690**	**108,130**	**133,977**	**167,289**	**179,450**	**226,585**	**244,070**
Economically Inactive Population	61,397	77,783	95,191	121,058	121,843	129,833	135,210
Economically Active Population (PEA)	24,293	30,347	38,786	46,231	57,607	96,752	108,86
Active Economic Population (%)	28	28	29	28	32	43	45
Employment Rate	87	97	96	98	98	99	93
PEA per sectors							
Primary	14,456	18,467	24,675	27,189	25,805	38,984	39,19
Secondary	3,873	4,419	4,901	6,477	9,195	17,442	17,418
Tertiary	5,18	5,986	6,791	11,046	21,932	40,325	51,164
Other	784	1,475	2,419	1,519	675	s.d.	1,089

Source: Own elaboration based on data of the DGEEC.

4.1.5. Services

This section presents content related to the availability of services in the Project IIA. The information is organized by type of service to which the population can access: basic services, education, professional and technical training, health, security and justice, infrastructure and accessibility, means of transport, information and communication technologies (ICTs), media, financial services, accommodation, state presence.

4.1.5.1. Basic Services

Taking into account that in item 4.1.2.4. Households and housing, details of the use of basic services in households were presented, in this section the information is complemented with data related to the service and providers.

In general terms, a significant percentage of the IIA population has access to two basic services: electricity and improved water. Regarding improved sanitation, the access percentages are much lower, as in the entire national territory. With regard to waste collection, the service is registered in some municipalities and a relatively small proportion of the population has access to it.

Electricity

The electricity supplier is the National Electricity Administration (ANDE), which has national coverage and provides electricity to 99.92% of the population (2017 data)[44]. The company's coverage in the AII is high, reaching 97.79% of households in Concepción, 99.24% in San Pedro, and 98.54 in Amambay (2017 data)[45].

n order to benefit the population, depending on the use that the client will give the electric current, the company establishes different requirements and rates. The categories of use (consumption) available are the following[46]:

- Domestic consumption group (housing or residential)
- Industrial consumer group
- Other consumer group: low and medium voltage
- High and Very High voltage consumer group
- Government consumer group
- Differential consumption group
- Electric Lighting Service

Improved Water

According to the sector study carried out by the Pan American Health Organization[47], in 2010, the Regulatory Entity for Sanitary Services (ERSSAN) had the following number of providers registered in the Project's IIA:

Chart 30. Amount of water systems and connections per lender, by department

	ESSAP		Sanitation Boards		Neighborhood		Private Operating Organizations		Others	
Dpto.	Nº of systems	Nº of connections	Nº of systems	Nº of connections	Nº of systems	Nº of connections	Nº of systems	Nº of connections	Nº of systems	Nº of connections
Concepción	1	5,183	127	11,104	65	3,628	2	1,056	1	100
San Pedro	1	1,311	261	32,196	64	4,376	1	100	0	0
Amambay	1	6,630	13	3,034	35	8,876	3	457	0	0

Source: MOPC-OPS/OMS

At present, it is possible to provide details on the following:

- **National Environmental Sanitation Service - SENASA**: It is the main institution that promotes the development of the Sanitation Boards, the main provider of improved water in the three departments according to 2017 data[48].

  In 2017, the SENASA office in Concepción had registered 81 artesian wells in the districts of Concepción, Loreto, Belén, Paso Barreto, José Félix López, San Alfredo, San Lázaro and San Carlos del Apa that had been built from 1993 to 2014 by the same institution or various others such as DINCAP, FONPLATA,

44 ANDE. Statistical Compilation 1997-2017.
45 Source: DGEEC. Permanent Household Survey term 2003-2004-2015-2016-2017
46 Details of rates and requirements can be found in the following documents: ANDE. List of Rates No. 21; and ANDE. Resolution No. 42.847 / 19 "By which the definitions and general conditions of the Schedule of Rates No. 21 are modified."
47 MOPC-OPS/OMS. Update of the Sectorial Analysis of Drinking Water and Sanitation of Paraguay. 2010.
48 Source: DGEEC. Permanent Houselhold Survey term 2003-2004-2015-2016-2017.

Concepción Government, Club de Leones, Office of the First Lady, IBRD, JICA and Sembrando Oportunidades. These wells had 8,904 users. Of the wells, 17.3% had chlorine treatment, the same percentage had systems that were not working and 65.4% did not have any system for chlorine treatment. 53% is managed by a Sanitation Board (which has Legal Status); and 47% is administered by Neighborhood Commissions. The number of users per well is variable, from 20 to 1,800 beneficiaries connected to the network. According to data provided by the head of the office, these numbers have varied very little in the last two years (Justino Blanco, personal interview, 2020).

- **Sanitary Services of Paraguay Company - ESSAP*:*** It is the second most important provider in the department of Concepción and reaches 11.28% of households in Concepción. It has two water treatment plants in the IIA[49]:

  - *Concepción Treatment Plant:* Located in the area north of the departmental capital, it extracts water from the Paraguay River and then distributes it to the city. It has a production capacity of 25,920 m^3, to serve 31,245 inhabitants.
  - *Pedro Juan Caballero Treatment Plant*: The production is 800 m^3 of drinking water, which is distributed to about 6,500 users.

- **Private Network*:*** It supplies 8.33% of the homes in Amambay (EPH, 2017), less than 1% in San Pedro, and is not registered in Concepción.

- **Other Sources**: They include artesian well, well with or without pump, spring, cutwater, river or stream, all in a much lower percentage of use by the population of Concepción and San Pedro; while almost 30% of the population of Amambay obtains water from wells and/or artesian wells (EPH, 2017)

Sanitary Sewer

There is a sanitary sewer service in the city of Concepción, provided by ESSAP; and that reaches about 3,742 users, approximately 23% of the population of the departmental capital. In May 2018, ESSAP presented the Preliminary Environmental Impact Report for the adaptation of the system, the data of which are reproduced in this section[50].

The system has an estimated flow of 5,760 m^3/d, which represents much less than 1% of the natural flow of the river. It includes a network of pipes of approximately 48,020 m in length that collects wastewater with the support of two pumping stations located in the Center of the city of Concepción; and then pour them underwater (through a final outlet of 150m in length) to the Paraguay River 10 m from the shore. The discharge point is located about 600m south of the ESSAP raw water intake for the Water Treatment Plant. Its geographic coordinates in UTM are: 21K 453777; 7410868.

On the other hand, the MOPC plans the construction of Wastewater Collection and Treatment Systems and Improvement of the Drinking Water System for the City of Horqueta[51], with an effluent collection network and a pumping station, within the framework of the Sanitation and Water Program. Drinking for the Chaco and

49 www.essap.gov.py. Consulted on 02/05/2020
50 ESSAP. Preliminary Environmental Impact Report. Entrepreneurship "Environmental Adequacy of the Sanitary Sewerage System of the City of Concepción - ESSAP S.A.". May, 2018.
51 MOPC Directorate of Road Planning. Summary of MOPC Works in Concepción, San Pedro and Amambay. August 2018-December2019.

Intermediate Cities of the Eastern Region of Paraguay. The mill would be located within the city of Horqueta, and would benefit the urban population of the city estimated at 13,222 inhabitants per year 2016[52].

Garbage Collection

In Paraguay, garbage collection is the responsibility of the municipalities.

In the Municipality of Concepción, garbage collection is a service provided by the Municipality that reaches 8,500 taxpayers (2016 data, ABC). For disposal, it has a landfill on a 22-hectare property located at kilometer 9 of Route PY05 "Gral. Bernardino Caballero". As indicated on the website of the Municipality of Concepción[53].

With respect to the other Municipalities in the Area of Direct Influence, Belén does not have a garbage collection system, therefore most of the population burns and others bury[54]. In Loreto, according to a publication of the MSPYBS-CIRD[55], only some homes in the urban area have access to the service provided by the Municipality and in rural areas, burning is used. Finally, in Horqueta, there is a collection service provided by the Municipality, but only a part of the homes in the urban area have access to it, while almost 90% of the homes resort to burning and a few others bury[56].

4.1.5.2. Education

In this section, statistical data related to the population of the Project IIA are presented in terms of education (school, middle and university level) and the number of institutions in the AID districts. With respect to the universities, considering that several have campuses in more than one district, consolidated information is provided.

According to data from the DGEEC, the young population of the AII (in general) has more than 9.4 years of education on average. In Concepción, the average rises to 10 years and 10.8 years of study for women, being the highest in the AII. Chart 31 presents information for each department and according to age group.

Chart 31. Average of study years of the population between 15 and 29 years old, by department and gender. Year 2018

Department, gender age group	CONCEPCION		SAN PEDRO		AMAMBAY	
	Man	Woman	Man	Woman	Man	Woman
Total	**10.0**	**10.8**	**9.4**	**9.9**	**10.0**	**10.2**
15 to 19	8.9	9.2	8.7	8.9	8.8	8.8
20 to 24	10.9	11.8	10.4	9.8	10.3	10.7
25 to 29	10.3	11.2	9.6	11	10.9	10.9

Source: DGEEC. EPHC 2017-2018

As the DGEEC publications indicate, the vast majority of the school-age population of the Department of Concepción attends an educational center (97.18% in 2017), presenting a gradual increase both in percentage

52 HYDEA-AESA-HIDROCONTROL Consortium. Preliminary Environmental Impact Study. "Construction of the Sanitary Sewerage System and Effluent Treatment mill of the City of Horqueta". Sanitation and Drinking Water Program for the Chaco and Intermediate Cities of the Eastern Region of Paraguay - MOPC. Loan Agreement 2589/BL-PR and GRT/WS-12928/PR. December 2017.

53 https://www.municipalidadconcepcion.gov.py/. Consulted on 02/05/2020

54 MSPBS-CIRD. Local Health Plan. Belén. Term 2014-2016.

55 MSPBS-CIRD. Local Health Plan. Loreto Term 2014-2016.

56 MSPBS-CIRD. Local Health Plan. Horqueta. Term 2014-2016.

terms and in average years of studies. The percentage of attendance of the population in 2017 is 97.18% for boys and girls up to 14 years old; and, the average years of studies of the population aged 10 years and over is 7.61.

Chart 32. Main indicators of education of the population in Concepción (% and absolute value)

	2003	2004	2015	2016	2017
Average years of study of the population aged 10 and over	6.34	6.47	7.53	7.6	7.61
Attendance of the population aged 6-14 years (%)	89.56	94.87	96.88	95.71	97.18
Attendance population 6 -14 years (absolute value)	44,994	50,466	53,779	52,599	51,736

Source: DGEEC. Permanent Household Survey – Term 2003-2004-2015-2016-2017

With reference to the department of San Pedro, a situation with similar characteristics is presented: 88,204 people of school age attended educational centers in 2017; which represents 97.33% of the school population, with an average of 7.21 years of studies (DGEEC, EPH 2017). In Amambay, although the absolute number of students attending an educational center is much lower (31,889 in 2017), the trend in percentage terms continues (97.48%) and the average number of years of studies increases to 8.48 (DGEEC, EPH 2017).

Basic School Education

In the Department of Concepción, most of the institutions that offer Basic School Education (EEB) are official (398 institutions) and the private ones are subsidized (32 institutions)[57]. 79% of the institutions are in rural areas. While 42% of all institutions offer all cycles (first, second and third cycle), the rest offer a combination.

In San Pedro, there are a total of 943 educational institutions that teach EEB; 87.7% of which are in rural areas and the rest in urban areas. 96% of the institutions are public and the rest are divided between subsidized private (2.86%) and private.

In Amambay there are 210 institutions that offer EEB. 91.9% are public; 5.7% are private and the rest are private subsidized. Although the majority are located in rural areas (65.7%), the percentage of institutions in urban areas is higher than in Concepción and San Pedro (34%).

Middle Education

There is a total of 111 institutions that provide Secondary Education in the Department of Concepción (2015 data[58]), 39 institutions are located in urban areas and 72 in rural areas. Of these, 106 offer a Scientific Baccalaureate (38 in urban areas and 68 in rural areas); and 22 teach Technical Baccalaureate (13 in urban areas and 9 in rural areas).

In San Pedro, there are 49 institutions that provide secondary education in urban areas and 222 in rural areas, while in Amambay there are 32 institutions in urban areas and 9 institutions in rural areas.

57 DGEEC. Statistical Yearbook of Paraguay, 2017, p. 77-79
58 DGEEC. Statistical Yearbook of Paraguay, 2017, p. 103, 104, 116, 117

In the three departments covered by the AII, the vast majority of students enrolled in Scientific High School and only a smaller percentage enrolled in Technical Baccalaureate, according to official data from 2015[59] included in Chart 33.

Chart 33. Students enrolled in high school, by department and gender (year 2015)

	Scientific Baccalaureate	Technical Baccalaureate	Total
Concepción	**8011**	**1323**	**9334**
Men	3824	742	4566
Women	4187	581	4768
San Pedro	**12689**	**2995**	**15684**
Men	6391	1616	8007
Women	6298	1379	7677
Amambay	**3832**	**514**	**4346**
Men	1778	224	2002
Women	2054	290	2344

Source: Own elaboration based on data of DGEEC

As can be seen in chart 33, both in Concepción and Amambay there is a slight majority of enrolled students who are women (51% and 54% respectively), while in San Pedro the situation is the reverse (49% are women).

On the other hand, with respect to the area in which they enrolled, both in the department of Concepción and Amambay, most of the students were enrolled in the urban area. While, in San Pedro, almost a third of high school students are in rural areas (see chart 34).

Chart 34. Students enrolled in high school with emphasis, according to department and zone (year 2015)

	Scientific Baccalaureate	Technical Industrial B.	Technical in Services B.	Technical Agricultural B.	Total
Concepción	8011	153	855	315	9334
Urban Zone	4359	131	713		5203
Rural Zone	3652	22	142	315	4131
San Pedro	12689	182	1725	1088	15684
Urban Zone	3826	93	1178	221	5318
Rural Zone	8863	89	547	867	10366
Amambay	3832	0	451	63	4346
Urban Zone	3542		451	50	4043
Rural Zone	290			13	303

Source: Own elaboration based on data from DGEEC

59 DGEEC. Statistical Yearbook of Paraguay, 2017, p. 103, 104, 116, 117

It is worth mentioning that, although most of the students enrolled in Scientific Baccalaureate (General), the second option for those enrolled was Technical Baccalaureate (emphasis on Services) in 2015.

Universities

In the Department of Concepción there are several public and private university educational offers, with a great concentration in the capital of the department. Most universities offer careers in the humanities, with a deficit in the offer of careers in the exact sciences.

Although the offers are many, the educational quality is still low, and a great lack of infrastructure and adequate hourly load may be noted. This can be verified, considering the low number of courses accredited by the National Agency for the Evaluation and Accreditation of Higher Education (ANEAES) in Chart 35, compared to those offered by the various universities, in Chart 36.

Chart 35. Universities, district and offered careers

University	Careers
Faculty of Veterinary Sciences UNA/Concepción Branch	Veterinary
UNC - National University of Concepción (districts of Concepción, Horqueta, Yby Yaú, Loreto)	Dentistry, Agronomy, Agribusiness Administration, Agricultural Administration, Commercial Engineering, Business Informatics, Public Accounting, Administration, Medicine, Education Sciences, Social Communication, Psychopedagogy, Social Work, Applied Mathematics and Civil Engineering
Universidad Nacional de Asunción/Facultad de Enfermería y Obstetricia Concepción	Nursing and Midwifery
National University of Asunción/ Faculty of Nursing and Obstetrics Concepción	Business Administration, Law, Accounting and Education Sciences
Uninorte/Concepción	Business Administration, Rural Administration, Accounting Sciences, Law, Notary Public, Commercial Engineering, Psychology and Specialization in University Didactics
San Carlos University (Horqueta)	Agrarian Administration, Agronomy, Zootechnics, Food Technology, Environmental and Forest Sciences
UPAP - Polytechnic and Artistic University of Paraguay. Concepción Horqueta	Nursing, Midwifery, Law, Educational Sciences, Psychology, Physical Education, Art Education, Accounting, Business Administration, Electronic Engineering, Industrial Engineering, Architecture Kinesiology and Physiotherapy, Medicine, Criminalistics, Criminology, Pharmacy, Nutrition and University Didactics
UTCD - Technical University of Marketing and Development. Concepción Loreto Horqueta	Environmental Engineering, Kinesiology and Physiotherapy., Sports Sciences. Education Sciences, Nutrition, Psychology, International Trade and University Didactics
TIC - Universidad Tecnológica Intercontinental Concepción Horqueta	Computer Systems Engineering, Accounting, Administrative Sciences, Educational Sciences, Computer Systems Analysis and Nursing
Autonomous University San Sebastián Concepción Horqueta	Agronomy, Physical Education, Educational Sciences, Law, Notary Public, Computer Systems Analysis, Production, Business Administration, Agricultural Administration, Accounting, Commercial

University	Careers
	Engineering, Nursing, Nutrition, Veterinary Medicine, University Didactics and Thesis Tutoring
Concepción	Nursing/Kinesiology/Physiotherapy, Pharmacy/Radiology/Chemistry and Pharmacy/Clinical Laboratory, Nutrition/Psychology/Obstetrics, Biochemistry
Private University of Guairá Horqueta Vallemi Yby Yaú	Law, Agronomy and Accounting

Source: Own elaboration

According to the ANEAES, the following careers are enabled:

Chart 36. Careers accredited by the ANEAES, department of Concepción

University	Faculty	Career
UNC –National University of Concepción	Agricultural Sciences	Agronomic Engineering
	Agrarian Sciences - Horqueta Headquarters	Agricultural Administration
	Humanities and Education Sciences	Education Sciences
	Odontology	Odontology
	Health Sciences	Medicine
	Economic and Administrative Sciences	Public accounting
UNA – Subsidiary in Concepción	Dr. Andrés Barbero Institute	Nursing
	Veterinary School	Veterinary
UCA – Campus Concepción	Accounting, Administrative and Computer Sciences	Public Accounting
		Business Administration
	Legal and Diplomatic Sciences	Law
UTIC –Intercontinental Technological University	Health Sciences - Horqueta Headquarters	Nursing

Source: Own elaboration according to data of the ANEAES, 2019.

In line with the professional orientation (and probable job prospect) in the department of Concepción, the Veterinary degree at UNA is the one that received the largest number of students enrolled in 2017, doubling the number of enrolled in Nursing and Accounting Sciences. The data can be seen in Chart 37.

Chart 37. Enrolled in Concepción

University/School	Career	Enrolled	Term
UNA – Veterinary Sciences School	Veterinary	440	6 years
UNA - “Dr. Andrés Barbero” Institute	Nursing	215	5 years
	Obstetrics	97	5 years
UCA – Legal Sciences School	Law	172	6 years
UCA – Accounting, Administrative and Economic Sciences School	Accounting Sciences	213	5 years
	Administrative Sciences	95	5 years
UCA – Education Sciences School	Teaching in Higher Education	61	1 year (Specialization)

Source: Own elaboration according to data of the DGEEC, 2017.

Chart 38 presents the number of graduates in a range of 4 years.

Chart 38. Number of graduated in Concepción according to the university, school, career years 2013 to 2016

University/School	Career	Number of graduated			
		2013	2014	2015	2016
UNA – Veterinary Sciences School	Veterinary	58	57	58	63
UNA - "Dr. Andrés Barbero" Institute	Nursing Obstetrics	24	50	25	60
UCA – Legal Sciences School	Juridical Sciences	s/d	s/d	16	17
UCA – Accounting, Administrative and Economic Sciences School	Accounting Sciences	s/d	s/d	16	15
	Administrative Sciences	s/d	s/d	9	14
UCA – Education Sciences School	Educational Sciences	s/d	s/d	15	17
	Social Work	s/d	s/d	11	15
	Teaching in Higher Education	s/d	s/d	37	33

Source: Own elaboration according to data of the DGEEC, 2017.

Educational Institutions in the AID

According to data recorded in the Municipal Development Plan of each Municipality (2016), in Concepción 60 educational institutions are enabled in urban areas and 50 in rural areas; Belén has 3 educational institutions in urban areas and 22 in rural areas; and in Horqueta there are 20 educational institutions in urban areas and 113 in rural areas. As for Loreto, the Local Health Plan designates 9 national schools and 32 basic schools.

In the Department of Concepción, professional training courses are offered by the government through SINAFOCAL and SNPP. In 2018, according to its management report, SINAFOCAL gave 9 courses on various topics, benefiting 234 men and 142 women. In the North zone (Concepción, San Pedro, Amambay, Canindeyú) 33 courses were given that year, constituting 7.7% of the total held in the country.

4.1.5.3. Health

This section presents statistical data related to the population of the Project's Area of Indirect Influence, in order to measure the demand for health services. Information related to the services available in the Project AID is provided below.

In Concepción and San Pedro, in 2018, a little more than 50% of women showed up for a medical consultation, while the average drops to 46.5% in Amambay. With respect to men, the averages remain below 50% in the three AII departments, the lowest being in Amambay and the highest in San Pedro.

Chart 39 presents data related to the health status of the population of each department, recording whether they presented at least one medical consultation, either due to illness or accident, during 2018.

Chart 39. Total population, per department, gender and health status (%). Year 2018

Department, gender and health status	CONCEPCION		SAN PEDRO		AMAMBAY	
	Man	Woman	Man	Woman	Man	Woman

Total	**124,338**	**123,357**	**225,411**	**199,370**	**80,534**	**86,478**
Ill/suffer from an accident (%)	44.1	51.2	46.6	51.1	39.5	46.5
Healthy (%)	55.9	48.8	53.4	48.9	60.5	53.5

Source: DGEEC. EPHC 2017-2018

According to data from the 2017 statistical yearbook, the Department of Concepción had 214 hospital beds. In 2015, 70,842 medical and dental consultations were carried out at the IPS and in 2016, a total of 70,477.

In 2018, 1,154 deaths were registered, of which 17% were due to diseases of the circulatory system; 11.6% were due to tumors; 9.4% to diseases of the respiratory system; 7.9% for various types of accidents; and 7.4% for cerebrovascular diseases. The other deaths were for other reasons. 61.3% of the deaths were registered in people over 60 years of age. According to MSPBS records, in 2017 there were 29 deaths from motorcycle accidents in the Department.

On the other hand, according to data from the DGEEC, only a small proportion of the population of the department of Concepción has medical insurance, either private or from the IPS. Thus, although the records indicate a slight increase to 16.52% of coverage in 2015, in the last years for which data are available, the trend remains in less than 15% of the population. However, the records indicate relatively high percentages of the population that came to consult due to illness or accident. Chart 40 provides data in this regard.

Chart 40. Main indicators of health of the population of Concepción per year in % and absolute value

	2003	2004	2015	2016	2017
In percentage					
Population with medical insurance (1)	12.02	13.94	16.52	14.2	14.72
Access to health (2)	63.79	53.03	79.5	78.4	71.48
In absolute value					
Population with medical insurance (1)	23,898	28,069	39,146	34,139	35,936
Access to health (2)	15,337	21,299	55,999	82,696	92,788

(1) Includes IPS and other type on insurance
(2) Includes sick population or the ones who suffer an accident and consulted
Source: DGEEC. Permanent Household Survey term 2003-2004-2015-2016-2017

In the district of Concepción and neighboring areas, the Concepción Volunteer Fire Department is the entity that helps victims of various kinds. However, according to conversations with referents of the entity, this type of services could be resented by the lack of budget, since they have difficulties to cover the cost of these.

4.1.5.4. Security, justice

This section contains information on security in the Project IIA. First, data related to violence and crime are provided, then details are given on justice and the institutions that intervene in the processes.

The content on crime and victimization that appears in this section was extracted from the Atlas of Violence and Insecurity in Paraguay (2018), which collects and analyzes objective data on insecurity from National Police records between 2010 and 2017; and from the 2017 National Victimization Survey. Information is collected at the departmental level in some cases, when it is clarified as such, all the other data mentioned correspond to the northern area comprised by Concepción, San Pedro and Amambay.

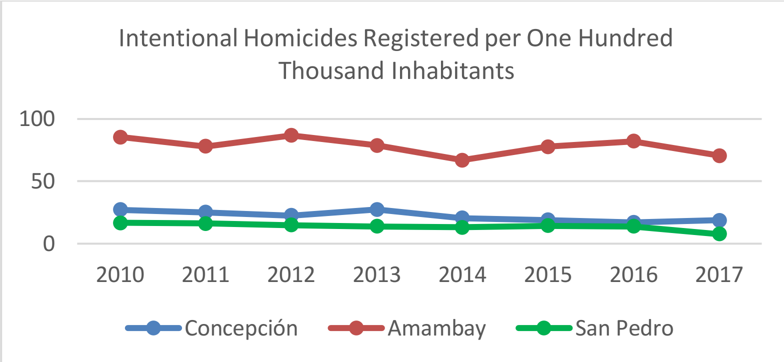
The rate of intentional homicides registered for every one hundred thousand inhabitants between 2010 and 2017 in the Department of Concepción was 18.85; while the hidden number of crimes (portion of crimes reported by victims in the National Victimization Survey that are not registered in the institutions in charge) in the northern region is 71.4%. The three departments present decreasing homicide registration rates, even so, it is the region with the highest homicide rate in the country. Chart 41 presents data corresponding to the three departments of the IIA, for the period 2010-2017.

Chart 41. Intentional homicide rate per one hundred thousand inhabitants, according to department, years 2010-2017

Homicide	2010	2011	2012	2013	2014	2015	2016	2017
Concepción	27.3	25.24	22.64	27.42	20.56	18.99	17.05	18.85
Amambay	85.37	78.1	86.78	78.73	67.03	77.86	82.17	70.53
San Pedro	16.79	16.17	15	13.83	13.11	14.41	13.99	7.63

Source: Atlas of violence and insecurity in Paraguay – 2018.

Graphic 6. Evolution of the number of intentional homicides per one hundred thousand inhabitants in the departments



Source: Own elaboration with data from the Atlas of the violence and insecurity in Paraguay – 2018.

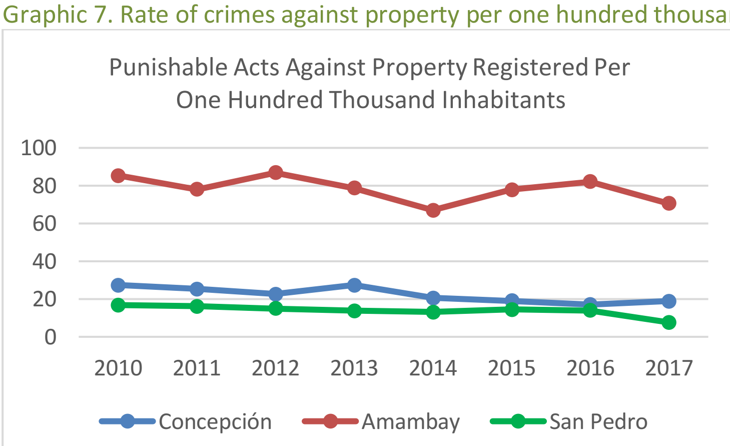
As for punishable acts against property, they have decreased in the three departments. In relation to 2010, in 2017 Concepción had a decrease of 40%, although in 2013 it had a much higher peak above the average for those years. As for Amambay, they decreased by 50% in 2017 compared to 2010; however, in 2011 there was a higher peak. This same situation occurred in the department of San Pedro in relation to the percentage of decrease in punishable acts and the peak recorded, as can be seen in Chart 42.

Chart 42. Punishable acts against property, por department, years 2010-2017

Punishable acts against property	2010	2011	2012	2013	2014	2015	2016	2017
Concepción	141.76	138.28	134.79	171.36	104.09	106.35	118.09	82.76
Amambay	315.94	475	357.45	335.6	265.57	146.93	148.27	165.39
San Pedro	155.63	190.98	130.52	120.05	121.94	135.81	108.56	75.3

Source: Own elaboration with data from the Atlas of the violence and insecurity in Paraguay – 2018.

Graphic 7. Rate of crimes against property per one hundred thousand inhabitants in the departments



Source: Own elaboration with data from the Altas of violence and insecurity in Paraguay – 2018.

With regard to victimization of the population, in the North zone (that is, the three departments of the IIA), 18.2% of the population has been the victim of crimes against the home, with theft in homes being the most recurrent event. Regarding the victimization of crimes against people, extortion is the most frequent fact with 18%. The highest percentage is observed in corruption victimization with 97.3%.

4.1.5.5. Infrastructure and accessibility

This section describes the main access routes to the Project's Area of Influence. The information is organized into the following three sections: ports, airports and road infrastructure.

Main Port son the Paraguay River

The Paraguay River is one of the access roads to the Department of Concepción; and to the area surveyed for the industrial component of the venture. The Concepción Local Health Plan indicates that, along its banks, north of Concepción, there are the following ports:

- Concepción Port
- Vallemí Port
- Risso Port: Lime port, produces hydrated lime.
- Fonciere Port: It is characterized by an important viewpoint and a large house dating from 1927.
- Max Port: Port “Tres Ollas”. Currently a livestock establishment, in front of Pinasco Port.
- Itapucumí Port: Used by the cement and lime factory, in front of Pinasco Port.
- Arrecife Port: With dangerous reefs when the river falls, it is ideal for fishing dorado.
- Abente Port: cattle ranch port, close to the Napegue stream.
- Pagani Port: Today abandoned.
- Negro Port: Used by stays.
- Algesa Port: Used for loading and unloading cargo and freight.
- Old Port: Used for the embarkation of passengers and minor loads.
- Itapuá Port: North of Fonciere Port, used by lime scale.
- Guyrati Port: Used by the lime factory, located about 10 km from Itacuá Port.

Although the Municipal Development Plan of Concepción states that "despite the fact that it has a port, river traffic has declined compared to its beginnings", a good part of the production of calcareous products, and grains of the region is mobilized through the ports. Another company that bet on the waterway is Frigorífico Concepción, which invested in private ports to facilitate and reduce the costs of transporting livestock. In addition, the Paraguay River and its ports constitute a means of transport, communication and commerce used by the inhabitants of the riverside communities located north of Concepción, which are frequently isolated by the rains.

It is also considered relevant to mention that upstream from Concepción, already in the Department of Alto Paraguay, there is a mooring in Carmelo Peralta, but in front of said Municipality, is the city of Puerto Murtiño (Brazil), an important connection port between the land transport of the neighboring country with the traffic of the Paraguay-Paraná waterway.

Airports

In the Department of Concepción, there are 2 airports with limited infrastructure that are rarely used:

- Airport "Tte. Cnel. Carmelo Peralta" – City of Concepción
- Airport "Dr. Juan Plate" - San Lázaro.

On the other hand, there are several landing strips located in the IIA, mainly in livestock establishments.

Road Infrastructure

For more than 50 years, the Paraguayan road network consisted of 12 national, departmental and municipal routes. In May 2019, the Ministry of Public Works and Communications (MOPC) classified and restructured the conformation of the National Road Network, expanding the number of national routes to a total of 22, as can be seen in map 3.

According to information published by the MOPC[60], the road network of the department of Concepción totals 3,213 km of national, departmental and neighborhood roads and routes, of which 19% are paved. In San Pedro, the road network reaches 5,806 km, of which 18% are paved and in Amambay, there are 2,666 km of road network, of which 12% are paved. These data are provided in Chart 43.

Map 3. National Road Network

Source: MOPC – Direction of Road Planning

60 Available at: https://www.mopc.gov.py/mopcweb/index.php?cID=769 consultado el 23.01.2020.

Chart 43. Road network per department according to type

Type of Road Network	CONCEPCION		SAN PEDRO		AMAMBAY	
	Paved (Km)	Not paved (Km)	Paved (Km)	Not paved (Km)	Paved (Km)	Not paved (Km)
National	383.73	20.52	583.68	116.97	207.37	134.92
Departmental	97.8	327.51	268.54	193.45	40.03	343.58
Local	134.88	2248.16	199.13	4444.05	62.85	1877.04
TOTAL (km)	**3213**		**5806**		**2666**	
% paved	19%		18%		12%	

Source: MOPC: Direction of Road Planning (data July 2019)

As can be seen in Map 3, the following three national routes pass through the Project's IIA:

Route PY05: From EAST to WEST, with a length of 577 km. It begins in the city of Pedro Juan Caballero (Amambay), located on the border with Brazil; it crosses the department of Concepción passing through the city of Concepción; it crosses the Paraguay River through the Nanawa Bridge and continues in the department of Villa Hayes until it reaches Fortín Pilcomayo, on the border with Argentina.

Route PY22: From SOUTH to NORTH, with a length of 424 km. It begins in San Estanislao (San Pedro) at the junction with Route PY03; it passes through the cities General Aquino, Villa del Rosario, San Pedro del Ykuamandiyú; It enters the department of Concepción through the city of Belén, passes through Concepción, Loreto, San Alfredo and ends in San Lázaro.

Route PY08: From SOUTH to NORTH, with a length of 588 km. It begins in Coronel Bogado (Itapúa), at the junction with Route PY01; it passes through the departments of Caazapá, Guairá, Caaguazú; enter San Pedro passing through San Estanislao: continue to Yby Yaú in Concepción and then to Bella Vista Norte in Amambay.

Maps 4 and 5 show in more detail the road network of the department of Concepción, indicating the type of paving of the roads and routes.

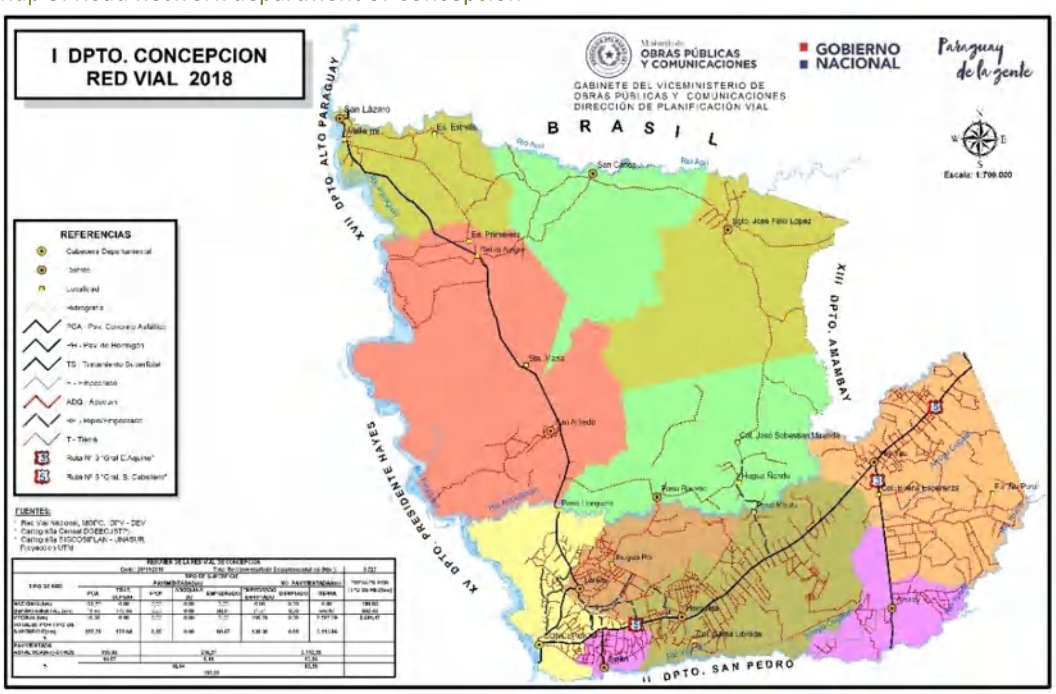
On the other hand, several routes and neighborhood roads link the towns of the Project IIA, some of which are currently undergoing improvement processes within the framework of the National Program for Neighborhood Roads and Bridges, executed by the MOPC in most part in the departments of the country. In the IIA, this program proposes interventions to improve bridges and roads according to the summary provided in the following chart 44[61].

61 MOPC/DGSA-BID. Preliminary Environmental Impact Study. Neighborhood Roads Improvement Program - Eastern Region (PRL-1084). 2015.

Map 4. National Routes in the Indirect Influence Area

Source: MOPC – Direction of Road Planning

Map 5. Road network department of Concepción



Source: MOPC – Direction of Road Planning

Chart 44. Bridges and roads in the process of improvement in the AII

	Bridges		Roads
Department	Bridges (Amount)	Length (M.L.)	Section
Concepción	11	119	-
San Pedro	11	200	4
Amambay	8	86	-

Source: MOPC

Map 6, extracted from the Program's Preliminary Environmental Impact Study, shows the works and their location, in the department of Concepción.

With the execution of these works on access roads of the department, it is possible to perceive an increase in road connectivity in the intervention areas, especially in the areas where gravel roads were transformed into asphalt roads. This allows for an increase in traffic, including truckloads, and a reduction in travel times.

Regarding the AID of the Project, more specifically, in Concepción, the MOPC is developing activities for the construction, improvement and maintenance of access roads; in addition to building bridges and water systems in support of the communities. According to information provided by the MOPC Road Planning Directorate, the main works in progress in the Project's Area of Direct Influence are those detailed in chart 45.

Map 6. Description of road works and their coordinates in the department of Concepción

CONCEPCIÓN				
ORIGEN - DESTINO	Largo (m)	Ancho (m)	Tipo	Coordenadas UTM
Paso Barreto-Cruce X	30,0	4,0	PM	21K464281 7456246
RUTA V KM 21 - LAS PALMAS	7,0	3,0	PM	21K471782 7419193
CURUZU ÑU - ROBERTO L. PETIT	6,0	4,0	PM	21K458340 7430807
COSTA PUCU - MBOCAYATY	12,0	3,0	PM	21K459379 7425970
CONCEPCIÓN - MARIA AUXILIADORA	6,0	5,0	PM	21K460058 7412237
RUTA V - CALLE 12 NORTE	5,0	4,0	PM	21K508322 7439014
	6,0	4,0	PM	21K512919 7433374
RUTA V - CALLE 9 NORTE	20,0	3,0	PM	21K508006 7429573
RUTA V - CALLE 20 NORTE	6,0	4,0	PM	21K524506 7444456
	10,0	4,0	PM	21K526683 7441681
YBY YAU - COL. MEDALLA MILAGROSA	11,0	4,0	PM	21K551330 7458412
TOTAL	119,0			

Imagen Satelital - Puentes Departamento de Concepción.

Source: MOPC

Chart 45. Infrastructure Works in course in the AID of the project (Dec. 2019)

Type	In course work	Length
Asphalt paving	Concepción - Vallemi Port and Access to Concepción Section (1.5 Km) and Variant (4.75 Km)	6.25 km
Asphalt paving on cobblestones	Section Horqueta - Río Ypané (Tacuatí) (Lot 1)	39 km
	Section Route 5 - Jhugua Ocampos - Ykua Jhovy - San Blas. 5ta. Tanda. Lot 3	17.56 Km
	Section Loreto - Las Palmas - San Blas – Route 5. 5ta. Part of the Direction of Roads. Lot 6.	15.1 Km
Rehabilitation and maintenance contract	Road 3. Road PY05 Section Concepción - Pozo Colorado Km 372+260 to Km 416+222. Lot 3	44 Km
Rehabilitation and maintenance	Route PY05. Section: Concepción – Yby Yaú (109 Km). Lot 2	109 Km
Sanitary sewer works	Construction of sanitary units for communities benefiting from the sanitary sewerage project for intermediate cities of the Eastern Region	
Processing facilities	Wastewater collection and treatment systems and improvement of the drinking water system for the city of Horqueta	

Source: MOPC- Direction of Road Planning

4.1.5.6. Means of Transportation

This section includes descriptions of the main means of transportation available to the population of the Project's Area of Direct Influence: River, air and land transportation.

River Transportation

The Paraguay River is navigable by vessels of greater draft, in the section that goes from the confluence with the Paraná River to Asunción; In the section from Asunción to Corumbá (Brazil) and passing through all the ports of the Department of Concepción, medium-sized vessels can navigate[62]. As it has already been presented, it is used to a great extent by vessels that carry out the transport of grains, lime, cement and livestock. Its affluents, the Apa, Aquidabán and Ypané rivers, are navigable only by small boats[63].

The Aquidabán Ship is considered an important means of transport, especially for the most isolated areas. This vessel transports products for sale and passengers between Concepción and Bahía Negra. It has weekly frequency, leaving on Tuesdays from Concepción and the trip lasts 3 days one way and 3 days back. It makes stops in all the ports of the department of Concepción and several riverside communities to offer its merchandise and to allow passengers to get on and off.

Some boats offer their services for recreational purposes (trips and fishing), leaving from Concepción: Barco Ten Caten, Barco Siete Cabrillas, Barco Santa Filomena, Agua Dulce Yacht, Cayman Yacht, El Dorado Yacht.

Air Transportation

62 MOPC-OPS/OMS Update of the Sectorial Analysis of Drinking Water and Sanitation of Paraguay. 2010.
63 Municipal Development Plan. Concepción

The Military Air Transport Service (SETAM) is authorized to carry out flights for the transport of passengers; and has a resolution of approval of the current price catalog. The planned route includes departures from Asunción to Concepción, Puerto Casado, Vallemí, Fuerte Olimpo and Bahía Negra, with 2 weekly frequencies. This service was authorized by Resolution in April 2019, and there are no statistical data in this regard.

The lack of adequate airport infrastructure could be a factor why this segment of services does not show signs of growth in the Department of Concepción.

Groud Transportation

The city of Concepción is relatively well communicated by land with other main cities in the northern region of the country, and with Asunción. In general, transport companies only provide services to towns and cities located on national routes, without entering communities far from them. Chart 46 lists the transport companies that provide daily services to other cities from Concepción.

Chart 46. Ground transportation companies from y to Concepción

Destination / Origin	Transportation Company
Asunción	Norte Poty SRL
	NASA
	La Ovetense
	La Santaniana
Pedro Juan Caballero	Ciudad de Concepción S.A.
	Transporte y Turismo Ligero SRL
Vallemí	NASA
	Transporte y Turismo Ligero SRL

Source: Own elaboration.

The transport companies that provide services on the route to Vallemí, also ensure the transport of passengers between Concepción and Loreto. While the companies that go to Asunción (by Route PY05) and Pedro Juan Caballero provide services to the inhabitants of Horqueta. Regarding the connection with the city of Belén, a local company called Puerto Ybapobo provides services to said city via Belén.

The city of Concepción has not had urban public transport services (buses) for several years. According to local digital media "motorcycles have displaced the company that was dedicated to this area a decade ago"[64].

In fact, most of the people who live in the Department of Concepción travel by motorcycle. This can be verified by simple observation on a tour of the city of Concepción and the surrounding districts. Likewise, this preference for motorcycles is evidenced in the number of authorized vehicles. The following chart provides a summary of the vehicles licensed in the three AII departments.

64 Concepción Noticias. http://www.concepcion-py.com/2016/05/concepcion-esta-sin-transporte-urbano.html

Chart 47. Number of vehicles enabled by type, according to department (2017)

Department	Total	Motorcycle	Cars	Pickup Trucks	Trucks	Buses	Others
Concepción	33,852	20,079	2,589	2,127	1,227	132	7,698
San Pedro	46,765	18,197	4,617	3,765	2,461	214	17,511
Amambay	49,475	26,030	6,105	2,918	1,538	160	12,724

Source: DGEEC, Statistical Yearbook, Year 2017.

In Concepción, almost 60% of authorized vehicles are motorcycles, far exceeding the number of cars and trucks (14%). The trend is similar in San Pedro and Amambay.

4.1.5.7. Technologies of the information and communication (TIC)

This section presents information related to the population's access to Information and Communication Technologies (ICT). First, statistical data on internet access are presented, then cell phone and / or personal computer ownership, and finally data on access to the telephone line.

According to data from the Permanent Household Survey, less than half of the population aged 10 years or more in Concepción had access to the internet in 2017, the percentage is even lower in San Pedro (almost 38%). The population of Amambay is the one that had the greatest access with almost 65%.

Chart 48. Population of 10 and more years by gender, according to the use of internet (%)

	CONCEPCION			SAN PEDRO			AMAMBAY		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Total	186,627	86,734	99,893	330,995	172,399	158,596	127,915	62,230	65,685
Used	46.05	47.07	45.17	37.63	39.16	35.96	64.61	62.57	66.55
Did not use	53.95	52.93	54.83	62.37	60.84	64.04	35.39	37.43	33.45

Source: DGEEC. Permanent Household Survey 2017

As can be seen in chart 49, almost all internet accesses were made from a cell phone. Second, "at home" is indicated with slightly higher percentages than "at work". This preference of use is common to the three departments and to both genders.

Chart 49. Population of 10 and more years who used internet by gender, according to access place (%)

	CONCEPCION			SAN PEDRO			AMAMBAY		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Total	85,946	40,826	45,120	124,537	67,503	57,034	82,648	38,936	43,712
At home	9.31	(*)	10.75	8.06	(*)	8.67	18.58	19.97	17.35
At work	9.14	(*)	(*)	6.88	(*)	(*)	14.89	17.12	12.9
In an educative institution	8.14	(*)	(*)	4.76	(*)	(*)	7.34	7.82	6.91
In another person's house	5.81	(*)	(*)				5.04	(*)	(*)
In a communitarian Access place							3.2	(*)	(*)
From a cell phone	97.07	97.55	96.63	98.65	97.74	99.72	98.35	98.32	98.37

Source: DGEEC. Permanent Household Survey 2017

The numbers mentioned above are directly related to the possibility of households to access durable goods, especially cell phones and computers, notebooks or similar equipment. According to data from 2017, in Concepción, 96.63% of households have a cell phone and 11.88% have a computer/notebook, while 9.35% have internet access[65]. In San Pedro 95.97% of the homes have a cell phone; 8.62% have a computer and 6.83% have internet access[66]. In Amambay 98.46% of households have a cell phone; 24.79% have a computer (7.25% tablet or similar) and 18.60% have internet access[67].

With regard to connection to the telephone line in Concepción 5,4%[68] of households have a fixed telephone line, while in San Pedro the figure is 4.21% and 11.45% in Amambay.

4.1.5.8. Media

This section presents the main means of communication available in the Project IIA, and those found in the Department of Concepción.

According to data reported by CONATEL in 2017[69], in the Department of Concepción, there are eight commercial FM radio stations and five AM radio stations with a valid license as of that date. Likewise, 13 TV stations are registered in the department. Chart 50 presents the data corresponding to the three departments.

Chart 50. Number of radio stations and TV services, per department. Year 2017

	Concepción	San Pedro	Amambay
FM Radio Station	8	9	8
AM Radio Station	5	2	4
TV Services	13	11	6

Source: CONATEL. Note PR No. 1138/2017

The following charts (51, 52 and 53) include details of the main media in Concepción, by type of media:

Chart 51. FM comercial radio stations – department of Concepción

	Indicative	Station	Licensee	Frequency (MHz)	Place	Decree Nº / Resolution	Date
1	ZPV 36	Ita Porá FM	Integración S.A	98.9	Vallemí	587/00	09/01/2000
2	ZPV 45	Aquidabán	María R. Cristaldo Leguizamón	100.5	Concepción	3881/94	05/25/1994
3	ZPV 48	Los Ángeles FM	Liz Naida Giménez Ramos	89.9	Horqueta	1077/2002	09/03/2002
4	ZPV 65	Continental FM	Cesar Raúl Coelho de Souza Ibarra	95.3	Horqueta	9084/91	04/04/1991
5	ZPV 184	Norte Comunicaciones	José Alberto González Mármol	94.5	Concepción	397/99	09/09/1999
6	ZPV 478	Kaagata Publicidad 100.3 MHz	Nilda Concepción Canale de Silva	100.3	Yby Yaú	1692/2004	12/02/2004
7	ZPV 509	GlobalMix FM	José Adalberto Pavón	95.9	Concepción	901/2010	08/26/2010
8	ZPV 510	La Favorita FM	Noelia Rocío Irala Insfrán	93.3	Yby Yaú	901/2010	08/26/2010

Chart 52. AM radio stations – Department of Concepción

65 DGEEC. Triptych Permanent Household Survey – EPH 2017 – Departament of Concepción – August 2018
66 DGEEC. Triptych Permanent Household Survey – EPH 2017 – Departament of San Pedro – August 2018
67 DGEEC. Triptych Permanent Household Survey – EPH 2017 – Departament of Amambay – August 2018
68 DGEEC. Departmental Yearly Results– EPHC 2017-2018.
69 National Commision of Telecommunications CONATEL. Note PR No. 1138/2017. Recibed by the H. Chamber of Senators date 07/07/2017

	Indicative	Station	Licensee	Frequency (MHz)	Place	Decree Nº / Resolution	Date
1	ZP 8	Radio Concepción	Sergio Enrique Dacak	1380	Concepción	1290/89	06/27/1989
2	ZP 37	Radio Yby Yaú	Reichardt	1360	Yby Yaú	29291/88	07/20/1988
3	ZP 74	Radio Regional AM	Myryan Stella Bareiro de Denis	660	Concepción	1138/2012	08/25/2012
4	ZP 29	Radio Vallemí	Industria Nacional del Cemento	1450	Vallemí	1290/89	06/27/1989
5	ZP 42	Radio Guyra Campana	Guyra Campana SRL	1420	Horgueta	1290/89	06/27/1989

Chart 53. TV Service – Department of Concepción

	Indicative	Station	Type of Station	Licensee	Place	Decree Nº / Resolution	Date
1	ZPD 277	Rep. Telefuturo - Ch 3+	Relay	TV Acción S.A.	Yby Yaú	10089/95	08/12/1995
2	ZPD 272	Rep. Telefuturo - Ch 9+	Relay	TV Acción S.A.	Concepción	10089/95	08/12/1995
3	ZPD 315	Rep. Red Guarani - Ch 18	Relay	Tevedos S.A.	Concepción	1292/2008	12/24/2008
4	ZPD 294	Est. Base Canal 40 TV Concepción - Ch 40	Base Station	Televisión Concepción S.A	Concepción	577/2006	05/17/2006
5	ZPV 927	Rep. SNT Cerro Corá - Ch 11	Relay	Televisión Cerro Corá S.A	Concepción	15858/92	12/21/1992
6	ZPD 683	Rep. SNT Cerro Corá - Ch 12+	Relay	Televisión Cerro Corá S.A	Vallemí	177/2011	02/03/2011
7	ZPD684	Rep. SNT Cerro Corá - Ch 13	Relay	Televisión Cerro Corá S.A	Yby Yaú	177/2011	02/03/2011
8	ZPV 914*	Rep. El 13 - Ch 7	Relay	Unicanal S.A.	Concepción	9948/91	06/18/1991
9	ZPV 910*	Rep. El 13 - Ch 10	Relay	Unicanal S.A.	Vallemí	9948/91	06/18/1991
10	ZPD 675	Rep. Paravisión - Ch 4+	Relay	Paravisión S.A	Vallemí	177/2011	02/03/2011
11	ZPD 651	Rep. Paravisión - Ch 5	Relay	Paravisión S.A	Concepción	12938/96	04/12/1996
12	ZPD 676	Rep. Paravisión - Ch 8+	Relay	Paravisión S.A	Yby Yaú	177/2011	02/03/2011
13	ZPD 299	Rep. La Tele - Ch 4-	Relay	Hispanoamérica TV del Paraguay S.A	Concepción	790/2007	07/20/2007

With regard to the written press, all national newspapers are available in Concepción, San Pedro and Amambay, including the following: ABC, Ultima Hora, La Nación, Crónica, Popular, Hoy and 5 Días.

Regarding local digital media in the AID, it can be mentioned:

Chart 54. Digital local communication media in the AID

Name	Link
Concepción al día. Interactive Magazine of the Perla del Norte	http://www.concepcion-py.com/ ; https://www.facebook.com/concepcionaldiapy/
Concepción Digital. Digital Creative Journalism	https://www.concepciondigital.com/
Concepción informa	https://www.facebook.com/pages/category/Media-News-Company/Concepci%C3%B3n-Informa-
Horqueta Digital	https://www.facebook.com/HorquetaDigitaldeNoticias/
Horqueta Informa	https://www.facebook.com/pages/category/Media/Horqueta-Informa-

Source: Own elaboration

No digital media were found for Belén and Loreto.

4.1.5.9. Tourist Services and Accommodation

This section presents information on available tourist services and rental capacity of the Project's Area of Influence.

For the development of information on rental capacity, data have been obtained from the Ministry of Tourism of the Government and SENATUR (National Tourism Secretariat). The Department of Concepción has several tourist attractions that, according to the Local Health Plan (2014), contribute as an important source of income.

The city of Concepción preserves its historic center and a barracks from the time of the War of the Triple Alliance, both witnesses of bygone times, as well as the Fort of San Carlos, on the Apa River, from the colonial era. The Kurusu Isabel oratory, near the departmental capital, is a place of pilgrimage.

The region has countless rivers and streams that offer the possibility of water sports, fishing, sailing and beaches. Numerous spas were installed in the area. Ecotourism services are offered at the crystalline Tagatiya Stream and the Aquidabán River. Some boats offer river tourism services on the Paraguay River, especially walks and fishing. There are establishments that offer stay tourism (camping, horseback riding, camping etc.); in addition, the use of beaches and lagoons on their properties. In Vallemí, tours of the characteristic caves of the place are offered, while it is possible to visit the hills of San Luis and Paso Bravo.

According to official records obtained from the Ministry of Tourism of the Interior, in the department of Concepción, there are 16 providers of tourist services; in addition to the accommodations, most of which offer gastronomic services. They can be classified into: 3 gastronomic places, 6 travel and transport agencies, 4 tourist guides and 3 that offer other services. In recent years, SENATUR has promoted a program of Tourist Inns, registering 2 in Concepción: Posada Doña Preta (20 beds) and Posada Isabel (60 beds), both in Vallemí. Regarding the rental capacity of the AID, the results are presented in Chart 55.

Chart 55. Settlements, romos and beds in the AID, per district

District	Number of Settlements	Number of Rooms	Number of Beds
Concepción	20	476	960
Belén	3	25	52
Horqueta (1)	5	22	43
Loreto	2	18	52
Total	**30**	**541**	**1107**

Source: Tourism Secretary, Concepción Governorate; SENATUR. Own elaboration
(1) Withou data: 3 settlements; (2) without data: 1 settlement; (*) Data is added from Vallemí and Yby Yaú (partial)

4.1.5.10. State Presence

This item presents the public institutions that have a presence in the department of Concepción and in the AID districts. Likewise, a list of instances of citizen participation in which State representatives attend has been included.

In the following chart 56, the institutions with a presence in the department of Concepción are listed, marking those that also have a presence in the AID municipalities.

Chart 56. Public institutions present in the municipalities

Institutions	Concepción	Belén	Loreto	Horqueta
Departmental or Regional				
Governorate	X			
Secretary of the Environment of the Governorate	X			
Secretary of Tourism of the Governorate	X			
Secretary of Health of the Governorate	X			
Ministry of Agriculture and Livestock (MAG) - Directorate of Agrarian and Livestock Extension (ALAT)	X	X	X	X
Regional Office, Ministry of Industry and Commerce (ORMIC)	X			
Ministry of Public Health and Social Welfare (MSPyBS), First Health Region (Concepción)	X			
Ministry of Education and Sciences (MEC), Departmental Coordination of Educational Supervisions / Supervisions	X			
Ministry of Urbanism, Housing and Habitat (MUVH), Regional Agency No. 6	X			
Distric				
Municipality	X	X	X	X
Municipal board	X	X	X	X
Municipal Council for the Rights of Children and Adolescents (CODENI)	X	X	X	X
National				
Ministry of Justice (MJ), Penitentiaries	X			
Ministry of Finance (MH), Undersecretary of Taxation	X			
Ministry of Public Works and Communications (MOPC)	X			
Ministry of Social Development (MDS)	X	X	X	X
Ministry of Industry and Commerce (MIC)	X			
Ministry of Justice (MJ)	X			
Judicial District, Justice of the Peace	X	X	X	X
Public Ministry (MP) or Prosecutor's Office	X			X

Institutions	Concepción	Belén	Loreto	Horqueta
Superior Court of Electoral Justice (TSJE)	X			
Civil registration	X	X	X	X
Electoral Registry	X	X	X	X
National Police, Police Stations	X	X	X	X
Military Forces: 4th Infantry Regiment and Military Hospital	X			
National Institute for Rural and Land Development (INDERT)	X		X	X
National Plant and Seed Quality Service (SENAVE)	X			X
National Service of Quality and Animal Health (SENACSA)	X	X		X
National Malaria Eradication Service (SENEPA)	X			
National Service of Environmental Sanitation (SENASA)	X			X
National Malaria Eradication Service (SENEPA)				X
National Forest Institute (INFONA)	X			
Regional Office for Fisheries of the Ministry of the Environment and Sustainable Development (MADES)	X			
Regional Environmental Center of the Ministry of the Environment and Sustainable Development (MADES)				X
Directorate of Agrarian Education (DEAg), Agricultural School of Concepción	X			
National Land Registry Service	X			
National Directorate of Civil Aeronautics (DINAC)	X			
Others				
Institute of Social Welfare (IPS), Regional Hospital	X			X
National Electricity Administration (ANDE)	X			X
Sanitary Service Company of Paraguay S.A. (ESSAP)	X			
Paraguayan Communication Company (COPACO)	X	X	X	X
Paraguayan Mail	X	X	X	X
National University of Concepción (UNC)	X		X	X
National University of Asunción (UNA)	X		X	
National Development Bank (BNF)	X		X	X
Agricultural Credit for Habilitation (CAH)	X		X	X
Livestock Fund (FG)	X			
National Administration of Navigation and Ports (ANNP)	X			
National Customs Directorate	X			
National Service for Professional Promotion (SNPP)	X			

Source: Local Health Plan, Municipal Development Plan. Own elaboration.

In addition, different instances of citizen participation have been created with the participation of State representatives, which are listed in chart 57.

Chart 57. Instance of citizen participation, with the participation of State representatives

Dependency	Concepción	Belén	Loreto	Horqueta
Municipal Development Council	X	X		X
Regional Health Council	X			
Local Health Council	X	X	X	X
District Board of Education	X			

Source: Local Health Plan, Municipal Development Plan. Own elaboration.

The Municipal Development Council is an instance of citizen participation, where the interaction of the public, private and civil society sectors is established, where joint actions are coordinated, articulated and implemented, for the benefit of the community. 7 Work Tables were formed for the Municipalities of Concepción, Belén and Horqueta: Productive, Health, Environmental, Public Safety, Children and Adolescents, Infrastructure, Education.

4.1.6. Land Use

This chapter contains information on land use in the Project's Area of Indirect Influence and in districts of the department of Concepción.

Taking into account the agricultural vocation of the area, which has a direct relationship with the economy, as shown in section 4.1.4. Economy; where, among others, specific data related to the farms and their productive uses are presented. In order to clarify the issue of land use, some tables already included in the section on economics are repeated here, referring to farms and their uses. As in many other cases, the information cannot always be compared, due to differences in the survey methodology; however, it contributes to the analysis.

The predominant activity in the area, livestock, occupies three-quarters of the territory of the department according to the publication "Concepción, demographic and socioeconomic characteristics, 2002", occupying 5% of the EAP, while only 4% of the total of the surface is used in agriculture, which occupies more than 38% of the EAP. The forested area represents 17% of all the lands of the department, according to data from the Agricultural Survey by Sampling carried out in 2002 by the Directorate of Agricultural Censuses and Statistics of the Ministry of Agriculture and Livestock (Pereira, 2008).

The Agricultural Survey by Sampling (2002), cited by the publication "Concepción, demographic and socioeconomic characteristics" refers that of the territory used for livestock, 76% is used for natural and implanted pastures, 17% are natural or cultivated forests and the rest are temporary and permanent crops, are fallow or have other uses. Pereira mentions that the publication "Territory and Population" indicates that there are 54 farms owned by Brazilian owners totaling an area of around 100,000 hectares in the district of Concepción. Likewise, he indicates that there are about eight ranches with almost 50,000 hectares in the department.

For its part, the 2008 Agricultural Census includes data related to the number of farms, according to use by department and number of hectares according to use by department, as can be seen in charts 58 and 59[70].

Chart 58. Land according to its usage in number of farms, by department on 2008

Department	Number of farms with land	Farms with permanent temporary crops and vegetables	Farms with natural or cultivated pasture	Farms with natural forests or forest plantations	Farms with fallow land	Farms with land destined for other uses
Concepción	17,377	15,285	10,071	6,414	7,485	15,583
San Pedro	45,875	42,889	23,866	18,468	24,154	40,784
Amambay	4,795	3,969	2,726	2,454	1,745	3,261
TOTAL, ESTIMATED All	68,047	62,143	36,663	27,336	33,384	59,628

Source: National Agricultural Census 2008. Own elaboration

Chart 59. Land according to its number in terms of area, by department on 2008

70 The analysis of this information was carried out in the section on economics.

Department	Total Area (Ha).	Farms with permanent temporary crops and vegetables	Farms with natural or cultivated pasture	Farms with natural forests or forest plantations	Farms with fallow land	Farms with land destined for other uses
Concepción	1,619,416	71,431	1,218,911	233,300	50,394	4,538
San Pedro	1,739,232	321,156	909,500	276,656	81,091	150,828
Amambay	1,217,077	134,925	806,876	224,785	28,567	21,924
TOTAL, ESTIMATED AII	4,575,725	527,512	2,935,287	734,741	160,052	177,290

Source: National Agricultural Census 2008. Own elaboration

According to Palau (2019), analyzing the report of the Statistical Synthesis of Agricultural Production 2017-2018 prepared by the Ministry of Agriculture and Livestock (MAG), it can be observed that the hectares devoted to soy cultivation in Concepción total 40,355 hectares. Corn occupies 8,222 ha, sugar cane 321 ha and rice 51 ha. Peasant family agriculture covers 21,443 ha, of which about 11,000 ha were used for manioc cultivation.

Regarding protected areas, the Municipal Development Plan of Concepción, of the year 2016, mentions the following:

- Range of mountains San Luis, with an area of 70,000 hectares.
- Itapucumí, with an area of 45,000 hectares.
- Estrella de Concepción, extension 2,400 hectares.
- Laguna Negra, an area of 10 hectares, is in danger of extinction.

The district of Concepción has 8,490 km2, the Municipal Development Plan (2016) mentions that, according to the Atlas of the DGEEC, the lands to the north and east of the department, in the proximity of the Apa and Paraguay rivers, are high and with some isolated hills of relative elevation. The center and north are of low and flat topography, with extensive pastures for grazing, which alternate with forested sectors. The southern part has higher ground. In the district of Concepción, the lands are high, slightly sloping, with forests of timber trees, used for cabinetmaking and construction.

Regarding the distribution of land by districts, according to data from the 2008 Agricultural Census, Concepción is the district with the largest number of farms and area, followed by Yby Yaú and Horqueta. It is worth mentioning that the surfaces of these two districts were modified after the Census, due to landslides and the creation of new districts. Likewise, the fact that the vast majority of farms are managed by a single producer in the four AID districts, as well as in the entire department of Concepción, stands out. Chart 60 presents data in this regard.

Chart 60. Land distribution by district, department of Concepción

Districts of the Department of Concepción	Number of Lands	Total Area	Farm Management				
			Un Solo productor	Dos o más productores asociados de hecho	Una empresa o sociedad legalmente constituida	El Estado	Otros
Concepción	4,214	924,385	4,083	61	59	2	9
Belén	1,479	16,080	1,421	57	1	-	-
Horqueta	7,075	195,727	6,870	183	17	1	4
Loreto	2,062	41,560	2,032	28	2	-	-
San Carlos del Apa	86	62,146	77	9	-	-	-
San Lázaro	219	56,161	199	19	1	-	-
Yby Yaú	2,242	323,357	2,127	74	35	1	5

Source: National Agricultural Census 2008. Own elaboration

The dominance of a single producer is verified in all the farm management strata, either by use of family labor or hired as day laborers.

Public Colonies[71]

According to Rojas and Areco (2017), from 1891 to 2010, 61 colonies have been formed totaling 388,247 hectares with 16,519 lots (almost 5,000 in the district of Concepción according to data provided by the local office); constituting 7% of the total authorized lots in the country. The average number of hectares per lot is 24. These colonies constitute 21% of the departmental territory. Of the 61 neighborhoods, 36% are in Horqueta, 23% are in the Concepción district, 18% are in Loreto, and the rest are in the other districts. Chart 61 presents a summary of the data of the Public Colonies formed between 1891 and 2010.

Chart 61. Public colonies formed between 1891 and 2010

Department	Number	Hectares	Lots	Average
Concepción	61	388.247	16.519	24
San Pedro	143	562.247	38.768	15
Amambay	42	176.605	8.626	20

Source: Elaborated by Rojas and Areco, 2017.

Rojas and Areco (2017) conclude: “The most frequently observed changes in the colonies, between the time of their formation and the present, were: 1) the reduction in the area of the colonies; 2) the significant increase in the number of lots in them; and 3) the sharp drop in the average size of the lots and the consequent increasing minifundization of the peasant farms, moving away from the necessary basic surface, established in the Agrarian Statute”.

There are also the so-called “communal fields”; that is, surfaces for free common use of the community, this for productive purposes. These can be enabled in the agricultural colonial settlements (whether official or private), this from what is described in Law 1863/02 establishing the Agrarian Statute, in its chapter IV[72].

71 Peasant colonies (or settlements), legally recognized by the National Institute for Rural and Land Development (INDERT), the official entity in charge of land policy in the country.

72 Law N ° 1863/02 of Establishment of the Agrarian Statute. Chapter IV Of the Communal Fields. http://www.bacn.gov.py/leyes-paraguayas/3124/establece-el-estatuto-agrario

During the work of collecting information in the field, residents of the localities near the area surveyed for the installation of the mill, mentioned belonging to groups that have **communal** fields, this in the communities of Curuzu Ñu and Mbocayaty (item 4.2.5.3: Economic activities and income).

4.1.7. Use of Water Resources

This section presents information on the use of water resources in the Project's Area of Influence. Considering that the subject has already been dealt with in previous items, general data on home use are provided, and other uses of the resource are incorporated.

In the document "Uses and governance of water in Paraguay", prepared by UNDP (2016) mentions that the department of Concepción is located on the Quaternary aquifer, using 60% to meet the needs of its inhabitants. The other 40% do so through surface waters.

According to the Ministry of Public Health and Social Welfare, "94% of the rural population of our country can access drinking water"[73]. However, despite the progress, there is still a sector of the population that does not have the service. One of the strategies at the country level to address the problem of access to water in rural areas was the interventions of the National Environmental Sanitation Service (SENASA), in order for the population to organize itself through boards or commissions for administration and maintenance. systems.

The provision of water service at the country level in urban areas is in charge of the ESSAP (the only concessionaire of the drinking water service, and attending to its origins, in the former CORPOSANA, it serves communities of more than 10,000 inhabitants), in areas rural areas by SENASA (it normally serves populations of less than 10,000 inhabitants, although there are cases where the population supplied by the Sanitation Boards is higher) and there are also other providers.

Regarding home use of water, according to the Environmental Statistical Compendium (2017), the department of Concepción has an ESSAP provider, and 837 from SENASA and a total of 97 correspond to private providers, neighborhood commissions and others; according to data provided by ERSSAN. ESSAP has 7,572 connections; while SENASA 19,624. There are also 6,689 connections that correspond to other providers. ESSAP takes the water from the Paraguay River to supply its users.

Regarding sanitary sewerage, ESSAP is the only one that provides this service in the capital of the department of Concepción with 3,691 connections, which constitutes approximately 7% of the total population of the department and 20% of the district of Concepción corresponding to the year 2017. The other places in the department do not have this service.

In the city of Concepción, in 2018, a total of 7,842 water connections were registered, with the population supplied with drinking water being 39,210 people, based on an average calculation of five inhabitants per dwelling; according to information contained in the Environmental Statistics compendium (2018).

In addition, it should be noted that the evolution of drinking water connections in the city of Concepción has been from 5,246 in 2008 to 7,572 in 2017, which constitutes an increase of more than 44% in less than ten years. That meant going from 26,230 people with drinking water supply to 37,860 in the aforementioned period. Likewise,

73 Access to water in rural areas is a priority for the National government. May, 2017.Available at: https://www.mspbs.gov.py/portal/12119/acceso-a-agua-en-zonas-rurales-es-prioridad-para-el-gobierno-nacional.html-

the connection to the sanitary sewer network went from 2,104 in 2008 to 3,691 in 2017, increasing by 75%. The benefited population rose from 10,520 to 18,455 people.

Another aspect is related to navigation. In this sense, the Paraguay River, which divides the country into two natural regions (Eastern and Western or Chaco), originates in Brazil, empties into the Paraná and empties into the Atlantic Ocean through the Río de la Plata. It is navigable by small vessels throughout its entire length and by large draft vessels during most of the year; except when low water cycles are recorded that affect navigability due to low water. This situation affects the river transport of cargo and passengers. Among the consequences are: increased travel time, reduced loading capacity of vessels or the fact that some deep draft vessels are stranded until the river level rises again.

Source: ABC Color, Año 2019.

Some press media also mention during the decrease in the water level registered in the years 2019 and 2020; that the "downspout lets us see, from the local port, a huge ravine on Isla Chaco'i"[74]; the difficulty of navigation since "for example, barges must do so in a fractional way, that is, in parts"; It also refers to the fact that "some boats are stranded and that others would stop making trips if the situation does not improve[75].

In 2020 there is a historical drop in the level of the Paraguay River after more than 50 years; and it is estimated that in April 2021 this will again reach optimal levels of navigability, as indicated by the head of the ANNP Department of Hydrology.[76]

The amount of water that circulates varies in time and space; in extreme cases it can produce periods of drought such as those mentioned or floods; the latter are registered in different parts of the department. In this sense, the floods of the river or internal streams produce economic losses and diseases, generate impacts on both agricultural and livestock production; as well as on the roads that serve as a connection between communities.

The river is also vital for many communities to have access to basic supplies. Such is the case of the riverside community of Bahía Negra, where once a week from the city of Concepción merchandise is transported by boat so that the locals can make purchases of products such as fruits, vegetables, clothing and other items.

74 ABC Color. Visible low water in Concepción. November, 2019. Available at: https://www.abc.com.py/edicion-impresa/economia/2019/11/26/visible-estiaje-en-concepcion/

75 Digital Camisa 12. Concepción: Navigation becomes more and more difficult and some trips could be suspended. October, 2020.Available at: http://www.camisa12.com.py/concepcion-navegacion-se-dificulta-cada-vez-mas-y-podrian-ser-suspendidos-algunos-viajes-p10105.html

76 Paraguayan Information Agency (IP). ANNP reports that the Paraguay River managed to rebound 30 cm after a historic downspout. Available at: https://www.ip.gov.py/ip/annp-reporta-que-el-rio-paraguay-logro-repuntar-30-cm-tras-bajante-historica/ NOVIEMBRE 2020

The waters of the Paraguay River also serve for the operation of local industries that are supplied by the river. This is the case of Frigorífico Concepción, both in the meat and tannery industries. This industry captures water from the river, makes it drinkable in its own treatment plant, uses it, reconditions it through a decontamination process and returns it to the river. The Belén refrigeration company uses the waters of the Ypané to carry out its operations.

As indicated in the UNDP document (2006)[77], citing Facetti, during the slaughter process, the average water used is 300 and 700 liters per beef, varying according to the availability of the product; which suggests the use of high volumes of the resource in the industries of the sector.

It should be noted that there is no record of the percentage of water used by agricultural, livestock and industrial activities in the country.

Likewise, fishermen use the river as a way of life; fishing is used both for consumption and for sale. There are two fishermen's associations in the city, one of which is inactive. The Nanawa Professional Fishermen Association has 25 members and they market their fish at the roundabout at the entrance to the city.

On the island of Chaco'i, located in front of the city of Concepción on the banks of the Paraguay River, a group of 30 people is part of the Union “Boteros Unidos Concepción Puerto Viejo”. 100% of the people who work in the industry are associated with the union; and one of the members is a woman. These people are dedicated to transferring passengers from the island to the urban center of the city of Concepción and vice versa.

The former has the need to cross the river daily to carry out their work activities or have access to health services, education, supply of food products or other uses such as clothing, fuel, and others. They also transfer those visitors who wish to reach the island from the city of Concepción, who preferably go to the site for recreational fishing.

Source: Members of the Boat drivers Union of Concepción. Field Rercord 2020.

The river area is widely used as a place of recreation. It is usually fished upstream and downstream. The most popular areas for this activity include: 7 Puntas, Ypané, Aquidabán; others go to the area of Peña Hermosa and Bahía Negra.

Likewise, as mentioned previously, the river is an important means of communication, since ships, boats and barges cross its waters to reach various locations such as Puerto Pinasco, Puerto Casado, Vallemí, Fuerte Olimpo,

77 PNUD. Uses and water governance in Paraguay. 2006. Available at: https://www.py.undp.org/content/paraguay/es/home/library/democratic_governance/usos-y-gobernabilidad-del-agua-en-paraguay.html

transporting food, fuel and passengers. The Aquidabán ship makes regular trips once a week from Asunción to Bahía Negra.

On the other hand, the Apa, Aquidabán and Ypané rivers; affluent of the Paraguay River, are navigable by small boats. There are also streams and estuaries that account for the availability of water resources in the area; which presents opportunities for the development of tourism. Promoting tourism can mean other sources of employment for the area.

Source: Concepción. Field Record 2020

Regarding the recreational use of water resources, there are currently 18 spas, of which 5 are authorized by MADES. Taking into account the high temperatures in the country, annually the increase of spas in the area can be observed, these in certain cases do not meet the optimal conditions for those who resort to them and as mentioned, they do not have the corresponding authorization by the MADES. Chart 62 lists the spas.

On the other hand, from Concepción, there are options within the city for walking and fishing trips. The boats Ten Caten, Siete Cabrillas and Santa Filomena are some of those that offer this service. They are private services available to those interested.

Chart 62. Watering places of the department of Concepción

Number of watering places	District	Enabled by MADES
2	Belén	1
7	Concepción	0
4	Horqueta	1
4	San Alfredo	2
1	Yby Yaú	1
Total: 18	**5 districts**	**5 enabled**

Source: Own elaboration con información proveída por la Secretaría de Turismo de la Gobernación

On the Aquidabán river in Paso Horqueta, 40 km from Concepción, on the route to Vallemí it has public beaches. On the same river, there are also recreational spaces in Paso Barreto (65 km from Concepción); and Paso Urundey, Horqueta district, which is distant about 15 km from the Bernardino Caballero route, at km 70.

In Vallemí, there is a municipal waterfront on the Paraguay River. Also, 4 km from the city, the Apa River offers an immense sandy area that is used by visitors.

The Tagatiyá stream, located in the San Alfredo district, is one of the department's greatest tourist attractions. It runs on a calcareous base and allows the bottom to be seen through its transparent waters.

4.2. Area of Direct Influence (AID)

This section describes the main features in terms of demographic, social, cultural and economic indicators of the districts that make up the project's AID; referenced in item 2.3 of this study.

In order to organize existing information; the content was structured in two sections:

a. Summary of the characteristics of the districts that make up the AID. In order to complement the quantitative records already indicated in the AII characterization section referring to the AID.

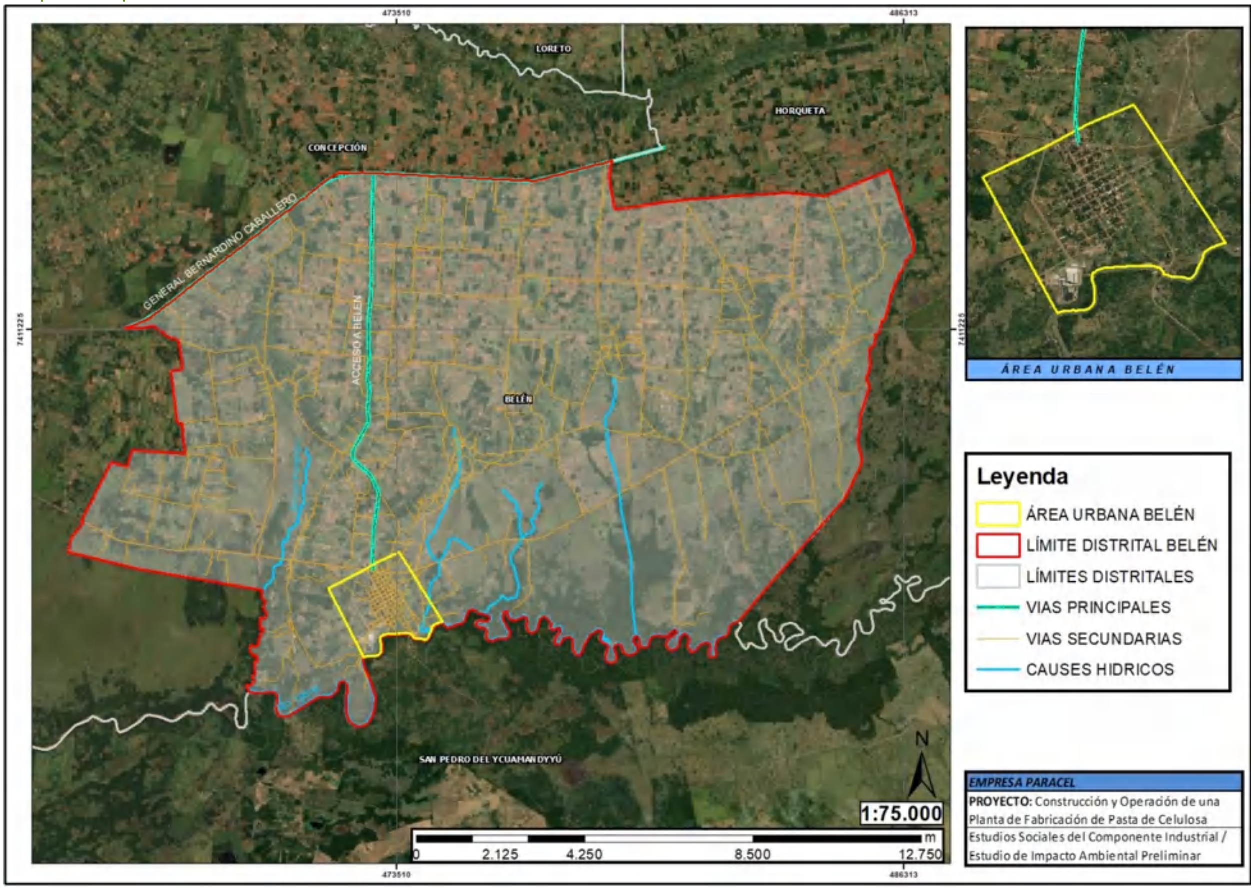
b. Summary of micro-territories identified in the AID from the communication routes that lead to the prospected property area. It will also be possible to access elements of the consultation process with key actors as central contributions for the characterization of the territory.

It is important to note that, for the characterization of the districts studied for the AID, 3 main Sources have been taken into account (Local Health Plan 2014-2016 of each district, Municipal Development Plan (PDM) and the DGEEC) as they do not have from other updated bibliographic sources.

4.2.1. Belén's District

Illustration 1. Picture of an access road to the city

Map 7. Map of Belén's District



General Characteristics

The city of Belén, in the department of Concepción, was founded on August 23, 1760, by Francisco José Sánchez Labrador and Hernández S.J. It is located 21 km from the departmental capital.

It is located on the banks of the Ypané River. It limits to the north with the districts of Concepción and Horqueta, to the south with the Municipality of San Pedro, to the east with the district of Horqueta and to the west with the district of Concepción. Its main road accesses are Route V General Bernardino Caballero and Route III Elizardo Aquino and a bridge located over the Ypané River[78].

As mentioned, it is located 21 km away from the city of Concepción and 437[79] km from the capital of the country. It has an area of 215 km^2, distributed in rural and urban areas. In 1917, 1 colony was created, corresponding to 433 lots and 7,408 hectares[80].

78 Belén municipal development plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/PDM%20Belen.pdf
79 Road distance from the capital of the country by Route 9 Don Carlos A. López
80 Rojas, L. and Areco, A. (2017). The Peasant Colonies in Paraguay.

Chart 63. Complementary information about Belén's District

Population	Regarding the population, the projection for 2019 is 13,014 inhabitants (6,766 men and 6,248 women) and for 2020 it is 13,215 inhabitants (being 6,874 men and 6,341 women)[81]. Of which, 73 inhabitants correspond to the indigenous population (being 39 men and 34 women)[82] of the rural area.
Economic Activity	The main economic activities are agriculture (fruits, yerba mate), industries, meat processing plants, tannery, shops and forestry activities
Tourism	For the exploitation of tourism, the city of Belén has five peculiarities that characterize it, Belén is the point where the tropic of Capricorn crosses the country; the mansions with colonial architecture that they conserve in the city; the spas located on the banks of the Ypané River, Pororó and Paso Pedroso; ecological tourism and stay and the Jesuit Ruins of Purutue Ka´i[83] which is located in the Urundey Pass 3.5km north on the way to Horqueta.
Health	The district health service is organized as follows: 1 Belén Health Center, 1 USF, 1 Maternal and Child Center of the SOS Village (gynecological care, childbirth, general medical clinic, laboratory and pharmacy), 5 Medicine Kits, 1 Private Family Medicine Clinic, 2 Empirical Midwives, Naturalist Doctors.[84]
Education	In the district there is access to 3 educational centers located in the urban area and 22 in the rural area[85].
Drinking Water and Energy	The drinking water service is provided by the Urban and Rural Sanitation Boards and the electric power by the National Electricity Administration (ANDE).
Sewage System	In urban areas, modern toilets with septic tanks predominate, they do not have a sewage system or network, and in rural areas, common toilets or latrines predominate
Garbage collection/disposal/ treatment	They do not have garbage collection service, the way to eliminate garbage is burning or burying.

Illustration 2. Picture of the city of Belén, representation of the indigenous culture

81 DGEEC. Concepción Department. Estimated and projected population, by district, gender and age groups, 2000-2025. Available at: https://www.dgeec.gov.py/vt/default.php?publicacion=2

82 DGEEC. III National Census of Population and Housing for Indigenous Peoples, 2012. Available at https://www.dgeec.gov.py/default.php?publicacion=33

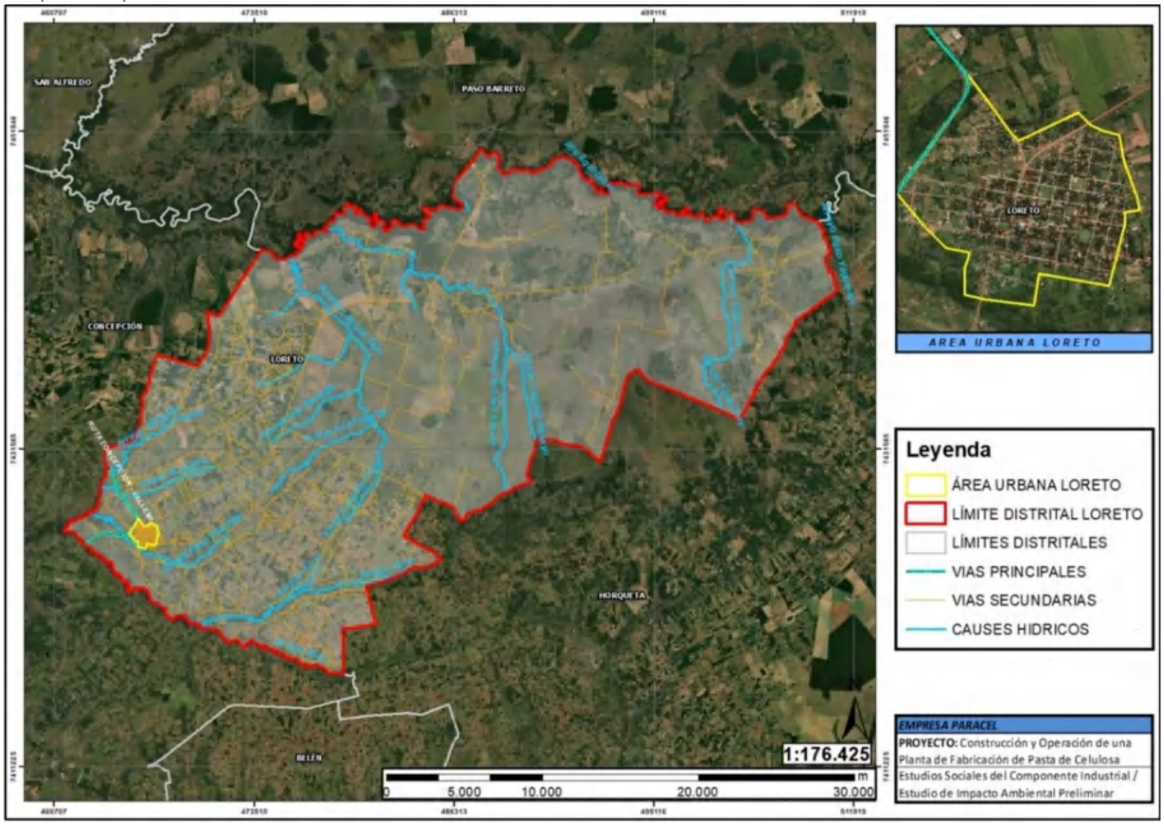
83 Belén municipal development plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/PDM%20Belen.pdf

84 Belén Local Health Plan, Concepción Department 2014-2016. Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Belen.pdf

85 Belén Local Health Plan, Concepción Department 2014-2016. Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Belen.pdf

4.2.2. Loreto's District

Map 8. Map of Loreto's District



General Characteristics

The city of Loreto was founded on December 10, 1792 by the Jesuits. It is located 20 km from the City of Concepción and 437[86] km from Asunción. It limits with the districts of Horqueta, Belén and Concepción. The city can be accessed by routes III Elizardo Aquino, V Bernardino Caballero and Coronel Franco-Chaco. It has an area of 996 km2. Organized in 31 rural companies and 4 urban neighborhoods[87]. From 1964 to 1981, 11 colonies were created, corresponding to 1969 lots and 46,323 hectares[88].

86 Road distance from Asunción through Pozo Colorado.
87 Loreto Municipal Development Plan. Concepción Department. 2016.Available at http://www.municipalidadloreto.gov.py/wp-content/uploads/2014/11/plan-de-desarrollo-distrital-loreto2016.pdf
88 Rojas, L. and Areco, A. (2017). Peasant Colonies in Paraguay.

Illustration 3. Pictures of the access of Loreto

Chart 64. Complementary information about Loreto's Disctric

Population	Regarding the population, the projection for 2019 is 18,791 inhabitants (9,973 men and 8,818 women) and for 2020 it is 18,879 inhabitants (being 10,034 men and 8,846 women)[89].
Economic Activity	The economic activities that predominate are agriculture (sesame, watermelon, melon, manioc, vegetables, etc.) on a small scale, production for consumption at the local and departmental level[90], livestock, crafts (crafts, textiles, painting on canvas, ao poi), wood industries, shops, fairgrounds, etc.[91]
Tourism	In the district, the places taken into account to visit as tourist sites are the spas, giant statues in the squares, the church, the Aquidabán River and streams, and the Prayer House dedicated to the Virgin of Tuparendá[92]. The view of the city is complemented by the old and large houses and rural houses. In one of them, the trophies of Mcal. José Félix Estigarribia[93].
Means of Communication and Transport	They have fixed telephony and internet service by the Paraguayan Communications Company (COPACO), as well as mobile telephony and internet access by private companies. Air channels and cable channels, AM and FM radios (community and commercial radios). The district does not have local transport service, they do use intercity and long-distance transport and private means. The main accesses are by Route V General Bernardino Caballero, Route III Gral. Elizardo Aquino and Coronel Franco-Chaco. There is also the branch of the National Post Office of Paraguay (DINACOPA)
Health	In Loreto they have 1 Health Center, 2 Health Posts, 1 USF, 1 Dispensary, 1 Social Pharmacy, 6 Private Pharmacies and 15 Empirical Midwives
Education	In the municipality there are 9 national schools and 32 basic schools
Drinking Water and Energy	The drinking water used in the area comes from the sanitation boards. They have electric power service.
Sewage System	The District does not have a drainage network. Only 16% in urban areas have modern bathrooms with septic tanks and septic tanks, and 72% corresponding to rural areas use latrines.
Garbage collection/disposal/ treatment	According to data from institutional interviews, the municipality has a municipal landfill, a part of the urban area accesses the collection service and in the rural area they eliminate by burning or burying.

Illustration 4. Picture of the City of Loreto

89 DGEEC. Concepción Department. Estimated and projected population, by district, sex and age groups, 2000-2025. Available at: https://www.dgeec.gov.py/vt/default.php?publicacion=2

90 Loreto Municipal Development Plan. Concepción Department. 2016.Available at http://www.municipalidadloreto.gov.py/wp-content/uploads/2014/11/plan-de-desarrollo-distrital-loreto2016.pdf

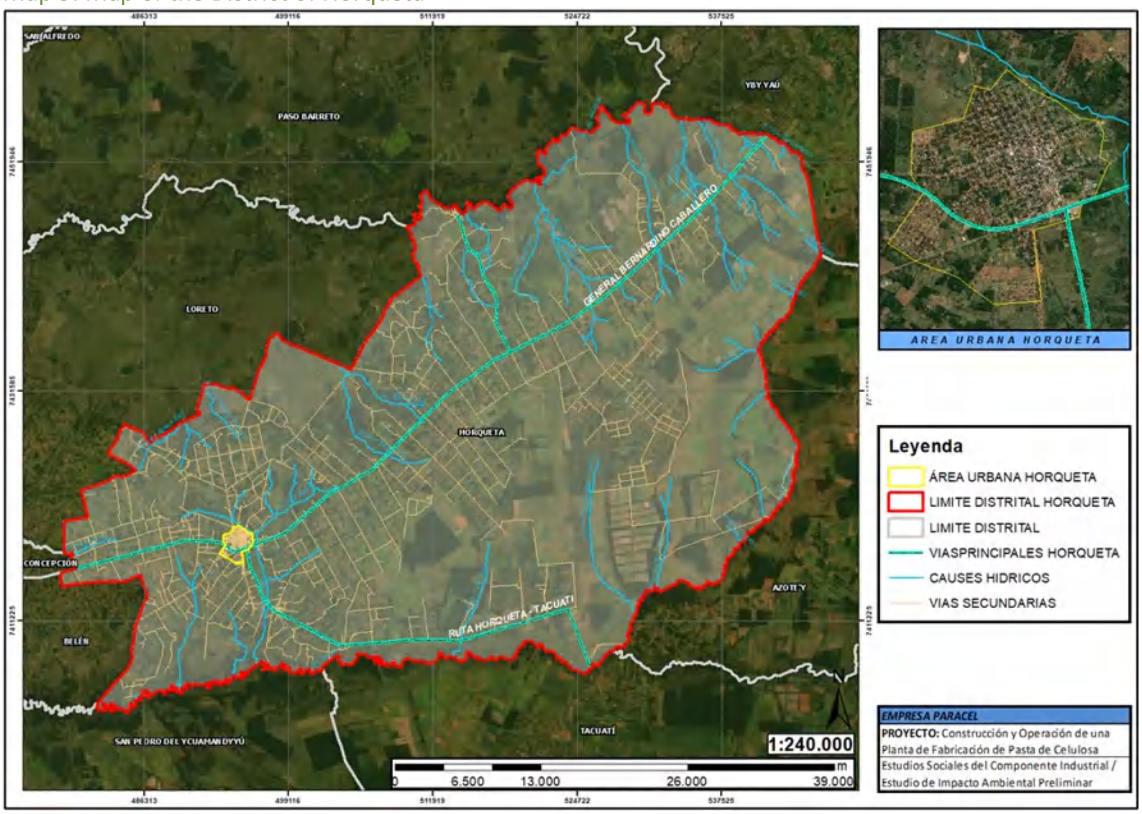
91 Loreto Health Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Loreto.pdf

92 Loreto Health Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Loreto.pdf

93 Loreto Municipal Development Plan. Concepción Department. 2016.Available at http://www.municipalidadloreto.gov.py/wp-content/uploads/2014/11/plan-de-desarrollo-distrital-loreto2016.pdf

4.2.3. Horqueta's District

Map 9. Map of the District of Horqueta



General Characteristics

The city of Horqueta was founded on May 10, 1793, by Juan Manuel Gamarra and Andrés Salinas. It is located 50 km from the City of Concepción and 434[94] km from Asunción, 172 km from Punta Porá (Brazil). It limits to the north with the districts of Loreto, Concepción and the Río Aquidabán, to the south with the Río Ypané, to the east with the district of Yby Yaú and to the west with the districts of Concepción and Belén. It has an area of 2,925 km2

94 Road distance, from Asunción along the Transchaco Route and Route 5 General Bernardino Caballero

distributed in urban and rural areas[95]. From 1917 to 2001, 22 colonies were created, corresponding to 6,957 lots and 124,391 hectares[96].

Chart 65. Complementary information about Horqueta's District

Population	Regarding the population, the projection for 2019 is 62,008 inhabitants (32,152 men and 29,856 women) and for 2020 it is 62,664 inhabitants (32,477 men and 30,187 women).[97] Of which, 339 inhabitants correspond to the indigenous population (162 being men and 177 women)[98] all from the rural area.
Economic Activity	The main activities of the district are agriculture (ka'a he'ê, cotton, spruce, beans, manioc, corn, fruits, yerba mate), shops and industries (agricultural products, cotton remover, oil mill, tannery, sawmills, logging)[99].
Tourism	The district has the museum called Las Raices de Horqueta, Luis Alberto del Paraná Museum (Radio Guyrá Campana), Virgen del Rosario Church, José Antequera y Castro Square[100] and the white sand beaches on the banks of the Aquidabán River, Paso Horqueta and the Bridge from Paso Horqueta [101].
Means of Communication and Transport	According to information obtained in institutional interviews, in Horqueta there is access to fixed telephony and internet services by the Paraguayan Communications Company (COPACO), as well as mobile telephony and internet access by private companies, there are air channels and channels cable and AM and FM radios (community and commercial radios). Currently there is no local public transport service, the means of transport used are intercity or long-distance buses and private means. The main accesses are Route V General Bernardino Caballero and Route III Gral. Elizardo Aquino. There is also the branch of the National Post Office of Paraguay (DINACOPA)
Health	The Horqueta District Hospital, 11 USF and 7 Health Posts operate in the district[102].
Education	According to the Municipality's Development Plan (2016), the district has access to 20 urban and 113 rural educational institutions, corresponding to subsidized initial, basic, secondary, public and private education. And higher education, public and private, with undergraduate and graduate degrees, at the following universities: Intercontinental Technological University (UTIC), San Carlos University, National University of Concepción (UNC), the Polytechnic and Artistic University of Paraguay (UPAP). Likewise, the Horqueta Teacher Training Institute (IFD Horqueta)
Drinking Water and Energy	The drinking water used in urban and rural areas is the running water system (80%) and the least used is well water (20%)[103]. Access to electricity is provided by the Costa Romero Sub Static, which processes the energy from the Itaipu Hydroelectric Power Plant for the entire north[104].

95 Horqueta Municipal Development Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/PDM%20Horqueta.pdf
96 Rojas, L. and Areco, A. (2017). Peasant Colonies in Paraguay.
97 DGEEC. Concepción Department. Estimated and projected population, by district, sex and age groups, 2000-2025. Available at: https://www.dgeec.gov.py/vt/default.php?publicacion=2
98 DGEEC. III National Census of Population and Housing for Indigenous Peoples, 2012. Available at https://www.dgeec.gov.py/default.php?publicacion=33
99 Horqueta Local Health Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Horqueta.pdf
100 Internal tourism Paraguay. Available at https://turismointernoparaguay.blogspot.com/2015/01/concepcion-atractivos-museos-y-centros.html
101 Horqueta Municipal Development Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/PDM%20Horqueta.pdf
102 Horqueta Local Health Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Horqueta.pdf
103 Horqueta Local Health Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Horqueta.pdf
104 Horqueta Municipal Development Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/PDM%20Horqueta.pdf

Sewage System	The District does not have a drainage network. Only 16% in urban areas have modern bathrooms with septic tanks and septic tanks, and 72% corresponding to rural areas use latrines.
Garbage Collection/ Disposal/ Treatment	Regarding the garbage collection service, although the municipality has a municipal landfill, only a part of the urban area accesses the collection service and in the rural area they eliminate by burning or burying[105].

Illustration 5. Picture of Horqueta

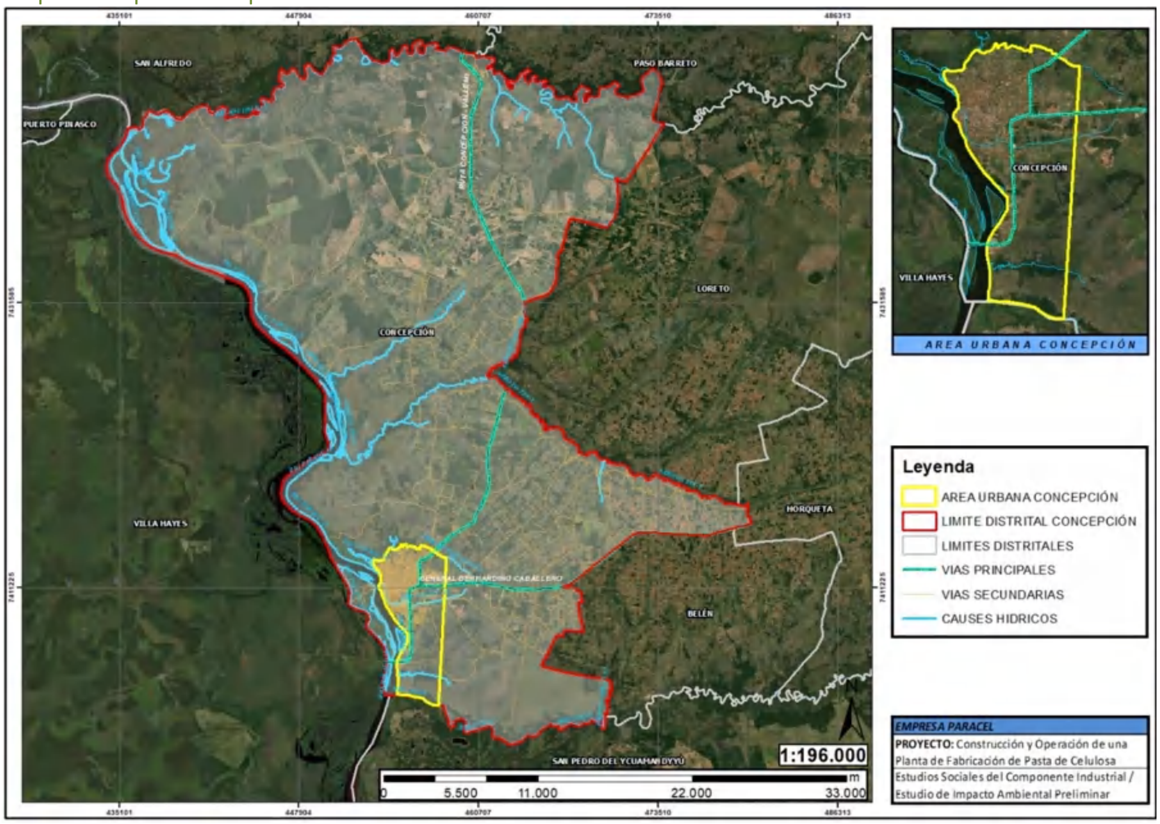
4.2.4. Concepción's District

Características generales

The city of Concepción is the capital of the Department. It was founded on May 25, 1773, by Colonel Agustín Fernando de Pinedo. It is located on the banks of the Paraguay River, with fluvial access (Puerto de Concepción), air (Concepción Airport, Tte. Col. Carmelo Peralta) and land (Route V General Bernardino Caballero that connects with the other districts)[106].

105 Horqueta Local Health Plan. Concepción Department. 2016.Available at https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Horqueta.pdf
106 Concepción Municipal Development Plan. Concepción Department. 2016.

Map 10. Map of Concepción's District



It limits to the north with the Municipality of San Alfredo, to the south with the district of Belén and San Pedro, to the east with the districts of Paso Barreto, Belén and Loreto and to the west with the Paraguay River that separates it from the district of Presidente Hayes. It is located at a distance of 415[107] km from the capital of the country. It has an area of 8,490 km^2 [108] distributed in rural and urban areas. From 1918 to 2008, 14 colonies were created, corresponding to 4,408 lots and 113,807 hectares[109].

Chart 66. Complementary information about Concepción's District

Population	Regarding the population, the projection for 2019 is 85,876 inhabitants (43,306 men and 42,570 women) and for 2020 it is 87,215 inhabitants (44,034 men and 43,181 women)[110]. Of which, 774 inhabitants belong to the indigenous population (407 men and 367 women), 393 in the rural area (206 men and 187 women) and 381 (407 men and 367 women)[111] in the urban area.
Economic Activity	In relation to economic activity, the district is characterized by agricultural and livestock production, shops, officials of public institutions and industries. Among the main agricultural activities are the production of sugar cane, corn, sesame, pineapple and watermelon among others; among livestock, bovine production in general and small livestock. Related to the latter, in the district there are important

107 Distancia vial, por Ruta 9 Transchaco Carlos A. López – Pozo Colorado – Puente Nanawa Coronel Rafael Franco

108 Local Health Plan, Concepción Department 2014/2016. Available at: https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Concepcion.pdf

109 Rojas, L. and Areco, A. (2017). The Peasant Colonies in Paraguay.

110 DGEEC. Concepción Department. Estimated and projected population, by district, gender and age groups, 2000-2025. Available at: https://www.dgeec.gov.py/vt/default.php?publicacion=2

111 DGEEC. III National Census of Population and Housing for Indigenous Peoples, 2012. Available at https://www.dgeec.gov.py/default.php?publicacion=33

	slaughterhouses, cold stores and saddlery[112]. In addition, the port of Concepción, which is the main port of the city with the most commercial and people traffic.
Tourism	In the City of Concepción, as part of tourism, the Municipal Museum of the Villa Real Barracks and the Diocesan and Historical Museum of Concepción are located, where objects from the time of the Chaco War and the Triple War are still kept. Alliance; the Locomotive that worked until 1960[113] and the House of Culture Carlos Colombino de Concepción[114] where old objects are also preserved.
Means of Communication and Transport	In the district there is access to landline and internet services by the Paraguayan Communications Company (COPACO), as well as mobile telephony and internet access by private companies, air channels and cable channels, and AM and FM radios (radio stations).). There is no local public transport service, the means of transport used are intercity or long-distance buses, and as private means they use motorcycles, cars and trucks. In addition, the Port of Concepción and the Concepción Airport "Tte. Cnel. Carmelo Peralta". There is also the branch of the National Post Office of Paraguay (DINACOPA)[115] and private services such as MC Courier Agencia Concepción, A.Y.A Correo Privado, J.F. Courier SRL.
Health	The health service is in charge of the Ministry of Public Health and Social Welfare (MSPyBS) through the 1st Sanitary Region of the country, there is the Concepción Regional Hospital, 14 Family Health Units (USF), 2 community dispensaries, 2 Health Posts, 1 Indigenous Mobile Unit and the Regional Hospital of the Social Security Institute (IPS).[116] You can also access private health services, clinics, sanatoriums, clinics, laboratories and pharmacies.
Education	According to the Municipal Development Plan of Concepción (2016), in the district there are 60 educational institutions enabled in the urban area and 50 in the rural area, corresponding to subsidized initial, basic, secondary, public and private education. Regarding higher education, there is the National University of Concepción (UNC) with undergraduate and postgraduate degrees, and the private ones, Nuestra Señora de la Asunción Catholic University (UC), the Polytechnic and Artistic University of Paraguay (UPAP), UniNorte Comunitaria de Concepción and the Intercontinental Technological University (UTIC)
Drinking Water and Energy	The drinking water service is provided by the Empresa de Servicios Sanitarios del Paraguay S.A. (ESSAP) and the Sanitation Boards, electric power, the National Electricity Administration (ANDE)
Sewage System	In urban areas, modern toilets with wells or septic chambers predominate, but there is no sewage system or network, and latrines predominate in rural areas
Garbage Collection/ Disposal/ Treatment	In the urban area of the district, the garbage collection service is in charge of the municipality, not all neighborhoods have coverage and there is a municipal dump. Health institutions have a system for collecting and treating pathological waste, however, in rural areas, since they do not have a garbage collection service or municipal landfill, the way to eliminate garbage is by burning or burying it

112 Local Health Plan of Concepción, Departament of Concepción. 2014/2016.
113 Local Health Plan of Concepción, Departament of Concepción. 2014/2016.
114 SNC. Available at: en http://www.cultura.gov.py/2014/05/se-inauguro-la-casa-de-la-cultura-carlos-colombino-de-concepcion/
115 Paraguayan mail http://www.correoparaguayo.gov.py/index.php/noticias/correo-de-concepcion-esta-en-zona-centrica
116 Local Health Plan of Concepción, Departament of Concepción. 2014/2016. Available at: https://www.cird.org.py/institucional/documentos/Plan_Local_Salud_Concepcion.pdf

Illustration 6. “Nanawa” Bridge, on the Paraguay River, city of Concepción

The urban area of the Concepción district encompasses 16 neighborhoods and the rural area is made up of 16 companies[117]. It should be noted that in 2014 Law No. 5328 was enacted[118] which modifies Article 3 of Law No. 426 “on the Political Division of the Territory of the Republic”. For the purposes of the Law, the island located in front of the urban center of the municipality of Concepción, better known as Chaco’i, is annexed to the first department of the country.

The community has around 400 families. Among the main means of subsistence, there are trades for daily wages in the city of Concepción (mainly in the areas of masonry and domestic service); About 30 families are “canoeists” and their income depends on the number of trips they make per day; Others are dedicated to the itinerant sale of drinks and food on the beach, considering the influx of people who visit the area for leisure and recreation. Likewise, a sector of the population raises small livestock and produces milk for consumption. In the areas closest to the Nanawa Bridge they have farms for consumption and some work as workers in the ranches in the Chaco.

4.2.5. Mapping, Characterization and Analysis of Micro-territories

4.2.5.1. Identification and presentation of the micro-territories

In this section, as referred to in item 2.3: Description of the areas of influence, information related to the communities identified in an approximate radius of 5 km around the area surveyed for the construction of the mill is presented.

It should be noted that taking into account the access roads located on the Vallemí-Concepción paved road, the peculiarity of the territory and the interconnections through the existing communication routes, it was considered pertinent to make a description of the micro-territories that are in a radius of 13 km around the project's property area, thus widening the 5km cut initially defined.

In this sense, the experience provided by field work during the information gathering period allows for the incorporation of some categories of analysis to refer to aspects in terms of territory. The characteristics indicated here were collected through community interviews and focus groups as part of the information gathering strategy. The data are constructed from the contribution of key actors in the area such as: representatives of neighborhood commissions, productive committees, water, health, education commissions, grassroots referents of the churches, young people and old inhabitants of the area; in order to contribute elements from different representative population groups.

It should be noted that given the lack of systematized information regarding the limits and names of the

117 Local Health Plan, 2014
118 Law Nº 5328. Available at: https://www.bacn.gov.py/leyes-paraguayas/3035/modifica-el-articulo-3-de-la-ley-n-426-del-7-de-diciembre-de-1973-que-establece-la-division-politica-del-territorio-de-la-republica

communities located in rural areas of the Concepción district; the territory was organized from the perspective of local actors.

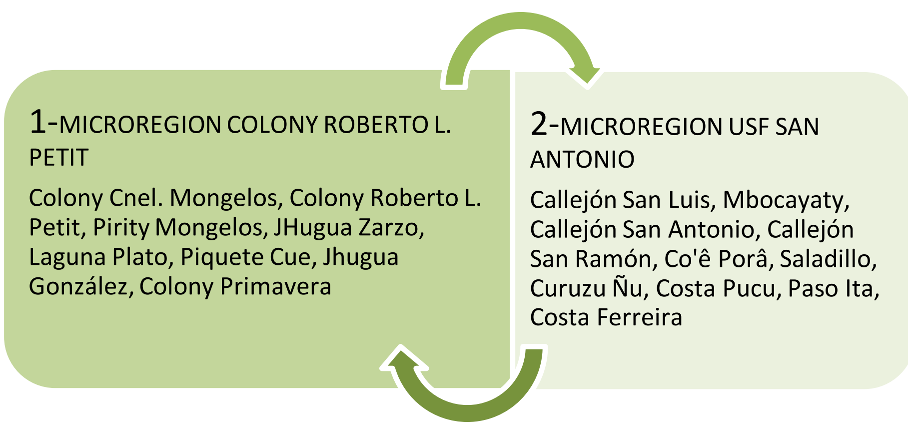
It is pertinent to highlight that the division presented in this section is an approximation based on the stories, the rescued perception and the observation records made; covering aspects related to identity, cohesion, organization, common interests, communication channels, institutions, ways of life and other elements of significance for the inhabitants of the area.

In order to better visualize the relationship system and the degree of existing interdependence, it was appropriate to subdivide the study area into 2 micro-regions; based on the coverage area assigned to the health units and the degree of proximity of the localities.

In this sense, it should be noted that the Family Health Units are formed under the assignment of a territory of responsibility; composed of "social micro-territories" (communities) in order to provide health coverage to a specific population.

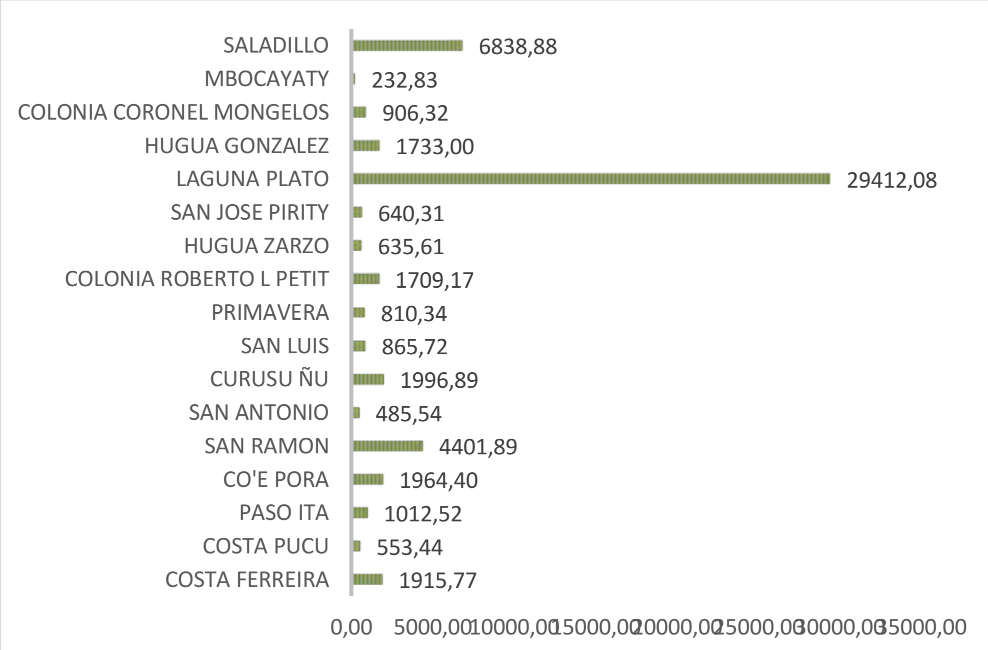
In accordance with what is stated in the previous paragraph, the denomination of micro-territories is acquired in order to name all those communities identified from the existing communication channels. Considering, those that are used to interconnect the communities and, on the other hand, those roads that lead to the prospected property area. Next, the distribution of communities by microregion determined for the purposes of this study is graphed.

Illustration 7. System of relationships and level of Independence



The microregions cover an estimated total of 56,114 hectares. Being the community of Mbocayaty the smallest; and Laguna Plato the largest; according to data from the General Directorate of Surveys, Statistics and Censuses for the year 2012 referred to in graph 8 below.

Graphic 8. Size of the micro-territories of Concepción in hectares



Source: Elaboration based on data of the General Direction of Surveys, Statistics and Census; year 2012.

In addition to the spatial dimensions, in terms of local capacities and available conditions, the following aspects were observed at a social and cultural level:

The presence of public institutions such as educational, health or security institutions are established by areas of intervention. That is, they are used by residents of various micro-territories. In this sense, it is worth highlighting the following:

- The communities of Col. Roberto L. Petit, Callejón San Antonio and Jhugua González are where the units that provide primary health care to a total of 4618 inhabitants are concentrated; Except for the micro-territories of Colonia Primavera and Costa Ferreira that belong to other health agencies.
- Although 83% of the micro-territories have public schools, only schools were registered in the localities of Saladillo, Col. Cnel. Mongelós, Curuzu Ñu and Colony Primavera.
- In terms of security, there is a police station in Colony Roberto L. Petit and a Police Station in Laguna Plato.

Internal roads are networks that link and interconnect micro-territories, enable the exchange of products and access to the communities where health, safety and education service institutions are concentrated. In addition, they constitute routes of connection with the paved routes and the urban centers of the cities.

In this sense, Saladillo and Costa Ferreira are the main communication routes used by the inhabitants of the area.

Organization and Participation are aspects that give cohesion to the territory. It was observed that all the communities have established and recognized neighborhood commissions. In addition, each micro-territory has commissions that are activated according to specific needs by defined area of action (water, health, education, roads and others) in order to improve the quality of life of the inhabitants.

Likewise, there were cases where the productive committees of each community are linked or unionized in Associations, which in turn bring together committees from different localities; evidencing a degree of exchange and participation.

Spaces for expresión and Social Interaction based on recreational activities, sporting events and celebrations of a festive, cultural and/or religious nature organized by micro-territories where residents from neighboring communities also participate.

These elements show that when naming the territory there are aspects, perceptions and behaviors that endow the identified micro-territories as part of a symbolic unit; evidencing the dynamism and integration of the area in multiple dimensions of daily life.

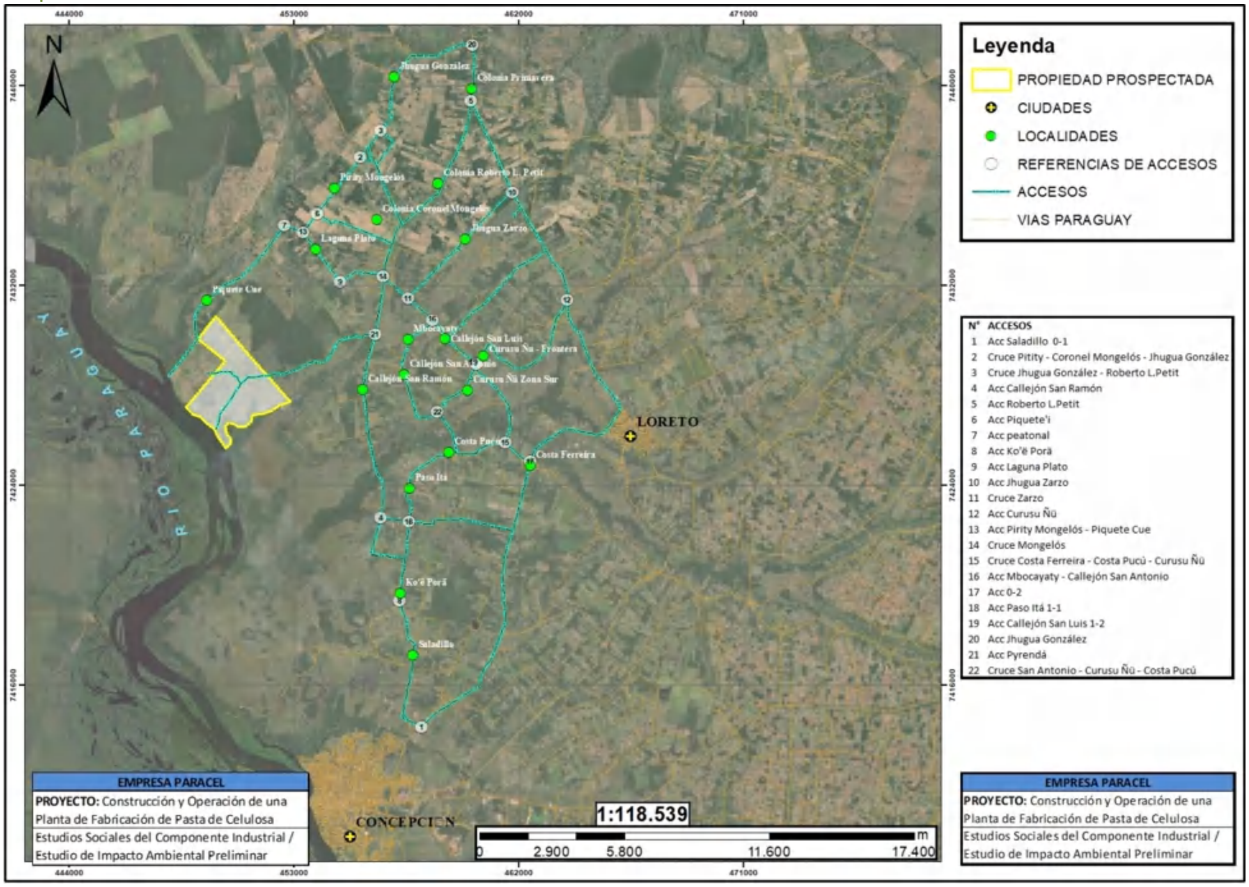
4.2.5.2. Characterization of each identified micro-territory

Map 10 shows the record of 18 micro-territories that are structured in this document according to study areas of influence. In addition, as a strategy for approaching the territory, the roads that interconnect the communities and lead to the prospected property area are referenced.

The micro-territories are described from the observed spatial characteristics, the relationships and interconnections established in the social and geographical sphere and the perception of the key informants; endowing with qualities that confer a collective identity of the population that can be visualized in greater detail in the subsequent paragraphs.

The information presented in this section is based on field records prepared from community interviews with key referents in the area, within the framework of the socioeconomic characterization of the project's AID.
It should be noted that the territory has the peculiarity of being a rural area, and in its entirety depends on the municipality of Concepción.

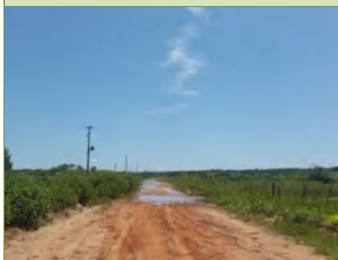
Map 11. Identified micro-territories

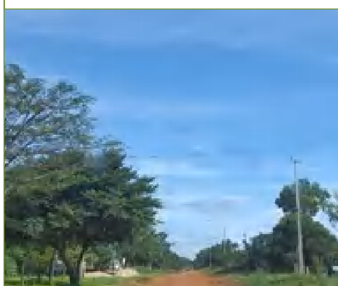
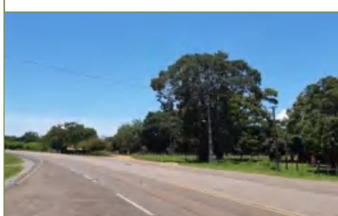


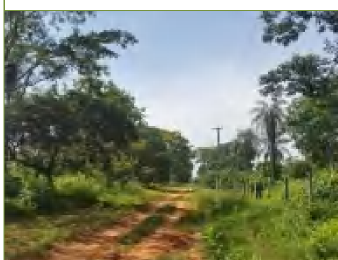
The following chart records information related to the mapped micro-territories; which are expressed below according to the volume of data obtained by community in relation to:

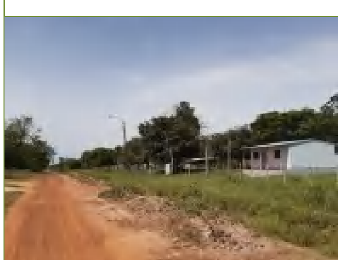
- Year of conformation
- Approximate distance in relation to the mill (distance in a straight line),
- Approximate distance in relation to the departmental capital (distance measured by route),
- Boundary micro-territories,
- Access roads,
- Special features and,
- Main holidays.

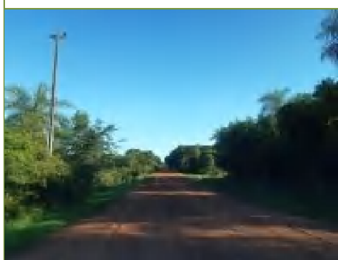
Chart 67. Descriptive summary of identified micro-territories

Micro-territories	Description
 **Colony Roberto L. Petit-** Approximated distance in relation to the mill: **6. 81 km.**	**Approximate distance from Concepción:** it is located about 23 km from the departmental capital. **Bordering micro-territories:** Colony Cnel. Mongelós, Mongelós Pirity, Jhugua González, Jhugua Zarzo. **Most used Access roads to the community:** From Concepción, through Saladillo, through San Ramón and an intersection known by the residents as the Mongelós crossing (Piquete Cue access). From Loreto, through Costa Ferreira, through Curuzu Ñu and Luis Alley. Less frequently used: Paved road Vallemí - Concepción, access Jhugua González. Paved road Vallemí - Concepción, access Jhugua Zarzo. **Particularities:** This micro-territory acts as a focus or center for communities in the area, since it is home to health, safety and education institutions and a horse race where horse races are held. In addition, due to its location it is used as a meeting point for meetings by different community organizations. The USF construction works are expected to be completed in 2021. Temporary attention is provided to the ACPN premises located in the neighboring community of Colonia Cnel. Mongelós. **Main Festivity:** Cristo Rey, is celebrated on the third Sunday of November.
 **Colony Cnel. Mongelos** Approximated distance in relation to the mill: **6.67km.**	**Year of conformation:** It was formed in 1921. **Approximate distance from Concepción:** it is located about 21km from the departmental capital. **Bordering micro-territories:** Colony Roberto L. Petit, Pirity Mongelós, Laguna Plato. **Most used access roads to the community:** The community of Colonia Coronel Mongelós is connected through local roads (all weather), the most used accesses being the same as those indicated in the description of the community of Colonia Roberto L. Petit. **Particularities:** A street divides the towns of Colony Cnel. Mongelós and Colony Roberto L. Petit. The School and College are located 500 meters from Police Station 18 in the neighboring town. At the organizational level, they are adhered in favor of the request for the district of Paso Horqueta; like other residents of neighboring communities. **Main Festivity:** On September 24 the day of the Virgen de las Mercedes is celebrated; Patron Saint of the community.
 **Pirity Mongelós** Approximated distance in relation to the mill**: 4.54 km**	**Approximate distance from Concepción:** It is located approximately 25 km north of the capital of the department. **Bordering micro-territories:** The neighboring communities are Colony Cnel. Mongelós, Colony Roberto L. Petit and Jhugua González. **Most used access roads to the community:** Cruce Mongelós, which connects the San Ramón Alley road with Saladillo (from Concepción), passing through Laguna Plato; and the Intersection between Colony Roberto L. Petit and Jhugua González. **Particularities:** It is called Pirity because in the area there is a pirizal of water. About 45 families live. The community has a school; attended by boys and girls from the area and neighboring communities such as Laguna Plato and Piquete Cue. **Main Festivity:** San José, March 19.

 **Jhugua Zarzo** Approximated distance in relation to the mill**: 7.56km.**	**Approximate distance from Concepción:** it is located 23 km from the departmental capital. **Bordering micro-territories:** Colony Roberto L. Petit, Colony Cnel. Mongelós, San Luis Alley. **Year of conformation:** In 1950 the first six settlers settled in the area; is recognized as a community in 1988. **Most used access roads to the community:** Most used access roads to the community: It can be accessed through the Vallemí-Concepción asphalt road; using the San Ramón Alley local road, connecting with Saladillo from Concepción. Another alternative is to enter through the town of Costa Ferreira, passing through the community of Curuzu Ñu and San Luis Alley, up to the intersection known as Zarzo crossing. **Particularities:** Approximately 25 houses and 50 families are registered. The area has a school up to 6th grade. Most continue their studies at the school of Cnel. Mongelós. **Main Festivity:** Sagrada Familia, is celebrated on the last Sunday in December. There are bullfights, lottery games, Mass, Baptism, First Communion, and parties.
 **Laguna Plato** Approximated distance in relation to the mill**: 3.43km.**	**Approximate distance from Concepción:** It is located 22 km north of the urban area of the city of Concepción. **Year of conformation:** It was formed approximately 100 years ago, as was the neighboring community of Piquete Cue. **Bordering micro-territories:** Piquete Cue, Pirity Mongelós. **Most used access roads to the community:** One of the ways to access the area is through the Mongelós junction that joins the road to the town of San Ramón Alley with Saladillo (from Concepción); or through the intersection of Colony Roberto L. Petit and Jhugua González, passing through Pirity Mongelós. **Particularities:** Through the Pro Health Commission, the creation of a Health Post was requested and construction works are expected to begin in the course of 2020. **Main Festivity:** December 8th, Virgen de Caacupé.
 **Colony Primavera** Approximated distance in relation to the mill**:** **12.46km.**	**Approximate distance from Concepción:** it is located 28km from the departmental capital. **Bordering micro-territories:** Jhugua González, Colony Roberto L. Petit. This micro-territory is located in the district of Concepción, approximately 14 km from the city of Loreto. **Most used access roads to the community:** The community can be accessed by the Vallemí - Concepción route or by entering the side of Police Station 18 in Colony Roberto L. Petit. **Particularities:** In the area there are an average of 80 homes and a total of 250 people. They have educational institutions and receive medical attention in Paso Horqueta. **Main Festivity:** San Miguel, September 29.
	**Approximate distance from Concepción:** it is about 25 km from the departmental capital. **Bordering micro-territories:** Mbocayaty, Curuzu Ñu, Jhugua Zarzo. **Most used access roads to the community:** From Loreto, via the Costa Ferreira access, passing the Costa Pucu and Curuzu Ñu junction. From Concepción, by access to Saladillo, passing through Co'ê Porâ crossing located in San Ramón Alley - Paso Itá, Costa Pucu and Curuzu Ñu. From Concepción, by access to Saladillo, passing through Co'ê Porâ, San Ramón, the intersection known as the Mongelós crossing (access to Piquete Cue), Colon Roberto L. Petit and the Jhugua Zarzo crossing. **Particularities:** There are approximately 60 homes in the area. It has the peculiarity

San Luis Alley Approximated distance in relation to the mill**: 6.65km.**	of periodically bringing together residents of Tres Cerros, San Alfredo, Paso Barreto, Loreto, Mbocayaty, Jhugua Po'i, Concepción, Piquete Cue, San Ramón Alley, San Antonio Alley, San Luis Alley, Laguna Plato, Potrerito and others; due to the fact they have a Lazo club where they meet with groups of Laceros. Work is currently underway for the construction of a concrete bridge that will facilitate the connection with the Vallemi-Concepción road. This road is mostly used by residents of the communities of San Luis Alley, Jhugua Zarzo, Colony Roberto L. Petit, Colony Coronel Mongelós, Pirity Mongelós and Jhugua González. **Main Festivity:** On June 21 is celebrated the day of San Luis González
 **Jhugua González** Approximated distance in relation to the mill**: 9.61km.**	**Approximate distance from Concepción:** it is located 28 km from the departmental city. **Bordering micro-territories:** The neighboring communities are Colony Roberto L. Petit, Pirity Mongelós and Colony Primavera **Most used means of communication**: The main access to the community is the asphalt road Vallemí - Concepción. You can also use the neighborhood road of Colony Roberto L. Petit and Colony Coronel Mongelós, which connects with Saladillo from Concepción. **Particularities:** It is located approximately 5 km from the Vallemí-Concepción asphalt road. The area has a health post that offers health coverage to 134 local families. **Main Festivity:** On November 15, the day of San Roque González de Santa Cruz is commemorated.
 **Mbocayaty** Approximated distance in relation to the mill**: 6.10km.**	**Approximate distance from Concepción:** it is located approximately 19 km from the city of Concepción. **Bordering micro-territories:** San Antonio Alley, San Luis Alley, San Ramón Alley. **Year of conformation:** The first inhabitants populated the place more than 50 years ago. **Bordering micro-territories:** San Antonio Alley and San Luis Alley, Curuzu Ñu. **Most used means of communication**: From Costa Ferreira, passing through Curuzu Ñü, on the way to San Luis Alley. On San Ramón Alley road that connects with the Saladillo access, from Concepción. **Particularities:** It is located in the center of the neighboring communities of San Antonio Alley and San Luis Alley. Formerly there was a room belonging to Florinda Peña that bore the name of Mbocayaty and served as a reference to get to the place. With the passage of time, it became part of the identity of the area, acquiring this name officially. At present, a total of 20 houses and 21 families are registered. In addition, there is a communal field with 68 ha of extension that are used for raising cattle; and a total of 44 associates.
 **San Antonio Alley** Approximated distance in relation to the mill**: 4.76km.**	**Approximate distance from Concepción:** it is located 15 km from the city of Concepción. **Bordering micro-territories:** Mbocayaty, Curuzu Ñu, San Ramón Alley, Costa Pucu. **Year of conformation:** approximately 51 years ago. **Most used means of communication**: To enter the community from Loreto, through the Costa Ferreira access, passing the Costa Pucú and Curuzu Ñu junction. From Concepción, by access to Saladillo, passing through Co'ê Porâ, crossing San Ramón - Paso Itá, Costa Pucú and Curuzu Ñu. From Concepción, by access to Saladillo, passing through Co'ê Porâ, San Ramón Alley, crossing Mongelós, Colony Roberto L. Petit, crossing Jhugua Zarzo and San Luis Alley. **Particularities:** In the community there are a total of 52 families and 242 people. The micro-territory is made up of an estimated total of 245 people. It receives the name of San Antonio Alley in honor of San Antonio de Padua. It has a USF that provides care

	to a total of 9 communities. They have a Health sub-council made up of 3 representatives from each micro-territory. **Main Festivity:** On June 13 is celebrated on the day of San Antonio of Padua. The activities for that day consist of: procession, mass, sports activities, artistic festival and a dance party.
 **Paso Ita** Approximated distance in relation to the mill**: 6km.**	**Approximate distance from Concepción**: about 10 km from the city of Concepción. **Bordering micro-territories**: Costa Pucu, Co'ê Porâ, Costa Ferreira, Curuzu Ñu **Most used means of communication**: From Concepción, entering through the community of Saladillo, passing through Ko'ê Porâ and the detour that interconnects with the community of San Ramón Alley. -From Loreto, via the Costa Ferreira access, passing the Curuzu Ñü junction and the Costa Pucu community. **Particularities**: It is located in the center of the towns of Co'ê Porâ and Costa Pucu; and 5km from USF of San Antonio Alley. There are approximately 60 families in the area. **Main Festivity**: Virgen de los Dolores, September 15
 **Costa Pucu** Approximated distance in relation to the mill**: 6.67 km.**	**Approximate distance from Concepción:** It is located about 13 km from the city of Concepción. **Bordering micro-territories:** the closest communities are Paso Itá, San Antonio Alley, Curuzu Ñu and Costa Ferreira. **Particularities:** There are around 56 homes and an average of 200 people in the area. Most used means of communication: they are the same as those mentioned in the description of Paso Ita. **Main Festivity:** Its inhabitants meet every May 6 to commemorate the day of the Patron Santo Domingo Sabio.
 **Costa Ferreira** Approximated distance in relation to the mill**: 9.86km.**	**Approximate distance from Concepción:** It depends institutionally on the municipality of Concepción and is located about 12 km from the capital of the department. **Bordering micro-territories:** Curuzu Ñu, Costa Pucu. **Most used means of communication:** The community of Costa Ferreira is located on a paved road that connects Concepción with Vallemí. Access 0.2 is located in the community of Costa Ferreira. **Particularities:** Formerly known as Ferreira Cue. The first settlers settled in the area more than 100 years ago. It is an area that has spas including one of the most recognized, the Paso Itá Spa, with a presence in the area for more than 20 years. **Main Festivity:** Santa Teresita, is celebrated on October 1, there is a novena and a festival to celebrate
 **Curuzu Ñu** Approximated distance in relation to the mill**: 7.78km.**	**Approximate distance from Concepción:** It is located about 15 km from the city of Concepción. **Bordering micro-territories:** Bordering the micro-territories of Costa Pucu, San Antonio Alley, Mbocayaty and San Luis Alley. **Most used means of communication:** From Loreto, via the Costa Ferreira access, passing the Costa Pucu junction. From Concepción, entering through the community of Saladillo, passing through Co'ê Porâ, Paso Itá and Costa Pucu. **Particularities**: It is divided into a South and North zone; the second better known as the Curuzu Ñu border. Both make up a single water commission and there is a system that supplies both areas In the South Zone there is a communal field that has 660 hectares destined to livestock

	and agriculture. **Main Festivity:** San Pedro and San Pablo, June 29
 **San Ramón Alley** Approximated distance in relation to the mill**: 2.99km.**	**Approximate distance from Concepción:** The micro-territory is about 13 km from the capital of the department. **Bordering micro-territories:** It borders the communities of Co'ê Porâ, Paso Ita and San Antonio Alley. **Most used means of communication:** From Concepción through the community of Saladillo passing through Co'ê Porâ; from Loreto through the Community of Costa Ferreira, passing through Curuzu Ñu, San Luis Alley, Junction Jhugua Zarzo and the intersection known as Junction Mongelós; or through Costa Ferreira, passing through Costa Pucu, Paso Ita and crossing San Ramón. **Particularities:** There are approximately 40 homes in the area. The school in the area has a level of schooling up to the second cycle of elementary school. **Main Festivity:** On August 31, the Patronal Festival is celebrated in honor of San Ramón.
 **Co'ê Porâ** Approximated distance in relation to the mill**: 7.16km.**	**Approximate distance from Concepción**: The community is located about 6 km from the city of Concepción. **Bordering micro-territories:** It borders the micro-territories of Saladillo, San Ramón Alley and Paso Ita. **Most used means of communication:** This micro-territory is connected through local roads (of all time), being the most frequent From Concepción, through Saladillo. From Loreto, through Costa Ferreira, through Costa Pucu and Paso Ita. **Particularities:** There are approximately 150 families in the area. **Main Festivity:** Sagrado Corazón de Jesus; it is celebrated on the third Sunday of June
 **Saladillo** Approximated distance in relation to the mill: **10.93km**	**Approximate distance from Concepción:** it is located about 2 km from the departmental capital. **Bordering micro-territories:** Co'ê Porâ **Most used means of communication:** You can enter the community through two main routes: From Concepción by the Concepción-Vallemí paved road. From Loreto, using the access to Costa Ferreira, passing through Costa Pucu, Paso Ita and Co'ê Porâ. **Particularities:** It is called Saladillo for the type of terrain; that has characteristics similar to the Paraguayan Chaco. It is one of the main roads used by residents of the area because it is less than 1km from the road that connects Vallemí with Concepción. In the area there are approximately 90 homes with an average of 400 people in total. The community has a school, a college belonging to the Congregation of the Sisters. Azules, a Recreation Center with swimming pools and a field used for women's and men's soccer tournaments. People of all ages and from various communities participate in this activity to encourage their teams or share with friends and neighbors. **Main Festivity:** San José, March 19

Source: Elaboration based on data obtained from interviews to key actors of the micro-territories.

Registry of institutions and reference sites identified

This section allows you to graphically view the institutions and sites of interest identified by each micro-territory. In the study area, educational institutions, spas, water systems, cemeteries, police stations, churches and some open spaces such as squares and sports sites were observed.

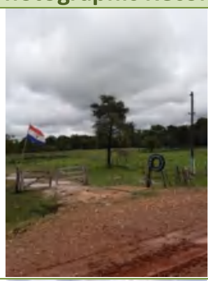
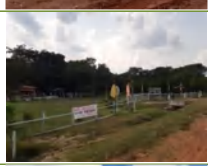
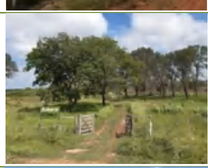
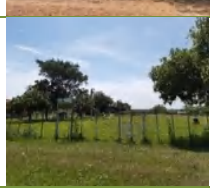
The spas are places frequented by residents of the area and other cities as a space for recreation and leisure; some charge a minimum entrance fee so that visitors can use the facilities of the place.

In the Saladillo area, the 20 de Octubre field is used for women's and men's soccer tournaments. It is frequented by neighbors and residents of the surrounding areas.

There are hardly any squares in the area; A record was only obtained from Plaza San Pedro, located in the Curuzu Ñu area. It is used by residents of the place mainly.

Below is a photographic record of the identified sites.

Chart 68. Registry of recreational places

Photographic Record	Recreational Place	Micro-territory
	Sin Colales Watering Place	San Ramón Alley
	Vy'a Renda Watering Place	San Ramón Alley
	La Familia Watering Place	Costa Pucu
	Ita Watering Place	Costa Ferreira
	San José Recreational Center	Saladillo
	20 de Octubre Field	Saladillo
	San Pedro Square	Curuzu Ñu

In the area, some cemeteries were observed that, although they are located in a defined micro-territory, are generally spaces shared between the communities. Cemeteries were registered in the micro-territories of Co'ê Porâ, San Ramón Alley, San Antonio Alley and Jhugua González. Reference photographs are incorporated below.

Illustration 8. Reference pictures

Cemetery Curuzu Ñu

Cemetery Co'ê Porâ

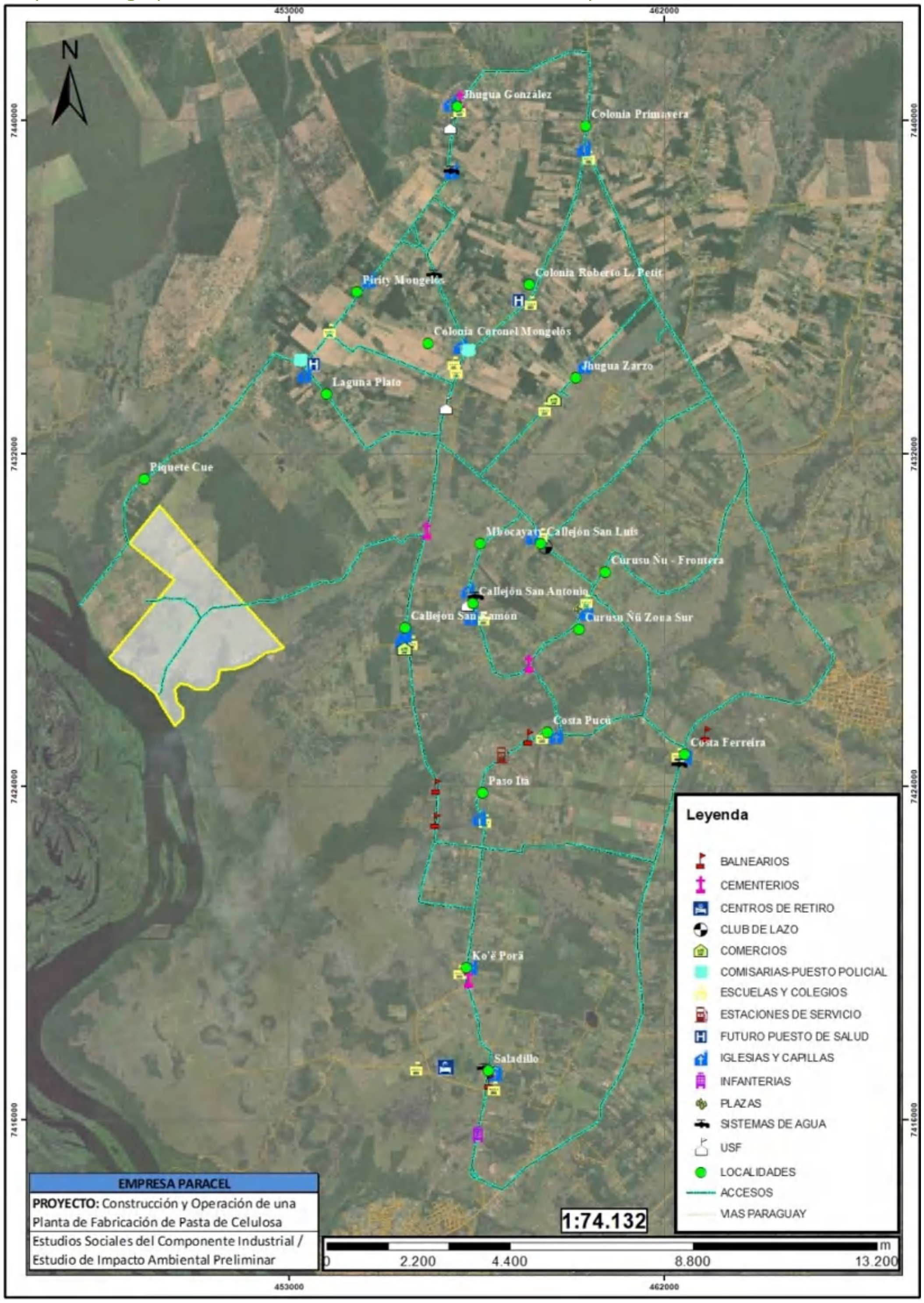
Police Station -Colony Roberto L. Petit

Police Post Laguna Plato

In terms of security, there is a police post in Laguna Plato and a police station located in Colony Roberto L. Petit with an intervention area for the communities of: Colonia Cnel. Mongelós, Pirity Mongelós, Jhugua González, Laguna Plato, Picket cue, Mbocayaty, San Ramón Alley, San Luis Alley, San Antonio Alley, Jhugua Zarzo, Col. Primavera.

Below, you can see the geographical location of places of interest such as recreational spaces, water systems, educational and health units, churches and cemetery.

Map 12. Geographical localization of interest institutions and places



4.2.5.3. Presentation of results generated from the field survey process

Population Density

According to projection data corresponding to the 2020 period, the population of the Concepción district amounts to 87,215 inhabitants.

Starting from the information obtained during the field work, it is evident that in the micro-territories there are a total of 4866 inhabitants; corresponding to 5.58% of the estimated population in the projected evolution line.

Chart 69. Total population in micro-territories of the identified district of Concepción

Microregion	Micro-territories	Number of Women	Number of Men	General Total
1	Colony Roberto L. Petit, Colony Cnel. Mongelós, Pirity Mongelós, Jhugua Zarzo, Laguna Plato, Piquete Cue,	734	900	1634[119]
	Jhugua González,	244	288	532[120]
	Colony Primavera	-	-	250[121]
2	San Luis Alley, Mbocayaty, San Ramón Alley, San Antonio Alley, Curuzu Ñu, Costa Pucu, Paso Ita, Co'ê Porâ and Saladillo			2450[122]
	Costa Ferreira	-	-	120
Obs. Data disaggregated by gender were obtained for 8 communities. Two of the 3 health units provided official data in greater detail. The chart that presents general data is based on the perception of key interviewees.				**4866**

Source: Elaboration based on data obtained from key actors of the micro-territories.

Homes and Dwellings

According to data provided by the key referents of the health micro-regions and inhabitants of the micro-territories, there are a total of 661 dwellings in micro-region 1 that includes the micro-territories of Colonia Roberto L. Petit, Colonia Cnel. Mongelós, Pirity Mongelós, Jhugua Zarzo, Laguna Plato, Piquete Cue, Jhugua González and Colonia Primavera.

In the micro-territories that are part of micro-region 1, no official data were obtained during the interview with a health reference in the area in greater detail by micro-territories. Therefore, approximate data are presented based on the data provided by some residents. The total being 356 dwellings without data from the micro-territories of Callejón San Antonio, Curuzu Ñu, Co'ê Porâ.

119 Interview referring to the Colony Roberto L. Petit Health Unit. Date 17.01.2020
120 Interview referring to the Jhugua Gonzalez Health Post. Date 20.01.2020
121 Interview referring to the Colony Primavera Neighborhood Commission. Date: 20.01.2020
122 Interview referring to the Callejón San Antonio Health Unit. Date 21.01.2020

Chart 70. Number of houses in the microregion 2

MICRO-TERRITORIES	NUMBER OF HOUSES
SAN LUIS ALLEY	60
MBOCAYATY	20
SAN RAMÓN ALLEY	40
SAN ANTONIO ALLEY	-
CURUZU ÑU	-
COSTA PUCU	56
PASO ITA	60
CO'Ê PORÂ	-
SALADILLO	90
COSTA FERREIRA.	30
TOTAL	**356**

Source: Elaboration based on data obtained from key actors of the micro-territories

Services

Water Systems

The majority of those interviewed in the AID mentioned that all the micro-territories have a water system coming from the local sanitation board, as already mentioned in the characterization of the project's IIA. Communities are often left without supplies due to permanent power outages in the area; since without it the engine cannot be started. To alleviate or prevent these shortcomings, cases were observed such as those of the USF of San Antonio Alley, which has its own water reservoir (tank) that is used when there is a shortage; but it is supplied from the same source of water from the community. There are only 2 villagers who have a well[123]. Others, such as the communities of San Luis, must move to neighboring communities; or have water tanks; but it is not applicable to all cases.

Waste Treatment

Regarding the final disposal of waste, it is mentioned in the description of the department of Concepción that the majority of the population resorts to burning because they do not have a waste collection service[124].

It was observed that this statement is applicable to the micro-territories of the project's AID. In the following chart it can be seen that 59% refer that the final treatment consists of burning, 38% buries and on a smaller scale corresponding to 3% mention that they deposit their waste in the farm (this system applies to organic waste).

Chart 71. Solid waste treatment

Micro-territories	Burning	Bury	Throw it in the farm
San Ramón Alley	3	1	-
San Luis Alley	2	1	-
San Antonio Alley	1	1	-
Colony Primavera	-	1	1
Costa Pucu	3	1	-
Jhugua González	1	1	-
Jhugua Zarzo	2	2	-

123 Interview to health referent. Date 01.21.2020
124 See page 17.

Co'ê Porâ	4	1	-
Curuzu Ñu	3	1	1
Laguna Plato	4	4	-
Mbocayaty	2	1	-
Pitity Mongelós	1	-	-
Colonia Cnel. Mongelós	-	1	-
Paso Ita	1	-	-
Colonia Roberto L. Petit	6	4	-
Saladillo	4	3	-
Costa Ferreira	1	1	-
Total	**38**	**24**	**2**

Source: Elaboration based on data obtained from key actors of the micro-territories.

Thus, vacant lots near the urban radius of the city were also identified that are used as landfills in the absence of collection service in the area.

Illustration 9. Picture took in the micro-territory: Saladillo regarding waste disposal


Sanitary and/or storm sewer

There is no sanitary and / or storm sewer system for the elimination of sewage or residual waste; and a high percentage of households have latrines. This can be compared with the characterization of the AII for the Department of Concepción and the results of the processing of interviews by micro-territory in the AID. In this sense, it can be observed that 43% refer to the use of latrines, 43% manhole and 14% have a manhole and/or septic chamber for the disposal of sewage waste in homes.

Chart 72. Sanitary and/or storm sewe

Micro-territories	Septic Tank	Septic Chamber	Latrine
San Ramón Alley	3	1	2
San Luis Alley	2	-	2
San Antonio Alley	1	-	1
Colony Primavera	1	-	
Costa Pucu	2	1	2
Jhugua González	1	-	1
Jhugua Zarzo	2	1	1

Co'ê Porâ	5	2	3
Curuzu Ñu	3	1	3
Laguna Plato	2	1	5
Mbocayaty	1	-	2
Pirity Mongelós		-	1
Colony Cnel. Mongelós	1	-	1
Paso Itá	1	-	1
Colony Roberto L. Petit	4	3	5
Saladillo	4	-	4
Total	34	11	34

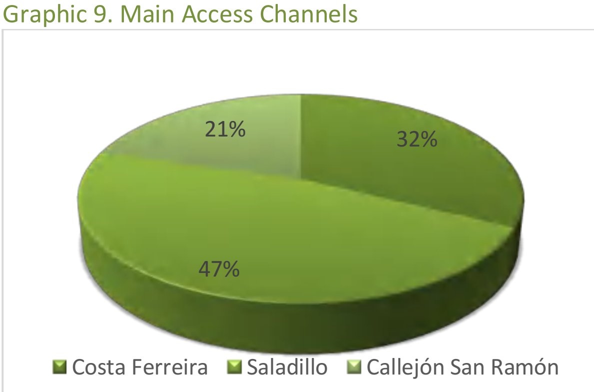
Source: Elaboration based on data obtained from key actors of the micro-territories.

Communication Channels

Considering the survey carried out, the most used roads indicated by the inhabitants are: Saladillo, Costa Ferreira and San Ramón.

In the territory, you can travel on local roads with gravel paving in the areas of Saladillo, San Ramón Alley, Paso Ita, Costa Pucu, Curuzu Ñu. Others, such as the case of the communities of Colony Roberto L. Petit, Colony Cnel. Mongelós, Mongelós Pirity, Laguna Plato, Mbocayaty, San Antonio Alley and Jhugua González have dirt roads. As the interviewees refer; many of these roads are in poor condition. This leads to communities being isolated on many occasions; specifically, in times of rain; since the access roads become impassable.

Graphic 9. Main Access Channels



Source: Elaboration based on data obtained from key actors of the micro-territories

Illustration 10. Pictures of micro-territories in rainy seasons


Micro-territory: San Ramón Alley


Micro-territory: Roberto L. Petit


Crosiing Costa Pucu-Curuzu Ñu-Costa Ferreira

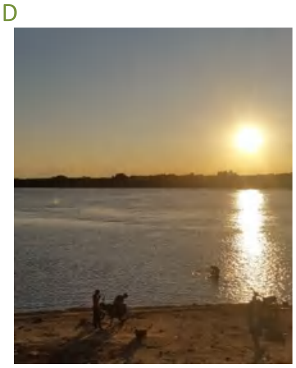

Micro-territory: San Luis Alley, detour Mbocayaty

Transport

All of the interviewees state that the area has not had public transport for approximately 15 years. This is due to the massive increase in the use of motorcycles to travel, which shows that it is the main means of transport used. Below is a reference photographic record at the district and micro-territory level of the AID.

Illustration 11. Pictures of the area of the AID


Micro-territory: Crossing San Ramón-Paso Ita


District: Concepción


District: Horqueta


Districto: Belén


Micro-territory: Saladillo

Use of Technologies

Regarding the use of technologies, 53% stated that they have a cellular device, of which 47% have access to an internet connection; being the most used social networks WhatsApp and Facebook.

One of the problems identified by the residents is the lack of signal in the area, which makes communication difficult. At the same time, they pointed out that the installation of a network system is necessary to improve the service. Next, chart 73 is recorded by micro-territory.

Chart 73. Use of technologies

Micro-territories	Telephone	Internet	WhatsApp	Facebook
San Ramón Alley	3	3	2	-
San Luis Alley	2	1	2	1
San Antonio Alley	1	1	1	1
Colony Primavera	1	-	-	-
Costa Pucu	3	3	2	1
Jhugua González	1	1	1	1
Jhugua Zarzo	1	1	1	1
Co'ê Porâ	5	5	4	4
Curuzu Ñu	3	2	2	2
Laguna Plato	4	3	5	4
Mbocayaty	2	1	2	2
Pirity Mongelós	1	1	1	1
Colony Cnel. Mongelós	1	1	1	1
Paso Ita	1	1	1	1
Colony Roberto L. Petit	5	5	3	2
Saladillo	4	4	4	4
Costa Ferreira	1	1	1	1
Total	**39**	**34**	**33**	**26**

Source: Elaboration based on data obtained from key actors of the micro-territories.

Health Services

In the study area there are 3 health units that provide primary health care. Covering a total of 4516 inhabitants distributed in 16 micro-territories.

The following chart shows some of the main characteristics observed.

Chart 74. Health Units

Category	Localization	Micro territories	Population	Characteristics
USF	Colony Roberto L. Petit	Colony Roberto L. Petit, Colony Cnel. Mongelós, Jhugua Zarzo, Laguna Plato, Pirity, Piquete Cue, and neighboring ranches.	Total in the area: 1634 Women: 734 Males: 900 Children from 0 to 27 days: men 2 Children from 28 days to 11 months: women 9, men 12 Children from 1 to 4 years old: women 65, men 61 Children from 5 to 14 years old: women 147, men 186 Women 15-49 years: 340 Women 50 to 64 years: 100 Men aged 15 to 64: 539 Men and women aged 65 and over: women 73, men 100	The USF has 5 community agents; 1 nursing assistant, 1 Degree in Nursing and 1 Doctor in Family Medicine. They are providing care at the ACPN headquarters while the construction of the new premises is completed
USF	San Antonio Alley	San Luis Alley Mbocayaty San Ramón Alley San Antonio Alley Curuzu Ñü Costa Pucú Paso Itá Co'ê Porâ Saladillo	2450 people total	20 years ago it functioned as a health post. For 10 years it has been classified as a Family Health Unit. This year the health council made up of sub-councils in each community is renewed. Each Health Sub-council has 2 to 3 members per community for representation. The USF has had 3 health agents for 4 months. In addition, there is 1 doctor for general medical care, 1 Nursing graduate, 1 nursing assistant, 1 doctor for dental care
Health Post	Jhugua González	Jhugua González	Total in the area: 532 Women: 244 Males: 288 Children from 0 to 27 days: men 1 Children from 28 days to 11 months: women 2, men 2 Children from 1 to 4 years old: women 23, men 14 Children from 5 to 14 years old: women 54, men 51 Women 15 to 49 years: 129	The health post has a Licentiate in Nursing, a Community Health Agent and a Doctor (general services). The hours of operation are from 8:00 a.m. to 7:00 p.m. and the days for home visits are Tuesdays and Thursdays.

Category	Localization	Micro territories	Population	Characteristics
			Women 50 to 64 years: 26 Women 65 years and over: 22 Men ages 15-49: 161 Men ages 50 to 64: 26 Men 65 years and over: 21	They are currently fighting to install a Family Health Unit

Source: Elaboration based on data obtained from key actors of the micro-territories.

Educational Institutions

A total of 15 educational establishments were registered, all corresponding to the basic school.

There is a total of 4 intermediate level educational institutions located in the micro-territories of Colony Primavera, Colony Cnel. Mongelós, Saladillo and Curuzu Ñu.

The towns of Mbocayaty and Laguna Plato do not have educational establishments; Those who, due to a question of proximity, go to the educational center closest to the community.

According to the Municipal Development Plan of Concepción (2016), referenced in previous paragraphs[125] there are 50 institutions located in the rural area. In this sense, the institutions registered in the micro-territories represent 30% of the existing rural educational offer in the district.

The following chart shows a list that contains the educational institutions corresponding to levels of Basic School Education and Secondary Education.

Chart 75. Educational Institutions

Photographic record	Micro-territories	Educational Institutions
	San Ramón Alley	Basic School Nº 4918 "San Ramón"
	San Luis Alley	Basic School Nº 4917 "Florinda Arce de Páez"

125 Summary of the District of Concepción, see page 89.

Photographic record	Micro-territories	Educational Institutions
	San Antonio Alley	Basic School Nº 2583 “San Antonio de Padua”
	Costa Pucu	Basic School Nº 1729 “Santo Domingo Sabio”
	Jhugua González	Basic School Nº 4922, San Roque González de Santacruz
	Jhugua Zarzo	Basic School “Don Juan Antonio Zaracho”
	Co’ê Porâ	Basic School Nº 841 “Sagrado Corazón de Jesús”

Photographic record	Micro-territories	Educational Institutions
 	Curuzu Ñu	Basic School Nº 1722 “San Pedro” National College of Secondary Education “San Pedro”
	Pitity Mongelós	Basic School Nº 2582 “Defensores del Chaco”
	Colony Cnel. Mongelós	Basic School Nº 2080 “Concepción Macedo de Denis” National School Coronel Mongelós,
	Paso Ita	Basic School “Virgen de los Dolores”
	Colony Roberto L. Petit	Basic School Nº 2670 “Cristo Rey”.

Photographic record	Micro-territories	Educational Institutions
	Saladillo	School Inmaculada Concepción “Irene Carduz” (Training Center)
	Saladillo	Basic School Nº 4909 “Don Trifón Echague”
	Costa Ferreira	Basic School Nº 1729 “Santo Domingo Sabio”
	Colony Primavera	Basic School No. 1721- Jesús Misericordioso National School Jesús Misericordioso

Source: Elaboration based on data obtained from key actors of the micro-territories.

Poverty

From the data referred to the department of Concepción in terms of poverty, it can be observed that approximately 107,097 people are in poverty and 15,911 in extreme poverty. Although the trend is towards the concentration of poverty in urban areas, the outlook for the rural sector is still a relevant indicator in quantitative and qualitative terms[126].

In this sense, the actors consulted in the micro-territories pointed out aspects related to social and economic problems. The following chart shows data provided by key referents of the micro-territories studied. It presents the five main social problems indicated on a rating scale from 5 to 1; in order from highest to lowest prioritization.

126 See item about Poverty, Distribution, Unsatisfied Basic Needs Page 21

Chart 76. Prioritization of social problems in the micro-territories of the Concepción's district

(purple)	Referenced in at least 3 levels of prioritization
(orange)	Referenced in at least 4 levels of prioritization
(yellow)	Referenced in at least 5 levels of prioritization

Problems regarding social and cultural aspects	Priority 5	Priority 4	Priority 3	Priority 2	Priority 1	Total Mentioned Amount
Cattle	9	4	1	1	0	15
Access to education	2	-	1	3	1	7
Road insecurity	3	4	3	2	0	12
Uprooting	3	3	2	3	1	12
Emigration	2	3	-	1	1	7
Migration	5	5	4	3	4	21
Poverty	4	1	3	1	1	10
Insecurity/Theft	6	6	-	-	1	13

Source: Elaboration based on data obtained from key actors of the micro-territories

Considering the established system, it is visualized that the main factors in order of priority are: cattle ranching (priority 5), insecurity/theft (priority 4), migration (priority 3), access to education, migration and uprooting (priority 2) and migration (priority 1).

According to the assessment scale, it is observed that migration was mentioned as the main problem in priority 3, 2, and 1; and it was also referenced in priority 4 and 5.

Given this particularity, it is interesting to visualize the degree of significance and importance that a factor acquires considering, in addition to the frequency of appearance, the fact of being identified in the different levels of prioritization. For a better visualization, the data is arranged in the following chart.

Social Problems	Number of Levels	Total Amount
Uprooting	5 levels	12
Migration	5 levels	21
Poverty	5 levels	10
Cattle	4 levels	15
Access to Education	4 levels	7
Road Insecurity	4 levels	12
Emigration	4 levels	7
Insecurity/theft	3 levels	13

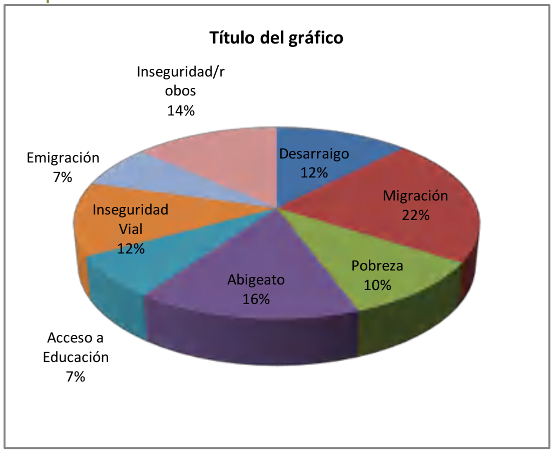
Source: Elaboration based on data obtained from key actors of the micro-territories

Considering the established prioritization system, it is observed that the factors referenced in all instances are: migration, uprooting and poverty.

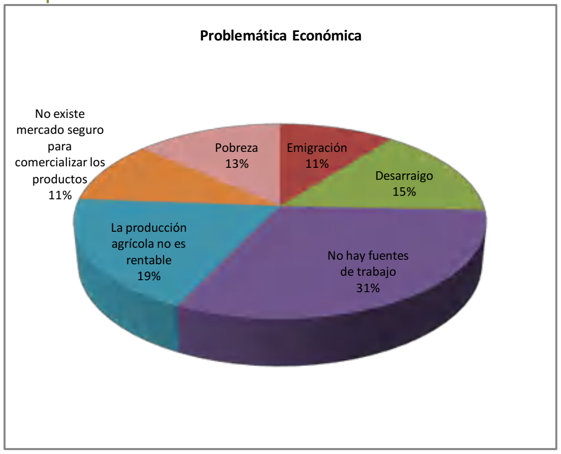
Rustling, road insecurity, access to education and emigration are mentioned in 4 of the three levels; and insecurity/theft is highlighted in 3 levels of prioritization.

In relation to social problems; In terms of quantification, they represent the following in order of importance: migration 22%, rustling 16%, insecurity/theft 14%, uprooting and road insecurity 12%, poverty 10%, access to education and emigration 7 %.

Graphic 10. Social Problems



Graphic 11. Economical Problems



Source: Elaboration based on data obtained from key actors of the micro-territories

However, as economic problems, the lack of sources of work (31%) is mentioned in the first place, followed by the lack of profitability of agricultural production (19%), uprooting (15%), poverty (13%) and in fifth place the lack of a secure market to market the products and emigration (11%).

In both cases the form of assessment varies, but factors such as poverty, emigration and uprooting are referenced both in the case of social and economic problems. These factors refer to socio-historical aspects; therefore, they cannot be considered in isolation but as phenomena with a greater or lesser degree of interdependence depending on the level of observation that is established.

Economic Activities and Income

The average income in the department of Concepción is almost 40% lower than in Amambay and 7.45% higher than in San Pedro, as referenced in the characterization item of the IIA [127].

Chart 77. Main economic activities

Economic Activities	Agriculture	Cattle Raising	Commerce	Day Laborer/Changa
San Ramón Alley	3	1	2	1
San Luis Alley	2	2	1	2
San Antonio Alley	1	1		1
Colony Primavera	1		1	1
Costa Pucu	3	3	3	2
Jhugua González	1	1	1	1
Jhugua Zarzo	2	1	1	2
Co'ê Porâ	4	3	1	3
Kurusu Ñu	3	2	1	

127 See item about Poverty, Distribution, Unsatisfied Basic Needs Page 19

Laguna Plato	3	5	2	4
Mbocayaty	2	2		
Pirity Mongelós	1	1		
Mongelós	1		0	1
Paso Ita	1	1		
Colonia Roberto L. Petit	7	7	4	3
Saladillo	3	3	3	2
Costa Pucu				
Costa Ferreira	1	1		1
Total	38	34	20	24

Source: Elaboration based on data obtained from key actors of the micro-territories.

The economic activities identified in the area in order of importance are: agriculture, livestock, work as a laborer/changa, and commerce.

A small number of the population has access to a permanent job. Most of the settlers, men and women, are dedicated to agriculture and livestock.

In the territory there is a predominance of small-scale production destined to a greater extent for family consumption and to a lesser extent for sale. Establishments operating at a large-scale production level were also identified.

People who are dedicated to the commercialization of products from the farm and garden report that, at present, the agricultural item is not profitable compared to previous years, where crops such as sesame and spurge were sold at a better price. Price and loss of production due to inclement weather and pests did not represent difficult risks to control.

Likewise, it was mentioned that the low profitability is associated with the absence of a safe market for commercialization, the high costs of transferring production and the lack of sustained technical assistance from local government actors. Therefore, they point out the need for greater accompaniment by local authorities in terms of training and delivery of materials and supplies to work the land; in order to make the peasant family economy sustainable.

Considering the particularities observed in the field of agriculture and livestock. It should be noted that the community of Curuzu Ñu has a communal field; which are community lands that operate under a solidarity contribution system that is intended to improve the infrastructure of the place. There are currently 60 associates. The land was parceled out in 1988, it has 60 hectares in total; where each partner has his lot wired. A fraction of the land is destined to livestock and another to agriculture (farm and garden).

This same system of community organization was observed in Mbocayaty. The land is used for livestock; therefore, the members use the lands for cattle breeding and pasture.

At present there are a total of 14 active members and 30 adherents. Active members must make a monthly contribution for maintenance and at the same time contribute to the cleaning of the land; the others are not obliged to contribute the stipulated amount.

On the other hand, 21% refer that a large fraction of the population engages in trades or wage work or piecework consisting of remuneration for activity or service rendered that is generally linked to an occupation system based on the economy informal. The average daily income is between 65,000 and 75,000 guaraníes. In many cases they face precarious working conditions that are accepted so as not to stop generating income. Among these, it is mentioned that they work more than eight hours, they must carry out other work in addition to what was agreed, they do not charge the entire amount established; among others for what they are part of a doubly vulnerable sector.

Under this logic the works in the neighboring and/or Chaco ranches are grouped. Which consist of the development of tasks for a defined period of time of one day or even months; which does not necessarily translate into a permanent change of residence. Among the activities they carry out are: wiring, painting, cleaning the grounds, caring for animals, carp, planting, among others. This item is characterized by being an activity predominantly of adult and young men.

Although the men are employed in the ranches, the women are the ones who are left to take care of the home and are in charge of raising the children. In addition, they are those that are dedicated to raising small livestock, selling the production of their orchards and farms and others that are usually offered in the fairs organized in squares or the market of the urban area of Concepción or they are sold home for house to neighbors in the area.

Other items that are grouped under this category are: collectors, those who are dedicated to the sale of coal, trocillo (wood for firewood) and macatería.

Illustration 12. Main economic activities

Illustration 13. Picture: cattle raising

17% mentioned commerce as the main activity in the area; this being the fourth most notable aspect. In the micro-territories it is possible to observe the existence of small commercial and service enterprises such as: pantries, butchers, fuel supply center, motorcycle workshop, rubber shops, hairdressers. In the framework of the characterization of the AID, some reference photographs are exposed.

Illustration 14. Pictures of the Curuzu Ñu micro-territory


Illustration 15. Pictures of the Colony Coronel Mongelós micro-territory


Illustration 16. Picture of the Co’ê Porâ micro-territory

Illustration 17. Pictures of the Pirity Mongelós micro-territory

Most of these businesses are family-owned; in which household members (boys, girls, adolescents and adults), both women and men have some degree of participation in the development of specific tasks such as: customer service, purchase of supplies and merchandise to restock the premises, collection and cleaning of the place, among others.

As it is a family type, what is collected is part of the daily sustenance so that although income is generated, the people who collaborate in the tasks do not receive remuneration.

Another activity identified in the area, but little referred to is fishing, both for consumption and for sale. The busiest area for fish extraction is Piquete Cue, where there is a path that connects to the river and is frequently used by residents of the area and further afield.

In the community of Laguna Plato there are four families whose economic activity has been fishing for several generations. They have been engaged in fishing, distribution and sale of fish for more than 40 years. These families go to the riverside sites located on the estates of Estancia Santa Clara and San Diego; in the community of Piquete Cue, for the extraction of fish and other times they cross the river in the direction of Santa Bella Island to fish. For sale they have a variety of fish such as Surubi, Mandi'i, Boga, Pacu, Carimbata, Mangú; among others. The costs are stipulated in relation to weight and species. For example, the cost of Surubí per kilo is G. 20,000.

Migration

According to Pereira, in his text "Department of Concepción. Wealth and social inequality", approximately 40% of the people who migrated between 1997 and 2002 went to the Central department, 16% to Asunción and 12% to Amambay. He also refers that "the emigration of the department of Concepción has the face of a woman. 57 out of every 100 migrants… were women"[128].

The migratory flows identified in the micro-territories have characteristics similar to those mentioned in the previous paragraph, considering some particularities such as those mentioned in the following paragraphs.

Most of the women who migrate from Asunción and Concepción are domestic workers and are seeking access to higher education levels and provide financial support to their families. Women emigrate mainly to Spain and Argentina, they also mostly work as domestic workers, caregivers of children and the elderly.

Previously they sent remittances to the country more frequently. The crisis and the increase in the cost of living are factors that influence the amount and frequency of sending money. Many people no longer return to the territory of origin because the countries where they reside offer conditions and access to basic services of better quality.

Many young people migrate before completing their secondary studies, they work in the ranches of the Chaco because their parents cannot afford their studies and/or the families require a higher income to survive.

4.3. Characterization of the Directly Affected Area (ADA)

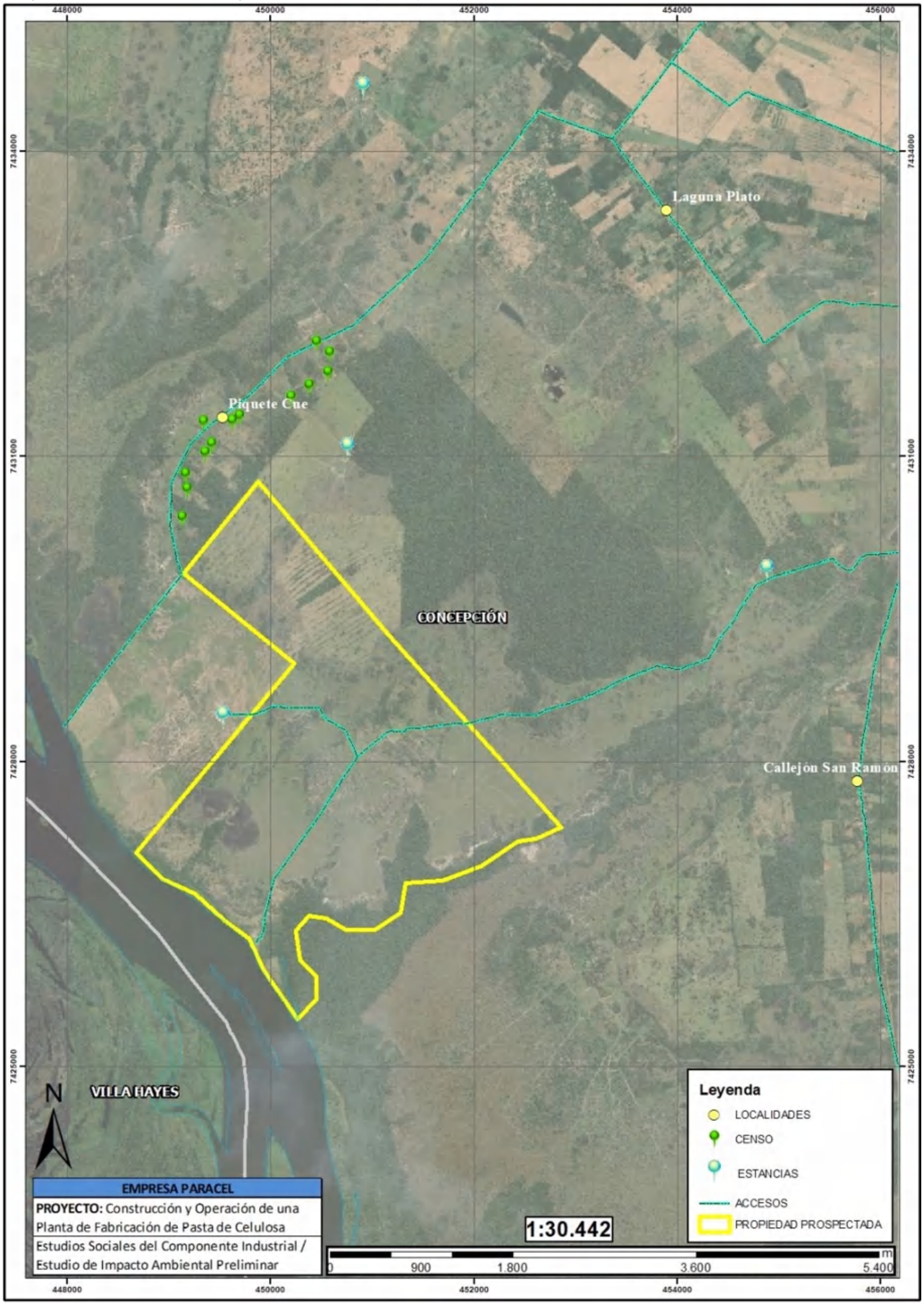
As mentioned in section **2.3. Description of the areas of influence of the project**, for the study, it is considered as part of the ADA, the social units and communities located in the immediate surroundings of the area surveyed for

128 Pereira, Hugo. *"Department of Concepción. Wealth and Social Inequality"*. Available at: https://revistascientificas.una.py/index.php/RE/article/view/714

the installation of the mill, within a radius of 1 km and considering the importance of such closeness, social work was planned prioritizing the initial information gathering in this area.

In this section, on the one hand, a description of the characteristics of the area as a result of direct observation and records made in this framework is made, and on the other, socioeconomic information related to the identified social units will be presented. Both in the AID and in this area, the perception of the inhabitants regarding the undertaking was surveyed. The results obtained have been included in Chapter 5: Survey of Social Perception.

Map 13. Limit of the Directly Affected Area (ADA)



Characteristics of the zone (ADA)

Taking into account the distance delimited for the definition of the ADA, the information survey was carried out in a micro-territory called Piquete Cue, where 13 social units could be visited, these located along approximately 3 km, mostly on the left side of the road (because it is the highest area) and at a distance of approximately 0.36km to 1.49km from the property area.

Likewise, as mentioned, it could be observed that there are ranches in the territory that are outside the analysis radius established for the study. However, given the peculiarity of using the same access routes and being social units adjacent to the enterprise, it was decided to include them as part of the sample to be consulted during the process.

Illustration 18. Picture of the Piquete Cue Access

Source: Picture Registry of the field work. Consulting Team. Concepción. January 2020.

Considering the difficulty of obtaining information from secondary sources and taking into account the variants indicated in previous paragraphs, two alternatives were determined to access precise information that enables the characterization of the area and the survey of social perception consisting of:

Working Methods Used

- Application of a socioeconomic census to the units that are within a 1km radius.
- Application of semi-structured interviews to owners or managers of the rooms adjacent to the surveyed area.

In the case of dwellings, 12 of the 13 units identified were registered because one of the owners was absent during the survey stage (due to travel reasons). The people consulted stated that the heads of household are made up of 11 women and 10 men.

Seven establishments were identified, predominantly cattle ranchers, and four interviews could be carried out; three of which were carried out with the managers or administrators and one with the owner of the establishment.

Two access roads to the community were also observed. One of the paths is located next to the Pirity Mongelós school; and it has exit to the curve before reaching the access gate to the San Diego ranch. This access is frequently traveled on foot or by motorcycle due to its narrow quality.

Illustration 19. Access roads to the community


Source: Picture Registry of the field work. Consulting Team. Concepción. January 2020.

Another way to access Piquete Cue is through the road that connects with the Laguna Plato community. The road is located next to Police Station No. 6 of the aforementioned town and is used by smaller vehicles such as motorcycles, cars, vans and small trucks; It is also traveled on foot by residents and used for the transfer and grazing of animals, since one of the livelihoods of the area is small-scale livestock.

Illustration 20. Access roads to community



Following this path, in a straight line, you reach the access gate of another of the rooms in the area. At this point, on the right bank, you can see a narrow path that can be traveled on foot or by motorcycle. The route leads to the waters of the Paraguay River and is frequently used both by local residents and neighboring communities for fishing and recreation.

Source: Picture Registry of the field work. Consulting Team. Concepción. January 2020.

According to the residents, the community has been established for more than 100 years. The surveyed families affirmed that they had roots in that area for between a minimum of 6 years and 94 years. They also mentioned that they reside in their homes as indicated in the following chart:

Chart 78. Rooting time in the structure

Rooting time in the structure	Number	Percentage
0 to10 years	8	66.67%
11 to 20 years	1	8.33%
21 to 50 years	2	16.67%
51 to 80 years	1	8.33%
TOTAL	**12**	**100%**

Source: Socioeconomic Census, January 2020

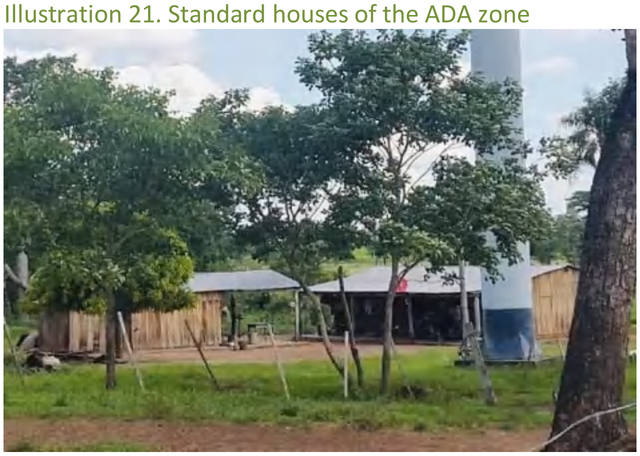
Of the total of 12 families registered, 8 declared having roots between 0 and 10 years, 2 families with roots between 21 and 50 years, 1 of them with the highest number of years of roots (between 51 and 80 years); and 1 rooted family between 11 and 20 years old.

Regarding the characteristics of the structures visited, it can be stated that in their totality they are family dwellings; In 50% of them, productive activities of self-consumption are carried out and in 50% they are houses that also have a business and/or some productive activity for sale.

The predominant economic activity in the area is livestock. The families registered in Piquete Cue work mainly by season/day in nearby farms (several in the Cerrito farm), they are also dedicated to the production of milk, cheese and animal husbandry for self-consumption and/or sale.

It could be observed that there are 2 cases (16.67%) in which the condition of the structure is good; and the majority, that is; 10 out of 12 (83.33%) has a regular structure, taking into account the construction materials that predominate in the unit and the condition in which they are found. With regard to tenure, the vast majority claimed to be an owner, specifically 11 and 1 case in which the home was transferred. When asked if they have another property in the area, 10 of them affirmed that they only have the property visited and 2 people have said that they have another property (Concepción, Barrio San Roque and Coronel Mongelós).

Illustration 21. Standard houses of the ADA zone



House in regular conditions

House in good conditions

Although it was observed that more than one house is located on the same property, the people surveyed affirmed that a single family lives in each house, this in its entirety.

Number of people living in a house

A particularity revealed during the census is that, of the 13 families identified, only one belongs to a different family group. Regarding the number of people who live in the house, as can be seen in the following chart, there are cases in which the house is inhabited by a single person, unlike others in which they have 7 people.

Chart 79. Number of people in each house

Number of people living in a house	Number of families	Percentage
1 person	2 families	16.67%
2 people	1 family	8.33%
3 people	3 families	25.00%
4 people	3 families	25.00%
5 people	1 family	8.33%
6 people	1 family	8.33%
7 people	1 family	8.33%
TOTAL: 43 personas	**12**	**100%**

Source: Socioeconomic Census, January2020

Chart 80. Number of people by age group

Under 18 years old	Adults from 18 to 64 years old	Adult older than 65 years old	Women	Men	Total
14	21	8	22	21	43

Source: Socioeconomic Census, January2020

There were no cases of pregnant women and people with disabilities. When asked about people with a chronic illness in the family and living in the home, they commented on 2 cases.

Number of people currently working/ Looking for work

When consulted on this point, they mentioned in their entirety 16 people in the family who currently have some type of employment, either outside the home or developing economic activities within (7 women and 9 men), they also commented that there are women who work exclusively as housewives (4) and 11 people, family members who live in the visited homes who are currently looking for work.

Access to Basic Services

In the case of access to services, it was possible to ascertain that regarding;

Electric Energy: 100% of the families registered (12) have electricity.

Drinking Water Network: Although the majority of the department's population according to the permanent household survey, between 2017 and 2018 they have accessed the drinking water supply service via SENASA and/or the local sanitation board[129], in the case of the homes in Piquete Cue, none have a drinking water network and the main source of water that household members drink is the well, practically no family performs any treatment, except for one of them (product - bleach is applied after rains). The distance from which it is extracted is less than 10 blocks in all cases.

25% (3 out of 12) of **the water that the household members drink** comes through pipes inside the house, 50% (6 out of 12) has pipes outside the house, but inside the land. 8.33% (1 of 12) well within the field and 16.67% (2 of 12) through the neighbor.

Chart 81. Arrival of water to the population

Drinking Water Arrives by	Houses	%
Pipe inside the house	3	25
Pipes outside the house but inside the land	6	50
Neighbour's	2	16.67
Well within the field	1	8.33
TOTAL	**12**	**100**

Source: Socioeconomic Census, January2020

The water that results from this Source is used, in 100% of the cases for drinking, preparing food, washing clothes, for personal hygiene and cleaning of your home.

Solid Waste Disposal

Regarding solid waste disposal, burning is a method used by the majority (11), not exclusively, but it is evident that this continues to be a deeply rooted practice, in accordance with the departmental level, as indicated in item **4.1.2.4. Households, the dwelling** of this study, which mentions burning as the main form of waste disposal, in addition to highlighting that only a third of the population of Concepción has access to garbage collection services. In the ADA there are also cases (8) in which waste is buried, and to a lesser extent, thrown into a vacant yard, street and/or is recycled. No family has a municipal collection service.

In the same way, what happens with the lack of availability of sewage, considering that no registered family has such a network, a reflection of what happens at the departmental level since only 6.55% of the homes have access to the sanitary sewer network (cloaca) in Concepción[130].

Through the census, other aspects related to access to services, such as:

- 100% access to telephone service;
- Internet access in 58.33%, that is, 7 families of the 12 that were part of the survey, and
- the absence of public transport service in the area. The communities in the area (such as Piquete Cue) mainly use motorcycles as a means of transportation. There is only one road that is used by its inhabitants to move to other communities in the area, and from there to other accesses to other points in the district and department, also for the transfer of animals.

Access to Health Services

129 Item 4.1.2.3: Houses, Dwelling.
130 Item 4.1.2.4. Houses, Dwelling.

As mentioned by the people surveyed, the community does not have health services in place, before which they must go to the nearest health posts or centers to receive medical attention. Based on the information referred to, the following data is obtained:

- 8.33% (1 of 12) mentioned that they attend the Loreto City Health Center; located 25 km from the community.
- 8.33% (1 of 12) indicated that they attend the Concepción Health Center; distant about 40 km from the community.
- On the other hand, 91.67% (11 out of 12) of the studied population attends the Roberto L. Petit Colonia Health Post, which is located at a distance between 9 and 17 km; (about an hour by motorcycle).

Access to Education

At the time of the census, family members who are currently in school were consulted, their academic level, educational institution they attend and distances traveled for such assistance, among others, to which they have affirmed that 13 people 11 attend educational centers, 11 at the primary level, one person at the secondary level and one person at the tertiary level. Most attend public educational institutions (11), eight people attend the Defensores del Chaco school in the Pirity Mongelós town, one go to the Coronel Mongelós College and two to the Concepción Macedo de Denis School, in the Colonia Cnel town. Mongelós, finally one person to the Rosa Mystica Institute and one to the Don Bosco School, both from the city of Concepción. The distances traveled daily vary between 1 km and 10 km (primary and secondary students) and 25 km (tertiary level).

Neighborhood Organizations/commissions existing in the community

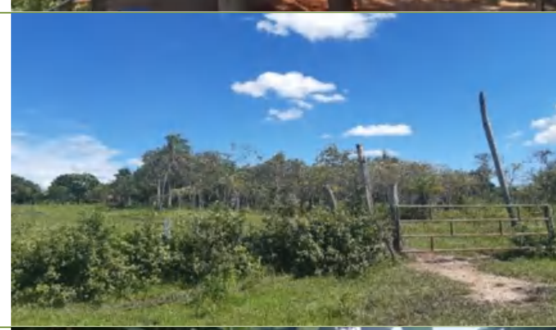
All the people surveyed responded that there is no organization in the Piquete Cue community. However, 3 people commented that they belong to an organization, as indicated in the following chart, these are not found in Piquete Cue.

Member of any Organization	Number	Percentage
Si (Association Karape de Laceros and Laguna Plato Health Center Commission)	3	25%
Does not belong to any organization	9	75%
Total	**12**	**100%**

Source: Socioeconomic Census, January2020

Finally, as a summary of the characteristics surveyed of each dwelling located in the ADA, the following chart is presented containing the location, rooting data, number of people living in the unit, employment situation and the photographic record of each of they:

Chart 82. Summary of dwellings of Piquete Cue and their characteristics

Family	Geographical Coordinates	Registered Characteristics	Picture Registry
1	-57.497371, -23.234877	- **Rooting:** 6 years of roots in the structure - **People residing in the house:**2 adults and 1 child under 18 - **Employment Situation:**1 person with a job and 2 looking for work	
2	-57.496780,-23232404	- **Rooting:** 32 years of roots in the structure - **People residing in the house:** 2 adults, 1 person over 65 and 1 child under 18. - **Employment Situation:** 3 people with a job and 0 looking for work	
3	-57.496887, -23.230906	- **Rooting:** 11 years of roots in the structure - **People residing in the house:** 2 adults and 2 children under 18 - **Employment Situation:** 1 person with a job and 2 looking for work	
4	-57.495075, -23.229251	- **Rooting:** 5 years of roots in the structure - **People residing in the house:** 2 adults, 1 person over 65 and 2 children under 18 - **People residing in the house: Employment Situation:** 1 person with a job and 0 looking for work	
5	-57.494401, -23.228139	- **Rooting:** 74 years of roots in the structure - **People residing in the house:** 1 adult and 1 person over 65 - **Employment Situation:** 1 person with a job and 1 looking for work	

6	-57.495193, -23.226429	- **Rooting:** 7 years of roots in the structure - **People residing in the house:** 1 person over 65 with a job	
7	-57.492462, -23.226415	- **Rooting:** 10 years of roots in the structure - **People residing in the house:** 2 adults and 1 child under 18 - **Employment Situation:** 1 person with a job and 1 looking for work	
8	-57.491872, -23.225842	- **Rooting:** 10 years of roots in the structure - **People residing in the house:** 2 adults and 1 child under 18 - **Employment Situation:** 2 people with a job and 0 looking for work	
9	-57.48687, 23.22382	- **Rooting:** 8 years of roots in the structure - **People residing in the house:** 1 person over 65 without a job (is not looking for one)	
10	-57.485053, -23.222897	- Not registered	

11	-57.48345, 23.22187	- **Rooting:** 3 years of roots in the structure - **Cantidad de People residing in the house:** 2 adults, 2 people over 65 and 3 children under 18 - **Employment Situation:** 4 people with a job and 2 looking for work	
12	-57.483039, -23.220062	- **Rooting:** 50 years of roots in the structure. - **People residing in the house:** 3 adults, 1 person over 65 and 2 children under 18 - **Employment Situation:** 1 person with a job and 2 looking for work	
13	-57.48425, -23.21912	- **Rooting:** 10 years of roots in the structure - **People residing in the house:** 3 adults and 1 child under 18 - **Employment Situation:** 3 people with a job and 1 looking for work	

Source: Own elaboration based on the information obtained in the field. Consulting Team. Concepción- January 2020.

Ranches located in the ADA

As mentioned at the beginning of this chapter, 7 ranches adjoining the area surveyed for the construction of the mill –Estancia Zapatero Cue- were identified. For the registration and characterization of these, 4 interviews were carried out; only for one of the cases was an interview with the owner; the other inquiries were made to authorized personnel, these being responsible or administrators. Information was obtained from 5 establishments because one of those consulted is the administrator of two of the existing ranches.

Considering the above, data of the stays visited are mentioned in terms of location, extension of the territory, staff and main activities carried out. From the records obtained, the following general characteristics can be considered:

- Most of the access gates to the rooms are in the Piquete Cue area.
- One of the establishments leases a fraction of the area surveyed for the installation of the mill. The predominant item is large-scale cattle ranching, although some are also engaged in agricultural production.
- The stays have permanent staff and others hired for specific tasks for specific periods of time. The average number of permanent workers is between 4 to 20 people and the maximum amount of personnel hired per product mentioned is 35 people.

- The property with the largest extension of land has 5850 ha and the one with the smallest proportion has a total of 600ha.

Below are specific data for each establishment as indicated by the interviewees:

The **Pyrenda** farm has four permanent workers and other people are hired for specific jobs. Its production area is Livestock and it leases a total of 1,200 ha. The closest health post for those who live in this area is in Colony Roberto L. Petit and the school in the Mongelós Pirity community.

The Irene Carduz ranch is currently owned by the Blue Sisters, the property originally belonged to the person whose ranch name bears who donated said lands to the organization in 1945. Since then, they have dedicated themselves to carrying out social work in the community. The ranch has a total of 5,850 hectares that start from the first curve located in Saladillo. The Calaverita creek divides the property at the southern boundary of the land.

A fraction of the land is used for agriculture for the production of corn, cassava and another for livestock: there is a total of approximately 880 head of cattle, they also have pigs and are dedicated to raising poultry. Also, on the premises there is a religious technical school, and a boarding school for children between 15 and 18 years old. They have a total of 16 workers permanently and 6 people are hired for specific jobs per day. There are 4 land tenants; 3 of them are dedicated to small livestock (between 10 and 15 heads) and 1 of them on a large scale with 1600 head of cattle.

The Cerrito ranch has a total of 600 ha, adjoining the Zapatero Cue ranch and, as mentioned by its owner, leases 900 ha from it to raise cattle. They have seven permanent workers, these come from Paso Barreto and Concepción.

The San Diego Agroganadera and San Miguel ranches belong to the same Owner. The Estancia San Diego Agroganadera has an area of 5000 ha of land and the Estancia San Miguel 2,400 ha of land. Both ranches adjoin the Cerrito and Zapatero Cue ones. San Diego has a total of 20 permanent workers; and San Miguel 5 and both indirectly employ approximately 35 people in different seasons.

Illustration 22. Pictures of the ranches in the zone


Pyrenda Ranch


Acess to Irene Carduz Ranch

Illustration 23. Pictures of the ranches in the zone

Access to San Miguel Ranch

Cerrito Ranch

Illustration 24. Picture of a ranch in the zone

San Diego Ranch

4.4. Cultural Heritage

This section presents the content and main findings of the "Cultural Heritage Report", prepared by the external consultant Lic. Enrique Bragayrac, specialist in cultural heritage and team. The full report is presented in Annex 5.

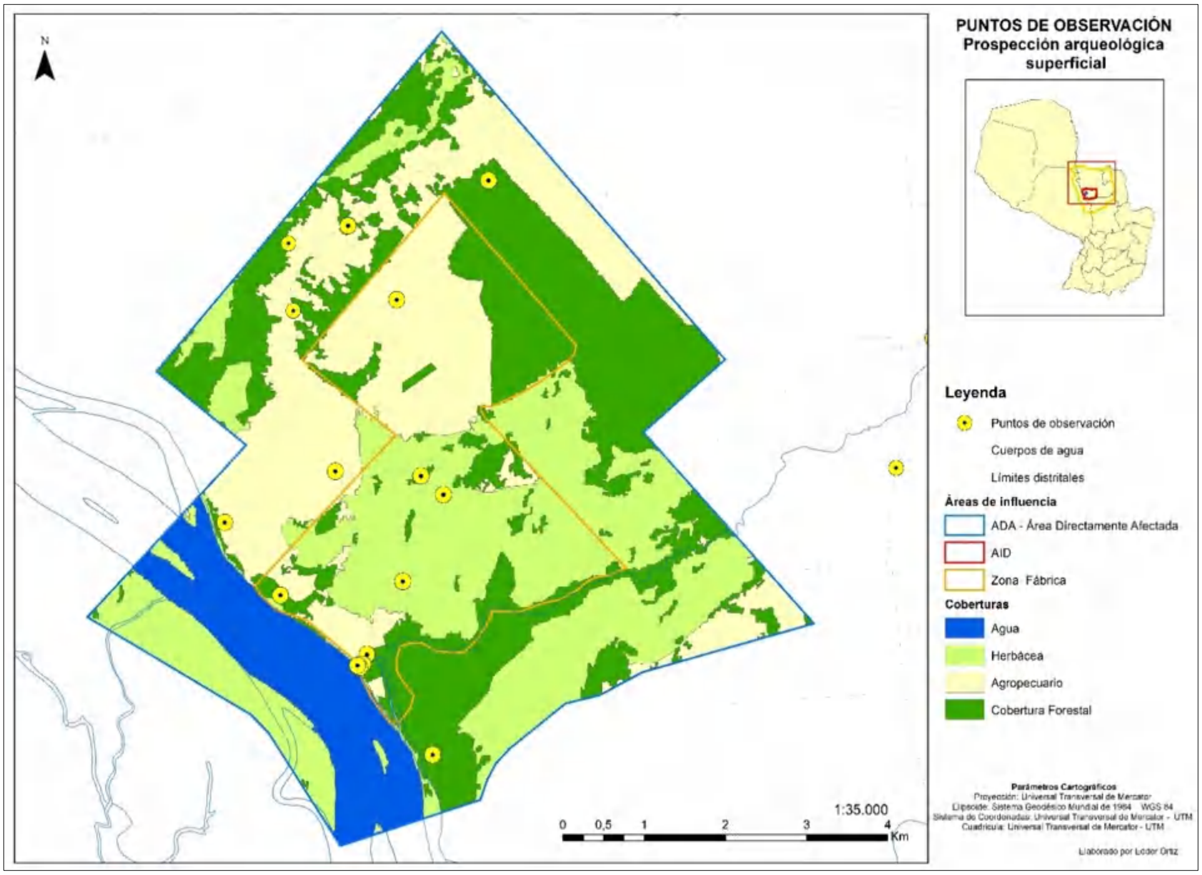
4.4.1. Synthesis of the main findings

The evaluation of the state of the cultural heritage, had as objectives the recognition of the cultural assets (archaeological, architectural, historical, ethnographic, etc.) present in the project area (including the districts of Concepción, Loreto, Belén, and Horqueta); the individualized evaluation of the impact that its execution could cause on said assets and the design of corrective measures aimed at the suppression or attenuation of such impact, seeking to reconcile the conservation of cultural heritage and the execution of the project involved in it.

The methodology and field work were based on the location of the project area (ADA), adjacent to the Paraguay River, with two accesses by land, with extensions of livestock enterprises, and with small agricultural communities. Due to the characteristics of the study site, with areas differentiated by their current and natural uses, it was impossible to work through quadrants, due to the roughness of some places, fences, and the gallery forest with flooded soils that are difficult to access. For this reason, for the planaltimetric control by areas and observation points, the natural and anthropic systems present (Map 12) in the ADA limits were taken as a basis, well delineated, with areas defined at the territorial level and satellite mapping.

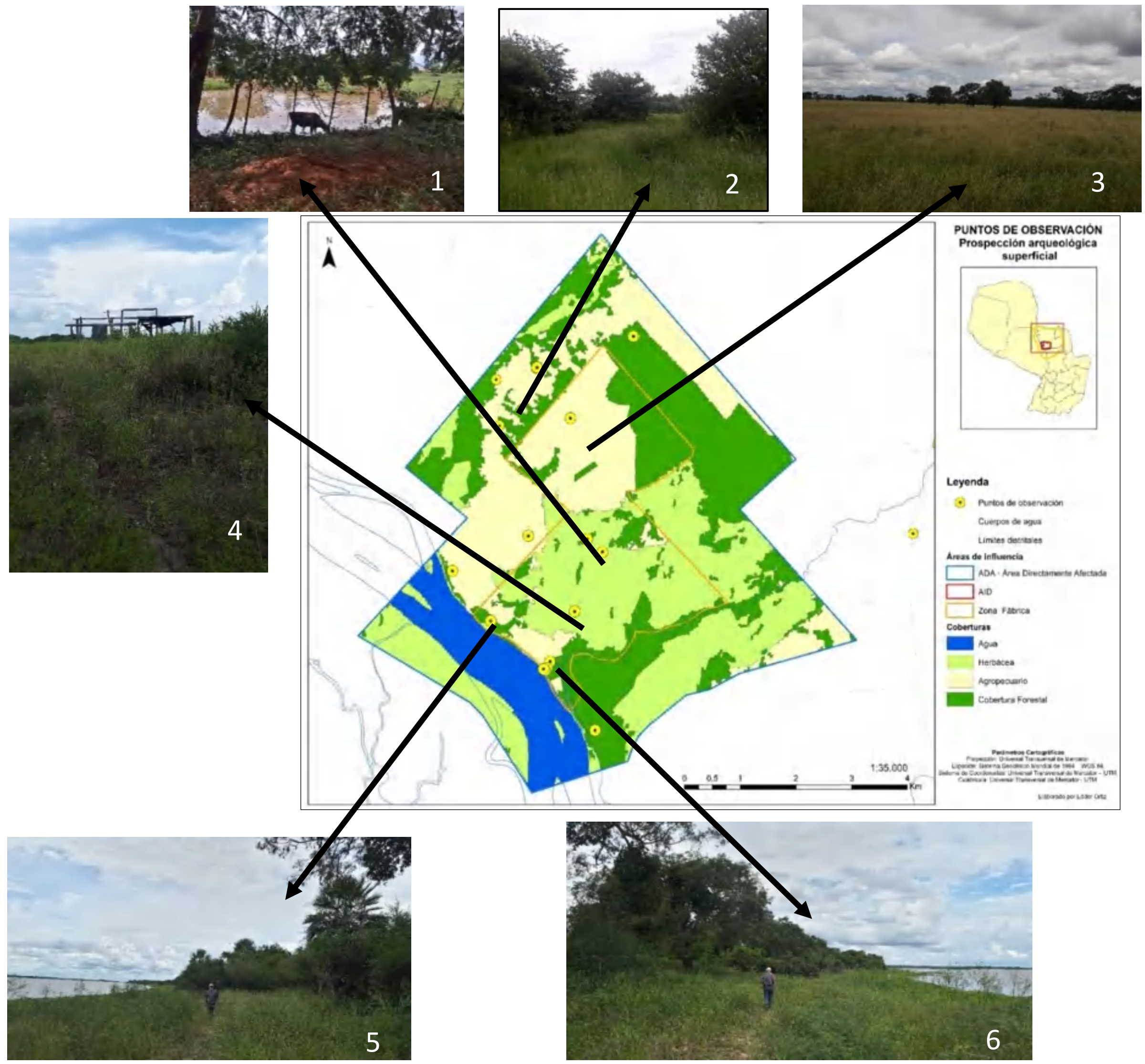
The archaeological surface characterization was carried out extensively throughout the ADA, in order to monitor the potential direct and indirect impacts on the cultural landscape and identify the heritage values at risk, through sampling and observation points in the areas identified on the ground. These are: agricultural area (1,322 ha), forest cover (1,531 ha), herbaceous (1,586 ha), and water (438 ha). The documentation of the terrain was carried out by arbitrarily selected field observation points (georeferenced), registering those sectors of the terrain that offered natural windows (erosion zones), cultural or other particularities.

Map 14. Map of the Directly Affected Area (ADA)



In the first campaign, the north and northwest sectors were evaluated, showing the most relevant anthropic transformation, with extensive livestock areas. In the second campaign, the southern and southeastern sectors were evaluated, taking the Paraguay River as the limit, with greater relevance near the gallery forests formed by water channels, forest cover in their environment and the river. Because it is an undisturbed area, with natural runoff in its channels, its dynamics leaves surfaces with cultural evidence in drags and outcrops of contexts, not being the case in this entire natural system, since no superficial evidence was found that indicates a historical occupation and/or other relevant cultural elements. The ADA, is released for not presenting superficial contexts of archaeological remains present.

Map 15. Reference zones categorized and presented in layer format with points



REFERENCES
(1) Tajamar, livestock use / ZH. - (2) Natural field - livestock use - (3) Intensive agricultural area - (4) Old jetty house - (5) Forest area in gallery / southwest sector / transects - (6) Forest area in gallery / southeast sector / transects - (7, 8, and 9) Soil and remains found

NOTE: After carrying out the study on cultural heritage, the current limits of the prospective property were updated on the same area, without representing changes for the evaluation and results of this analysis.

For the AID and AII of the project, a quantitative inventory of the present cultural heritage was carried out, characterized by an exceptional and particular architecture of a historical period. For the territorial registry of movable/tangible heritage, geographic coordinates were used, obtained through the Avenza Map application, to identify and create categorized reference points and presented in layer formats with points referring to the real estate registered and adjusted to the cadastre.

For the dating of archaeological sites settled in similar contexts along the Paraguay River, current research validates and complements these links; and they indicate the presence of pre-Hispanic societies along the entire Paraguay River, with radiocarbon dates from ca. 100 BC until ca. 300 AD for the Pantanal Tradition (Lamenza, 2015). Reports of rock art findings in the project area are mentioned for the site called Barrero Guaá, near

Gamarra-cué, a place located at the headwaters of the Tagatiyá stream (AII), department of Concepción (Díaz-Pérez, 1904). It is also important to point out reports of paleontological remains (Báez Presser, et al. 2004), for flora (fossil plants: fern and coniferous woods - Itapucumí Group), as well as fauna.

Starting from a primary assessment, based on the secondary information available, the importance of a deeply rooted cultural territory can be affirmed, with local testimonies alive and present in their experiential imaginary. Regarding the potential impacts generated, specifically with regard to cultural heritage, we can mention that it will be significantly affected (intangible or intangible heritage), due to changes in habit and significance as social capital.

Chart 83. Assessment and impacts on the evaluated cultural heritage

AREAS/ IMPACTS	TANGIBLE HERITAGE			INTANGIBLE HERITAGE			NOTES
	A	M	B	A	M	B	
Directly affected area			X	←	X		PT/Low impact on the subsoil/potential presence of associated cultural contexts PT/Moderate to high impact due to increased vehicular traffic. PI/Moderate/high impact - on livelihoods/productive areas and immediate environment/social capital
Direct area of influence	←	X		←	X		PT/Moderate impact PT/Moderate to high impact due to increased vehicular traffic and possible new settlements for goods and services. PI/Moderate/high impact on livelihoods and natural environment/ecosystem services. PI/Moderate impact/by loss of collective memory/migration/Roots territorial/identity
Indirect area of influence		←	X	←	X		PT/Low to moderate impact/on the architectural heritage, which is protected and there is a public awareness of respect - tax exemptions are municipal benefits for the safeguarding of heritage. PI/Moderate/high impact on livelihoods and their cultural identity. PI/Moderate impact/loss of collective memory/ population growth

Reference: (A) High – (M) Medium – (B) Low - (PT) Tangible Heritage – (PI) Intangible Heritage

In chart 83, it can be observed that the most relevant impacts are in the Area of Direct Influence (AID), since it directly affects their livelihoods and the provision of ecosystem functions and services, initiating a process that would weaken their capital. natural and social, with the loss of collective memory. New settlements and the increase in vehicular traffic are part of the impacts that will affect ways of life.

For the indirect area of influence, a low to moderate impact on tangible heritage (architectural and historical) is observed, since they are protected by Municipal Ordinance and their intervention/conservation is given with authorization through a municipal resolution, thus as its tax exemption (district of Concepción), however, for the districts of Loreto, Belén and Horqueta, the patrimonial houses are around their main squares, all of them preserved and others restored. The collective respect of the population and institutions in the affected districts in the AID, for their tangible heritage is part of their cultural identity.

In the potential impacts identified by areas of intervention (ADA/AID/AII), the loss and need to reinforce livelihoods and cultural identity, present in all stages of the mill implementation process, stands out, in order to generate Rooting, human development and appropriation.

4.4.2. Valuation and Methodology

The Cultural Heritage of a people includes the works of its artists, architects, musicians, writers and scholars, as well as the anonymous creations, arising from the popular soul, and the set of values that give meaning to life, that is, the material works and not materials that express the creativity of that people; language, rites, beliefs, historical places and monuments, literature, works of art, and archives and libraries (Definition prepared by the UNESCO World Conference on Cultural Heritage, held in Mexico in 1982).

Geographic, human and cultural diversity is expressed in its tangible or material heritage (movable, immovable property) and intangible or intangible (intangible heritage); and it makes sense thanks to the appropriation assumed by the communities.

The present study, due to its cultural, historical and archaeological character, defines a geographical space or territory as an action scenario, where a historical construction and a cultural practice were developed, and where the cultural identity of the community or communities that support it is clearly reflected.

The Baseline of this section begins with the Villa Real de Concepción Foundation (1773), its current characterization, its historical milestones, and the legal support that allows the protection and revaluation of heritage, specifying which area of intervention of the project is applicable. The identification of the existing types of heritage is disaggregated by its specificity and valuation.

The study area [131] is based on a territory founded in 1773 by Agustín Fernando de Pinedo, with the name of Villa Real de la Concepción. This name, like other frontier towns founded under the reign of Carlos III, recalls the Immaculate Conception, patron saint of Spain. It was a military town for 40 years, until the town hall was founded in 1812, with which the town became a civil settlement. The arrival of Italian, Syrian-Lebanese and Catalan immigrants around 1880 promoted the district as a commercial port and initiated a sustained process of development of Italian-style architecture. At the beginning of the 20th century, the Port of Concepción was an active center for trade and exchange of products, especially with Matogrosso, Brazil (Yubi, 2011).

The cultural and archaeological heritage survey was focused on identifying tangible (material) and intangible (intangible) heritage, through secondary and primary information, as well as local testimonies of its social dimension. In the case of architectural heritage, the one that was most relevant due to its magnificence, the selection and evaluation criteria are described, and in this way its originality, attributes, and relative temporality are measured.

Based on the location of the project area, on the banks of the Paraguay River and two accesses by land, the superficial archaeological characterization was carried out extensively throughout the Directly Affected Area (497 ha) and the Central Area (1,211 ha), the Area of Direct Influence (278,070 ha), and the Area of Indirect Influence (3,329,828 ha) in order to monitor the potential direct and indirect impacts on the cultural landscape and identify the heritage values at risk. The design of the archaeological characterization was carried out taking into account

131 Defined by the direct and indirect intervention zones.

the variables that the researcher controls (intensity) and does not control (visibility, accessibility), in a way that maximizes[132] the probability of finding archaeological records in the broad sense (artifact, structure and feature)

The entire surface was surveyed looking for areas of open terrain or erosion to prospect archaeological indicators, taking as reference the natural and anthropic systems observed in Map 14 duly identified as study areas through observation points: agricultural zone (1,322 ha), forest cover (1,531 ha), herbaceous (1,586 ha), and water (438 ha).

The first field campaign was aimed at prospecting in agricultural areas and observation points in areas with forest cover and native herbaceous. As well as interviews with residents settled in the Area of Direct Influence. In this same campaign, data were collected from the historic center of the main towns in the Area of Direct Influence, as well as interviews with local authorities and leaders of cultural and social work.

In the second campaign, a tour was made in the central area of the project with observation points of the areas of livestock use, both implanted pastures and grasslands and savannas, up to the river bank and dry channels. These observation points sought to find materials that allow us to understand possible present cultural contexts.

The documentation of the terrain was carried out by arbitrarily selected field observation points (georeferenced), registering those sectors of the terrain that offered natural windows (erosion zones), cultural or other particularities where to prospect superficial archaeological evidence, with a greater probability of finding. During the surface survey, observation points were recorded on the ground, which were documented on Map 14 (Fig. 1).

For the AID and AII of the project, a quantitative inventory of the present cultural heritage was carried out: furniture, real estate, gastronomy, historical events, popular festivals and other elements that the local imagination recognizes as heritage. As it is a quantitative inventory and record of the state of conservation of tangible and intangible, spiritual and archaeological heritage, methodologies were combined, according to the specificity of each element and heritage asset identified. The use of tokens through online systems was the basis of the work, due to the combination of digital support information in real time.

For the territorial registry, the geographic coordinates, obtained through the Avenza Map application, were used to identify and create categorized reference points and presented in layer formats with reference points to the registered tangible heritage, adjusted to the cadastre.

132 To do so, Schiffer, Sullivan and Klinger criteria were followed (1972).

Chart 84. Selection and evaluation criteria for the study of architectural cultural heritage

Selection Criteria	Evaluation Criteria
1. Testimony of cultural and symbolic tradition Being associated with events or living traditions of a local, regional and national character	**1. Antiquity** Time of construction - Dating of the building.
2. Building quality It represents the quality of the design of the real estate at a typological and morphological level, the relevant constructive and decorative elements, the technology used in the construction system and use of materials, the visual impact caused by the building within the immediate environment at an urban and natural level	**2. Architectural-aesthetic** Style or stylistic influence. Volumetry and design; Architectural plastic (scale, unity, rhythm, harmony, color, texture, symmetry, asymmetry, composition, proportion, balance, highlight). Integrating elements: decorative, ornamental, structural.
3. Integrated with the urban environment (formation of urban ensembles) Preserve homogeneity in typology, morphology, construction system and use of materials. The rhythm, the arrangement of the openings and the fillings, the height of the buildings are some factors that express a clear language of architectural unity within an urban complex.	**3. Typological-functional** Location, distribution and relation of the spaces. (Accesses, portals, hallways, patios, gardens, orchards, green areas, galleries, stairs, arcades, circulation elements, social, intimate and service areas) Identification of the typology (traditional building, vernacular, farms, villas, etc.). Type of use: original, current.
4. Associated with the cultural landscape Establish a relationship between the human being - architecture - physical environment (cultural landscapes).	**4. Technical-constructive** Technology and/or traditional construction systems. Contemporary technology and/or construction systems. Mixed materials/mixed construction.
5. Associated with historical events Being associated with significant historical events that happened at the real estate locally or nationally.	**5. Historical- testimonial-symbolic** - Sociocultural-economic value. - Associated with a historical event (s) or the collective memory related to important person (s) and/or representatives of the place. - Urban, architectural, productive landmark.
	6. Architectural- urban environment - Property integrated into the urban environment. Urban ensembles. - They generate visual impact. - It favors the urban perspective. - Urban plot. - Related to archaeological sites or archaeological sites.
	7. Authenticity and integrity - Volumetry/shape, - Design, - Integrative, decorative, ornamental, structural elements, - Internal distribution of spaces, - Construction technology and systems, - Urban layout (orientation, shape, design, dimensions, construction materials and finishes).

4.4.3. Description and Evaluation of the Cultural Heritage of the Project Area

For the present study, cultural heritage will be understood as the set of tangible and intangible assets that constitute the inheritance of a human group, that emotionally reinforce their sense of community with their own identity and that are perceived by others as characteristic.

To better understand the concept of Cultural Heritage, its appreciation will be divided into tangible and intangible heritage, for the purpose of its study and treatment:

4.4.3.1. Tangible or Material Cultural Heritage

It is made up of objects that have physical substance and can be preserved and restored by some type of intervention; are those manifestations supported by material elements products of architecture, urbanism, archeology, crafts, among others. It is made up of movable and immovable property made by the societies of our past.

a) **Movable Cultural Heritage** (PCMU) is the set of assets that communities, social groups and public and private institutions recognize as part of their memories and identities, or as part of the memories and identities of the nation, whenever that attribute to them, among others, collective, historical, aesthetic and symbolic values. These assets are generally protected and passed on to future generations[133]. The assets that make up movable cultural heritage can be representative: 1) for a group, community, community or people; 2) for a municipality; 3) for a district; 4) for a department; 5) for the nation, or 6) for the world.

b) **The Immovable Cultural Heritage** (PCIMU) are removable assets that are an expression or testimony of human creation or the evolution of nature and therefore have an archaeological, historical, artistic, scientific and / or technical value. Examples of this are: an aqueduct, a mill, a cathedral, an archaeological site, an industrial building, the historic center of a city, among others.

   In the case of the survey of the immovable cultural heritage, they were categorized as follows, taking into account the historic center of the city of Concepción, identified through municipal ordinance No. 09/04 on zoning - land use; Nº 12/04 By which the protection, conservation, recovery and transmission of the cultural and natural heritage of the Municipality of Concepción is established, and Nº 13/04 by which the general catalog of assets comprising the cultural and natural heritage of the Municipality of concepción; and testimonies of the local imaginary, with the following categories: Mansion - Casonas - Houses and Port area.

   This category was also applied to Belén, Loreto and Horqueta, where only historical dwellings stand out.

   Mansion: Buildings that have more than two levels or finishes worked with details in walls and cornices. They are buildings that have a larger constructed area and a large internal patio. The ornate lid-type facades predominate with pilasters on the walls and ciboriums as a finish. The pilasters had moldings on the shaft and on the capital with acanthus leaves, characteristic of European homes with mixtures of styles such as classic, neoclassical, Renaissance among others. Relative temporality: XIX century.

   Big Houses: Buildings that have a certain bearing similar to mansions, but do not have as many details on the façade. It predominantly has a cover-type façade. They were used as homes as well as local and regional

133 https://www.mincultura.gov.co/areas/patrimonio/patrimonio-cultural-mueble/Paginas/default.aspx

businesses since products were brought from the surrounding settlements. They have the smallest patio compared to the mansions.
Relative temporality: XIX century.

Houses: Buildings destined to residences of smaller size in comparison with the other categories, the facades type cover and the colonial galleries predominate where the inhabitants sat to take terere under its shade. It presents characteristics similar to the large houses, but with less ornamentation. Relative temporality: XIX century.

Port Area: Buildings dedicated to port activities, it is an interconnection zone between riverside towns and commercial exchange of the time. The houses closest to the port have a greater architectural presence since the inhabitants were dedicated to this trade, both fishing and commercial exchange, as it moves away from the site, more precarious houses are observed. Relative temporality: 19th century.

Illustration 25. Heritage bars present in the city of Concepción with hierarchical symbol

The relevant tangible heritage of the city of Concepción is listed below, where there are 209 registered and declared for the Historic Center of the City of Concepción, by the Municipality of Concepción.

Chart 85. List of the relevant tangible heritage of the City of Concepción

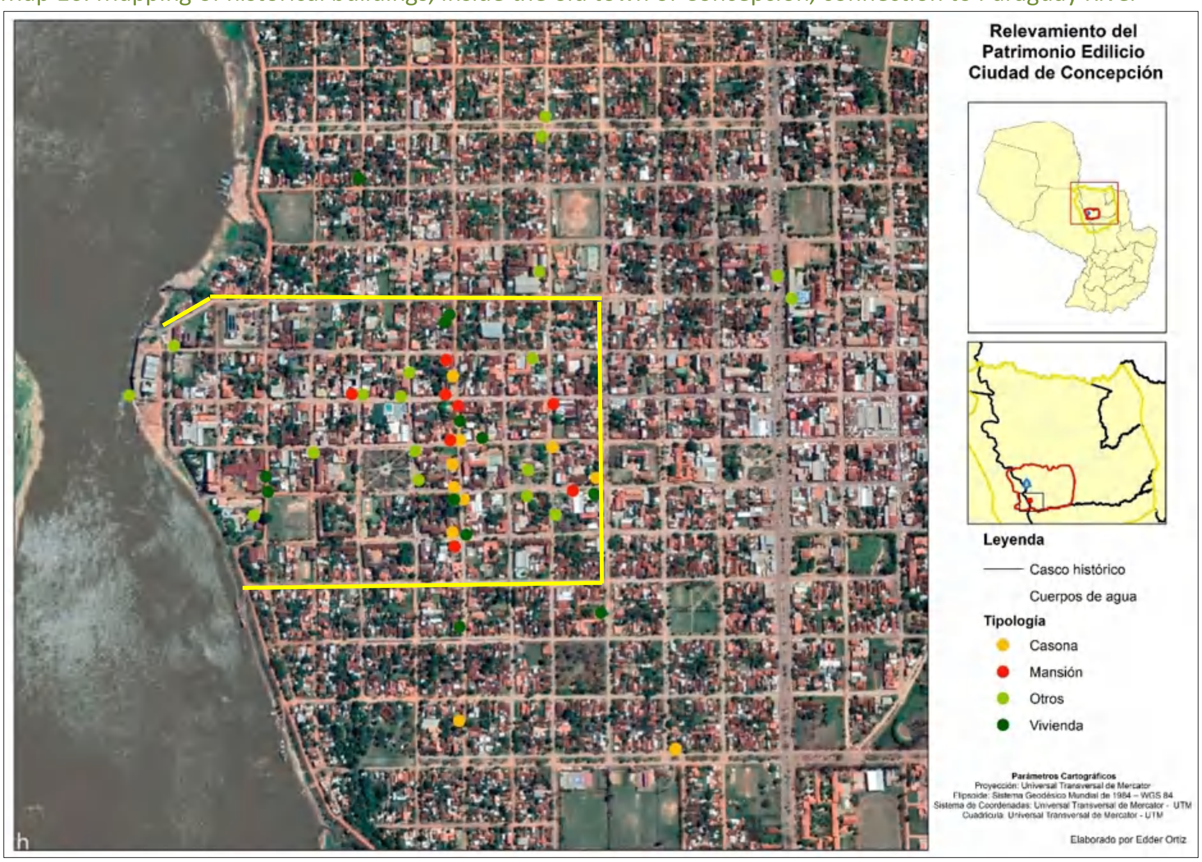
	Tangible Cultural Heritage	Place	Notes
1	Municipal Theater	Concepción (AID)	SNC Resolution No. 217/2019 was declared of Cultural Interest to the project of "Refurbishment and remodeling of the Municipal Theater Don Pedro Gregorio Antonio Alvarenga Caballero"
2	National North Railway	Concepción (AID)	Declared Heritage by Ministerial Resolution No. 1 (4-I-2008) (components that were elements of the Northern National Railroad, which are located in the Department of Concepción, linking the Departmental capital-Concepción, to the Capitán Gumersindo Sosa - Arroyo Karé Station). Source: SICPY http://sicpy.gov.py/busquedas/index.php?categorias-3=&page=96
3	Contemporary Museum of Art	Concepción	It no longer exists, it was in the Otaño Mansion. It revolved around the work of Carlos Colombino.

	Tangible Cultural Heritage	Place	Notes
4	Nuestra Señora de la Concepción Church	Concepción	Its construction began in 1960, after the collapse of a large part of the old church factory and the demolition of what was left. The work concluded in 1968 and in December of that year the inauguration took place. Its interior houses a font of holy water carved in pink marble, a sculptural group of the Crucifixion in wood, the images of the Virgen del Carmen, San José and Sagrado Corazón de Jesús, a pictorial painting by Carlos Colombino and the altar that is the work of this, and the painting of the Virgin of Chestokowa, a gift from Pope Juan Pablo II. https://www.bienvenidoaparaguay.com/showdata.php?xmlcity=22&xmldestino=64
5	San José Church	Concepción	Built at the time of the European mandate. Façade -cover building with neoclassical reminiscences. It stands out for the beauty of its façade among the other religious buildings, despite the transformations that it has undergone with a mortar altarpiece, the work of Don Pedro de Alcántara. It has a bell brought from Italy in 1911, which is owned by the people of Concepcion. A huge Carrara marble tombstone inside recalls the great benefactor Don Julián Quevedo y Gómez de la Pedrueza, who contributed a large sum for the construction. (Catalog No. 200 - Municipality of Concepción and Cultural Association of the Villa Real de Concepción)
6	Museum of the Barrack of the Villa Real	Concepción	The Barracks was built, as soon as the city of Concepción was founded, in 1773. It was not until 1862 that it began to "modernize" when the Mcal. assumed the presidency. Francisco Solano López. In this place the War of the Triple Alliance began and ended. Madame Lynch's wagon is the most attractive relic in the Museum. (Catalog No. **85** - Municipality of Concepción and Cultural Association of Villa Real)
7	Mansion Paciello	Concepción	Today UTIC University. Declared Heritage of Concepción
8	Mansion Villa Ida Albertini Quevedo.	Concepción	It has an incredible coffered ceiling made by hand by Quevedo himself. There passed the US President Theodore Roosevelt, in 1913. Declared Patrimony of Concepción
9	Mansion Aquino Quevedo	Concepción	Declared Heritage of Concepción
10	Mansion Chatelain – Jantou	Concepción	Declared Heritage of Concepción
11	Mansion Peluffo Quevedo	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04
12	House Miltos Herrero	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04
13	House Ugarte Zabala	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04
14	Government House of 1947	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04
15	Villa Heyn	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04
16	Hotel Francés	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04

	Tangible Cultural Heritage	Place	Notes
17	Zavala, Benítez, Cabrera y Cía.	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04
18	Cinema Theater Paradeda y Pampliega	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04
19	Solar of the Gral. Francisco Isidoro Resquín	Concepción	Declared Patrimony of Concepción - Ordinance Nº 13/04

Within the architectural heritage, the old town of the first Concepción Foundation stands out, with homes, large houses and mansions of higher hierarchy, on a plot of the old port of Concepción and the Barracks of the Villa Real de Concepción (1773 - 1864). On map 15 you can see the limits of the historic center, where it also shows in georeferenced points the existence of a greater number of large houses, as well as mansions, all of them having their main access in corners, with two facades in two streets and a hallway, which marked a greater social hierarchy. Outside the limits of the historic center, only some relevant mansions are observed.

Map 16. Mapping of historical buildings, inside the old town of Concepción, connection to Paraguay River



The Museum of the Barracks of the Villa Real of Concepción

Historical time: 1773 – 1864

Illustration 26. Picture: Barracks of the Villa Real de Concepción-1886

The originality of this infrastructure, which was a main barracks, represents the oldest building, dating from the founding of the city of Concepción, in 1773. It was not until 1862 that it began to “modernize” when Mcal. Francisco Solano López. In this place the War against the Triple Alliance began and ended. Despite what was written, it was never López's Barracks but his Barracks from the time he reopened in 1864, with the presence of the President. The facilities were renovated in 1862-64, at the time of López (Catalog No. 85 - Municipality of Concepción and Cultural Association of Villa Real).

The materials that it has protected through its presentation represent historical moments of high heritage value, many of them "unique". Among them we can mention Madame Lynch's wagon, considered a relic and what it represents for the local and regional imagination. The cart dates from 1864 and was used to transport the belongings of the Mcal's wife. Lopez[134] .

Currently, this Museum is restored and open to the public, with two municipal officials responsible. Its restoration took place through the Workshop School created in the Municipality, with the support of the Spanish Cooperation. At its best, this school trained more than 30 young people in different trades[135], with an emphasis on the restoration of the Museum (1999). It is still in operation.

According to the museum's reference card to the building, placed at its entrance, it mentions that on May 25, 1773, the city of Concepción was founded by Brigadier Don Agustín Fernando de Pinedo y Valdivieso, a military member of the Spanish army appointed to govern for 6 years. Its Hispano-Paraguayan style are reported by Du Graty, and published in Europe in 1862. This building also called as "The House of the King." Its urban territorial location places it on the current site, which overlooks the Plaza Mayor (current Plaza de la Libertad).

134 https://www.abc.com.py/edicion-impresa/suplementos/centinela/el-museo-de-concepcion-una-opcion-turistica-1615023.html
135 Testimony M. Ibañez/Museum Barracks of the Villa Real

Illustration 27. Picture: Current facade of the museum. 2020

Illustration 28. Picture: Intern gallery of the museum

In the internal Gallery where its current conservation is observed, after its restoration. You can see the space that faces the internal patio, a ceramic brick floor, a carved column with a molding on its capital that supports the weight of the main ceiling beams, the braces are made of caranday and the seat of Spanish tiles are tacuaras in section.

The openings are made of thick solid wood with a curved crossbar in such a way that it functions as a lintel.

The plastered walls with painted rustic finish.

Illustration 29. Picture: Municipal Museum of the Barracks of the Villa Real

Activities around cemeteries deserve special attention[136], where the local population accompanies, with great devotion and respect, forming a group of friends from the cemetery. This activity is carried out every year, in the two cemeteries of the city. These tours, called Necrotourism, are carried out by the Villa Real Cultural and Historical Studies Association, specifically in old areas of the Municipal Museum, where characters who contributed to the history of the city and the country lie[137]. The cemeteries located in the communities of the Area of Direct Influence stand out.

Illustration 30. Pictures: Cementery, Antique sector – Villa Real of the Concepción

In the middle image, the pantheon belongs to Mrs. Caballero de Saviex and in the image on the far right, the pantheon belonging to the Isnardi Family appears, known as the neo-Gothic “El Castillito”. Pictures Cultural Association of the Villa Real. Posted January 12, 2019.

The pantheons present very elaborate architectural designs, among them neo-Gothic, classical, neo-classical among others (Fig. 22). Major Rufino Pampliega Franco, Major Lorenzo Medina, Captain Gumercindo Sosa, Lt. 1st. Manuel Irala Fernández, "Yacaré Valija"; the Tte. 1st. Aniano Cabrera, Vicente Cabañas, Pedro Céspedes, Ladislao Cabrera are some of the hundreds of heroes that rest in the “Pantheon of the Heroes of Concepción”.

136 Testimony Porfirío Báez, president of the CVR Association
137 https://www.abc.com.py/nacionales/realizan-necroturismo-en-concepcion-1583796.html

Illustration 31. House – typology

Architectural Heritage of the Cities of Belén, Horqueta and Loreto (AID)

In the case of the cities of Horqueta, Belén and Loreto, located within the AID, they present different periods of construction and settlement, many of them involving immigrants or part of a rural development project implemented by the National Government. All the relevant architectural manifestations are around the central square and Church, with monoliths representative of their saints, or a feature that makes it visible in the collective memory, as is the case of Belén and the imaginary line of the Tropic of Capricorn. The relevant historical element that defines the collective memory of these cities is given by the events of the War of the Triple Alliance.

BELEN. The city of Belén, capital of the district of the same name, is also called "the city of the Tropic" because the imaginary line of the Tropic of Capricorn passes through there. It is considered the oldest city in the department of Concepción. The district of Belén was founded on August 23, 1760, in a place known as Paso Mbayá.

Map 17. Satellite imagen of the City of Belén

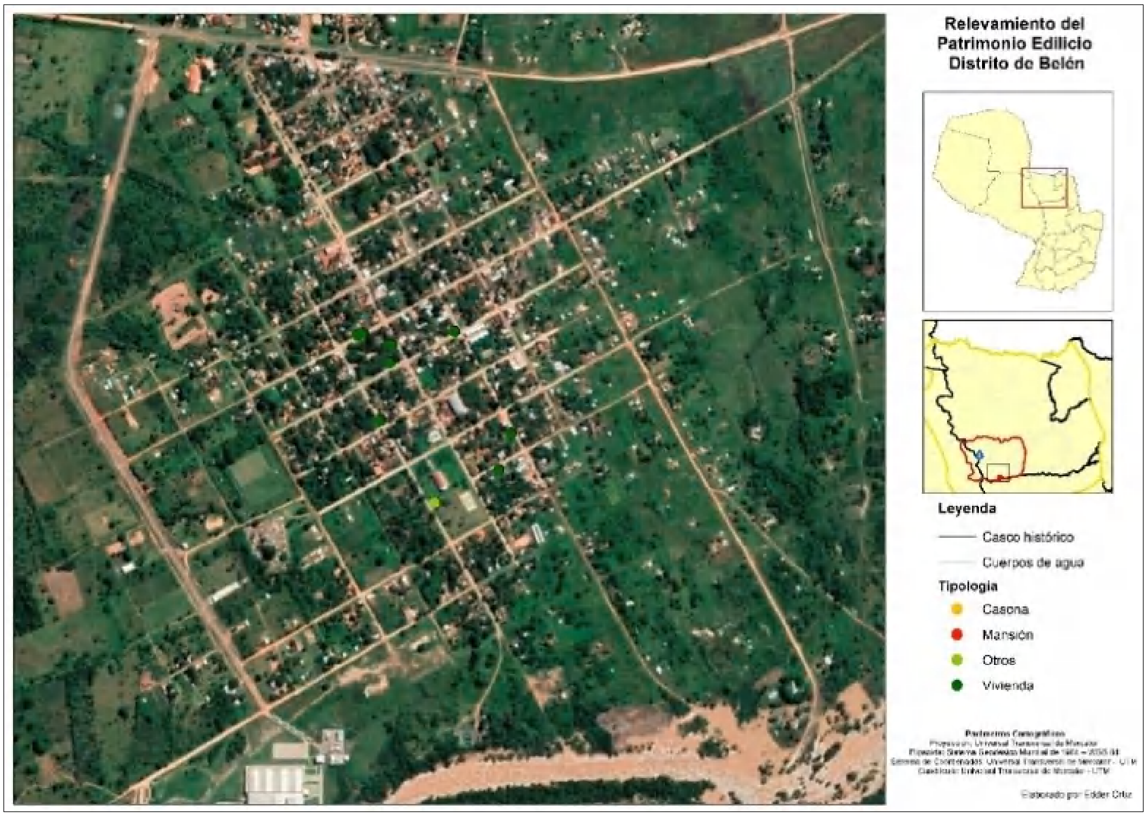


Illustration 32. Lateral facade of the Church of Belén

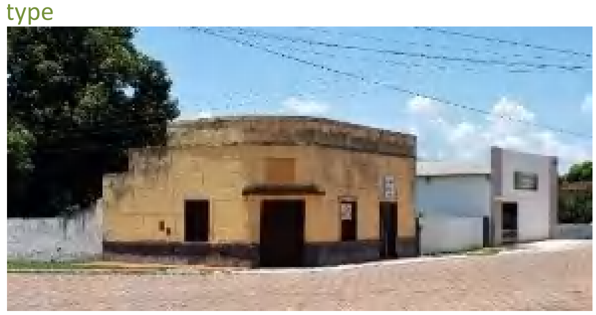
(Lat. 23º28'21.19"S Long 57º15'43.84"O)

Illustration 33. Back facade of the Church of Belén

(Lat. 23º28'21.19"S Long 57º15'43.84"O).

Illustration 34. Colonial house with front gallery. Av. Padre Sánchez in the corner with Uruguay

Illustration 35. House in a corner with facade cover type



(Lat 23º28'12.57"S Long 57º15'45.89"O)

Illustration 36. Colonial house with front gallery with details of columns of Jesuit style

(Lat. 23º28'10.18"S Long 57º15'49.90"O)

Illustration 37. Colonial house with frontal gallery with details of columns of Jesuit style

(Lat. 23º28'9.72"S Long 57º15'47.76"O)

Illustration 38. Monument to the Capricorn Tropic. Belén, Concepción

Latitude 23º26''21'. Toursitic pasage with relevance to the city.

HORQUETA. It is a city that had its origin as a chapel in the 18th century, officially founded in 1793. It was the first city with a pedestrian street in the country. The city bears the name of Horqueta, because it is located at the fork of roads, hence its name (Tape Horqueta). The first construction was a large house where a family settled, and since then the place known as Paraje Horqueta or Tapé Horqueta, became a place where the traveler had a roof and a corral, where they could rest and give respite to the animals. Several others approached this first family, occupying the four corners of the TAPE HORQUETA, with time new immigrants have already arrived, forming a conglomeration of ranches of farmers and hunters. It is located 50 km from the city of Concepción.

Map 18. Satellite image of the city of Horqueta

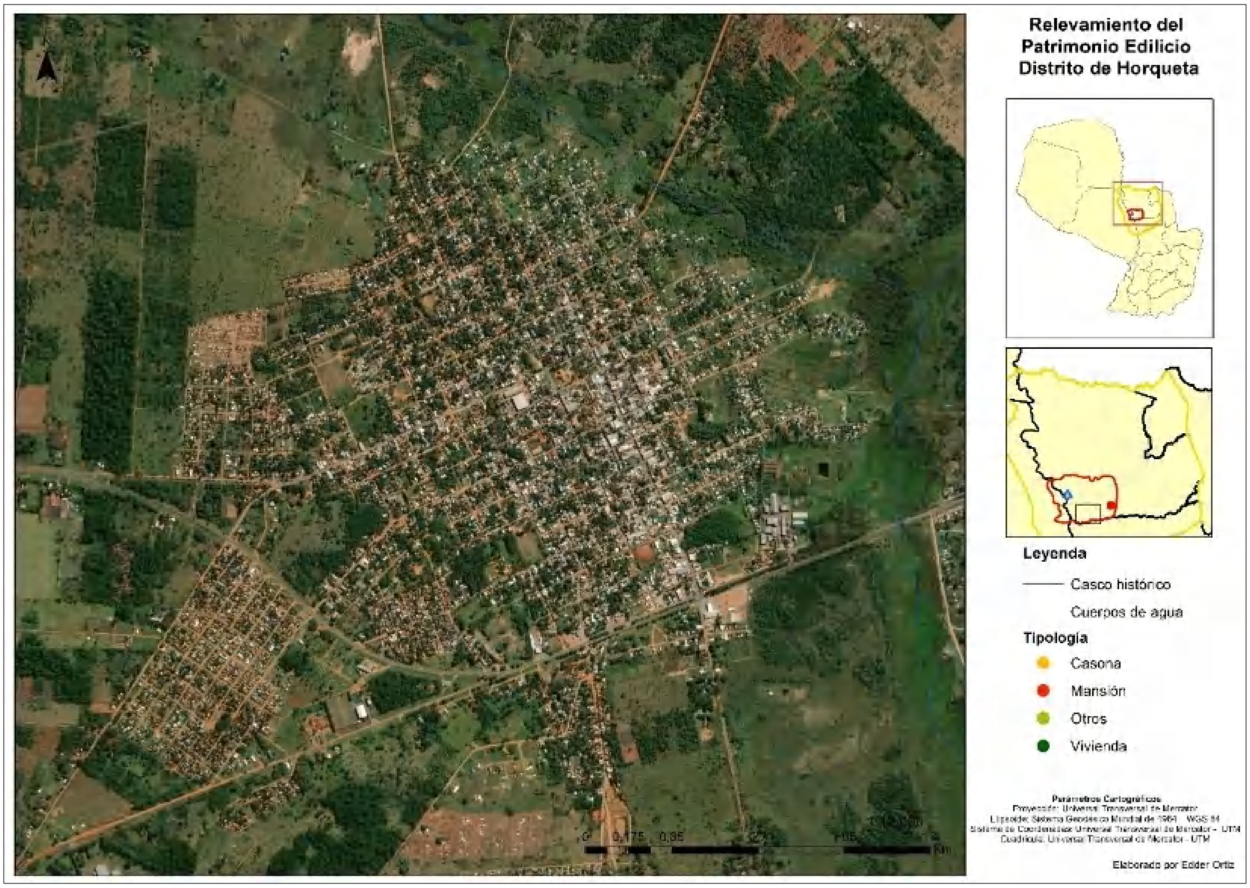


Illustration 39. House transformed into a corner with a cover type façade and ciborium on the cornice

Location: Mariscal José Félix Estigarribia esq. Curupayty. Horqueta.

Illustration 40. House in a corner with a cover type façade and ciborium and baluster

Location: Mariscal José Félix Estigarribia esq. Curupayty. Horqueta.

LORETO. The city of Loreto, capital of the district of the same name, is known first as "Paraje Jui´y, later "Capilla Zarza", to later be called Loreto, in honor of "Nuestra Señora de Loreto", it was founded by Jesuits, who arrived in 1686. The city of Loreto was founded on December 10, 1792. In the urban layout it is observed that the oldest houses are located in the center of the city and the newest ones are outside.

Map 19. Map of the city of Loreto – heritage survey

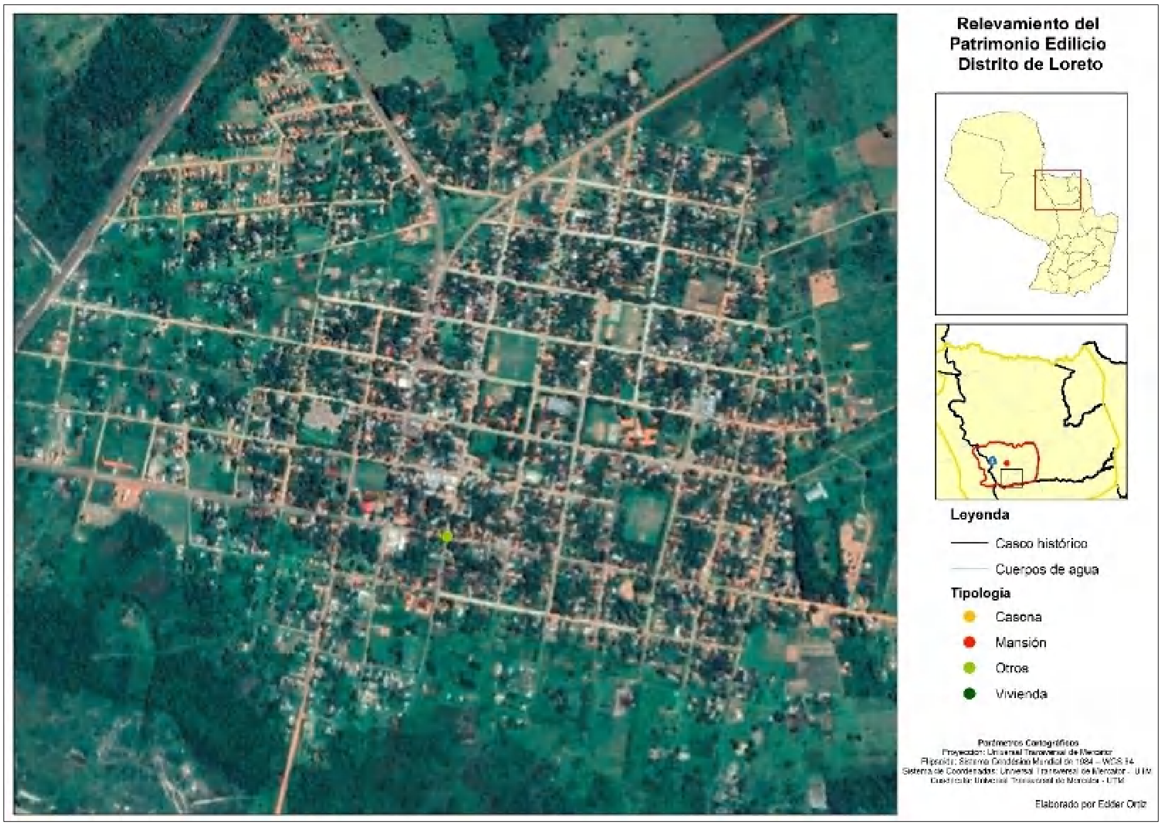


Illustration 41. House in a corner with cover type facade

llustration 42. House of colonial style with frontal gallery

-23 16 37 -57 19 38

4.4.3.2. Intangible or inmaterial heritage

Intangible cultural heritage has been defined as: "*the uses, representations, expressions, knowledge and techniques - together with the instruments, objects, artifacts and cultural spaces that are inherent to them - that communities, groups and in some cases, individuals, recognize as an integral part of its cultural heritage. This intangible cultural heritage, which is transmitted from generation to generation, is constantly recreated by communities and groups based on their environment, their interaction with nature and their history, infusing them* *with a feeling of identity and continuity and thus helping to promote respect. of cultural diversity and human creativity"*[138].

Chart 86. List of intangible heritage relevant in the AID

Intangible Heritage	Place/locality/District
Pieces of the Municipal Museum of the Barracks of the Villa Real of Concepción.	Concepción
Pieces of the Diocesan Museum of Sacred Art	Concepción
Monument to the Virgen María Auxiliadora	Main Street - Av. Agustín Fernando de Pineda. Concepción
Obelisk to the Virgen de Fátima	Concepción
Obelisk to the Indian	Concepción
Monolith of the Tropic of Capricorn	Belén
Monument to the Republic.	De la libertad Square or Fundacional Square, Concepción.
Bas-relief of Concepción Foundation	Pinedo Square, Concepción
Outdoor museum	In the East Boulevard, Concepción

Festivities. The management festivities or major festival shall be understood as the set of solemnities with which a population –may be neighborhoods, in the case of large cities– annually celebrates the date of its patron saint. It is a tradition implanted, essentially, in the countries of Hispanic culture[139]. These festivities usually include religious acts such as a solemn office– and pagan celebrations that take place in the streets of the town, such as parades, concerts, dances, festivals, fairs, children's games, bullfights and rides.

Chart 87. List of relevant Patronal Feasts

	Patronal Feasts/others	Date	Place/locality/District
1	Nuestra Señora de La Paz	January	Belén (AID)
2	Paje Festival - Anniversary of the City of Belén	January	Belén (AID)
3	Civil, Student, Police and Military Parade in Tribute to the City of Horqueta	January	Horqueta (AID)
4	Patronal Feast for María Auxiliadora	January	Concepción (AID)
5	Student Festival – Foundation of Concepción.	May	Concepción (AID)
6	Student, Civil, Police and Military Parade / Tribute to the Villa Real of Concepción Foundation	May	Concepción (AID)
7	Patronal Feast: San Juan Bautista	June	Yby Yaú
8	Integration Part	July	San Lázaro (in Vallemí)
9	North Expo	September	Concepción (AID)
10	Festival in Tribute to the Youth of Concepcion	September	Concepción (AID)
11	Paraguay River Festival	October	Concepción (AID)
12	Patronal Feast: Virgen del Rosario	October	Horqueta (AID)
13	Festivity Nuestra Señora Aparecida	October	Yby Yaú
14	Patronal Feast: Virgen de Fátima	October	San Lázaro (in Vallemí)
15	San Carlos de Borromeo	November	San Carlos del Apa

138 Convention for the Safeguarding of the Intangible Cultural Heritage convened by UNESCO, held in Paris, 2003.
139 Convention for the Safeguarding of the Intangible Cultural Heritage convened by UNESCO, held in Paris, 2003.

16	Apa River Festival.	November	Vallemí
17	Nuestra Señora de la Inmaculada Concepción	December	Concepción (AID)
18	Nuestra Señora de Loreto	December	Loreto
19	San Lázaro	December	San Lázaro

Illustration 43. Monolith María Auxiliadora – main street

4.4.3.3. Natural Heritage

It is the set of natural or environmental assets and wealth that society has inherited from its predecessors. It is made up of: natural monuments made up of physical and biological formations or groups of such formations that have exceptional universal value from an aesthetic or scientific point of view, geological and physiographic formations and strictly delimited areas that constitute the habitat of animal and plant species, threatened or endangered, natural places or strictly delimited natural areas (such as national parks, nature reserves, conservation areas, among others) that have an exceptional value from the point of view of science, of conservation or natural beauty[140].

Chart 88. List of relevant natural heritage: Protected areas and reserve in the area of the project/ AID

	Natural Heritage	Area (Ha)	Norm for its creation	Bonding
1	Paso Bravo National Park	93,612	Decree Nº 20712/98	All
2	Serranía San Luis National Park (1991/2010)	10,282	Decree Nº 11964/91	All
3	Bellavista National Park	7,397	Decree Nº 20713	All
4	Private Natural Reserve Cerrados del Tagatiya	5,281	Decree Nº 7791/06	All
5	Private Natural Reserve Tagatiya mi	28,755	Nº 10396/07	All

140 https://moodle2.unid.edu.mx/dts_cursos_mdl/lic/ET/FT/AM/09/Patrimonio_clasificacion_y_definiciones.pdf

	Natural Heritage	Area (Ha)	Norm for its creation	Bonding
6	Natural Monument Santa Elena	36	Law Nº 4577/11	All
7	Natural Monument Cavern Kamba hopo	17	Law Nº 4577/11	All
8	Natural Monument Tres Cerros	140	Law Nº 4577/11	All
8	Natural Monument Cerro Morado Cavern Ycua pa`i	77	Law Nº 4577/11	All
10	Private Natural Reserve Guayacan I, II y III	1,447	Decree 1230/	All
11	Private Natural Reserve Kai Rague	1,769	Without data	All
12	Place RAMSAR Estero Milagro	26,503	Law Nº 350/94	All
13	Private Natural Reserve Arrecife	7,812	Without data	All
14	Area of Indirect influence Cerrados of the Apa River Biosphere Reserve		267 836 ha.	All
		183,128		

Source: MADES, 2018; Guyra Paraguay, 2007 IBas. Among the areas of importance as bird conservation sites (Ibas) there are 4 recognized for the study area (Guyra, 2017): Ypane medio - Tagatiya Stream - Estrella and Cerrados de Concepción.

4.4.3.4. The Cultural-natural Heritage

The Cultural-Natural Heritage is made up of elements of nature, which are kept in their original context, intervened in some way by human beings. Examples of this are: archaeological or historical remains in their original natural context; paleontological fossil remains associated with human activity in situ; underwater vestiges of human activity, and the cultural landscape, produced in a certain time and space, which has remained unchanged.

For the project area, we can mention the presence of reported paleontological remains (Báez Presser, et al. 2004), both in flora and invertebrates. In the case of Flora, they mention that the first fossil vegetables of Paraguay, such as fern and coniferous woods, were found in the surroundings of the city of Villarrica, Department of Guairá, by Carnier in 1911, which was cited in Eckel (1959). Predominantly carbonate exposures from the Corumbá Group in Brazil, known as the *Itapucumí* Group in Paraguay (Concepción area), presents a paleontological content that includes the macroscopic alga T*yrasotaenia* sp. (Zaine, 1991), in addition that it is associated with the primitive invertebrates *Claudina lucianoi and Corumbella werneri* and the *microfossil Sphaerocongregus variabilis* (Zaine, 1991) (= *Bavlinella faveolata cf. Boggiani et.al.,* 1993)[141].

Regarding archaeological sites, we can mention the presence of potential sites of Mbayas and other indigenous peoples, associated with the use of temporary fishing areas. Archaeological research reports mention the presence of shells, bone remains and ceramics with sgraffito and painted designs, at the level of the upper parts of the banks of the Paraguay River, up to the area of Corumba, Brazil, and linked by Susnik (1978) to Paraguay, with the archaeological finds in Belén (Concepción department).

Current investigations in Brazil and Argentina validate and complement these links, and indicate the presence of pre-Hispanic societies along the entire Paraguay River, with radiocarbon dates from ca. 100 BC until ca. 300 AD for the Pantanal Tradition (Lamenza, 2015).

Regarding Rock Art in the project area, there are reports of findings and photographs of Dr. Carlos Teichmann (1904) in a place called Barrero Guaá, near Gamarra-cué, a place located at the headwaters of the Tagatiyá stream (AII), Department of Concepción (Díaz-Pérez, 1904).

141 https://www.researchgate.net/publication/263727484_ALGUNOS_ANTECEDENTES_PALEONTOLOGICOS_DEL_PARAGUAY

4.4.3.5. Gastronomic/Culinary Heritage

Culinary heritage will be understood as the element of cultural communication, and in this both the cultural traditions and the natural idiosyncrasies of a place are manifested. Cuisine and gastronomy imply an indissoluble relationship between rural life and the service sector. Thus, gastronomy is local development and also tourism development [142].

In 2017, the National Secretary of Culture decided: "To declare as Intangible Cultural Heritage of Paraguay the production, artisanal and traditional elaboration of four typical Paraguayan foods still in force such as vori-vori, locro, sopa paraguaya and yopará (mixture bean and locro); and thus also its recipes, knowledge, practices and knowledge that are transmitted from generation to generation and the material and immaterial elements associated with it (corn, in its different varieties) are documented as a cultural manifestation"[143]. Next, chart 89 lists the relevant gastronomic heritage.

Chart 89. List of relevant typical food with local testimony

Food		Ingredients	Testimonies
Based on flour and vegetables			
1	Pirón	Onion, oil or fat, water, manioc flour, and salt	**JB**, It's like ... reviro. In a cast iron pot, the fat is melted ... it is fried and mixed with the fariña ... it must be mixed to avoid burning and generating lumps
2	Locro	Locro and fried vegetables with various seasonings	**PAEZ.** The Páez family mentions, who are dedicated to the manufacture of desserts and sweets ... that nowadays the locro is no longer as before ... it is smaller and is no longer consumed as before. Its preparation process begins early in the morning, since it takes a long time to cook
3	Poroto Ipokue (Poroto with cow leg)	Beans, leg of the cow, vegetables, and various condiments.	**PAEZ**. Its preparation process would begin with the frying of the vegetables (onion, bell pepper, tomato and garlic), and spices... add the water, the beans and the cow leg... let it boil until it is soft and flavored
4	Polenta - Mbaipy	Corn flour, natural fat, Paraguay cheese, and minced meat as a final sauce	**PAEZ**. You must fry the onion, garlic, tomato and bell pepper and spices are fried ... add the water and boil it with avati morotî corn flour, until it thickens ... then the meat is minced and a separate tomato sauce is made, which is put on top of the polenta.
Based on fish			
1	Sardina	Small fish, seasonings and vinegar	**JB**. Small fish... they are boiled in a pressure cooker... and vinegar is added to let them rest.
2	Piracaldo	Fish: Surubí, Mandi'i, Tres Puntos and/or Pico de Pato; Paraguay cheese, milk, onions, bell peppers and garlic	Brown the vegetables in a pot, put hot water in the pot, place the fish fillet, wait for it to cook and pour water, mix and wait for it to boil
3	Chupín		**CD**. It has the same process as the broth pyre, but milk or cream is added to it..

142 Francesc Fusté-Forné - Universitat de Girona. 2016. The landscapes of culture: gastronomy and culinary heritage. In: DIXIT vol.24 No.1 Montevideo. Available in: http://www.scielo.edu.uy/scielo.php?script=sci_arttext&pid=S0797-36912016000100001
143 http://www.cultura.gov.py/2017/08/cultura-declara-patrimonio-cultural-inmaterial-del-paraguay-la-sopa-paraguaya-el-vori-vori-el-locro-y-el-jopara/

	Food	Ingredients	Testimonies
Based on meat			
1	So'o hu'û (soft meat)	Meat and offal	**CD.** The meat is boiled with other giblets.
2	Morcilla - Mbusia	Thick casing	**EO**. In family gatherings an animal is butchered ... the blood and intestines are collected, which are cleaned and later stuffed as sausage ... this work begins early in the morning ... and the Mbusia stuffing begins ... and must be finished to 10 am, where its broth with blood sausage and other giblets (churra) ... and is served as the first course of roasts and preferably for older adults.
3	Caldo Ava	Offal onion, green onion, locote, spicy bell pepper and parsley	It is a broth or soup that is obtained by boiling all the giblets of the cow in water, cooking them, mainly the tripe (intestines and belly of the cattle), the booklet (the third of the four cavities into which the stomach of ruminants is divided), the fat intestine and the chinchulín, the latter the edible small intestine
4	Akangue yvyguy (buried head)	Cow's head	**JC.** First, a hole of approximately 75 x 75 centimeters is dug in the ground in which pieces of firewood are placed for an hour, which acquires the necessary heat for cooking. Next, a bed of banana leaves is made, where the head of the cow is placed wrapped in banana leaves, tied with wire, later it is wrapped in a burlap cloth and tied with wire. Formerly, banana leaves were placed on top of which they were covered with earth and with a wooden lid. Currently, a metal sheet is placed and the earth on top, for half a day of cooking.
5	Asado a la estaca (Stake Roast)	Meat	**EO; JC.** This meal is generally for large events since the pieces of meat are selected whole pieces, crossed with sticks of guayaibi of approx. 1.50 meters. A well is made where the curupay wood is burned in such a way that the fire does not expand, and the stakes are supported on other wood that serves as a support.
6	Caldo Ava	Offal	It is a soup made from the giblets of the cow, it has a dense and dark consistency, but it has a good flavor and a lot of caloric value.
7	Carretero Rice	Dried meat	There are several ways of cooking, one is to fry the vegetables, add water and then the rice, cut the jerky into small pieces and place it on the rice, the order usually varies.
Sweets			
1	Dulce de leche	Cow's milk and sugar	**CC.** The sugar is melted to the point of caramel ... the milk is poured in and stirred until it has a solid, thick and creamy consistency.
2	Pumpkin Sweet – andai	Pumpkin and sugar	**JC**. The sugar is boiled with the water ... until it is completely diluted ... then the sucker is placed one day in advance ... it is cleaned ... and left to boil until the water evaporates.
3	Papaya Sweet	Papaya and sugar	**JC.** The sugar is boiled with the water ... until it is completely diluted ... then the papaya is placed one day in advance ... it is cleaned ... and left to boil until the water evaporates

Food		Ingredients	Testimonies
4	Cow's leg sweet (cow's leg jelly)	Osobuco of cow's leg, milk, cloves and sugar.	**JC.** The cow leg is boiled until the ossobuco softens, with the obtained broth it is mixed with milk and sugar, it is left boiling, stirring until all the ingredients are mixed, at the end the cloves are placed and left to cool at room temperature until it is hardened like a flan.

Source: CC: Crispín Concha (Piquete Kue) – JC: Juana Cubilla (Horqueta) – EO: Edder Ortiz - CD: Celeste Díaz. - PAEZ: Family (Concepción). -ID Irene Díaz (Concepción). Own elaboration

4.4.4. Final Thoughts

Based on a primary archaeological and historical assessment, based on the secondary information available (historical antecedents and local testimonies), added to the field survey carried out in the area of direct and indirect impact of the project, the importance of a cultural territory can be affirmed. rooted, with local testimonies alive and present in his experiential imagination. For each of the documented testimonies, an assessment is made and measures are proposed that generate a cultural Rooting and protection of the present collective memory.

Regarding the valuation and potential social impacts, both in the Direct and Indirect Area of Influence of the project, specifically with regard to intangible cultural heritage, we can mention that it could suffer a moderate to significant alteration, due to changes in habit and significance as social capital. The presence of external personnel, to complete the spatial modification of the project in the first part, is also considered a cultural impact on the uses and forms of appropriation (livelihoods).

5. Survey of the Social Perception

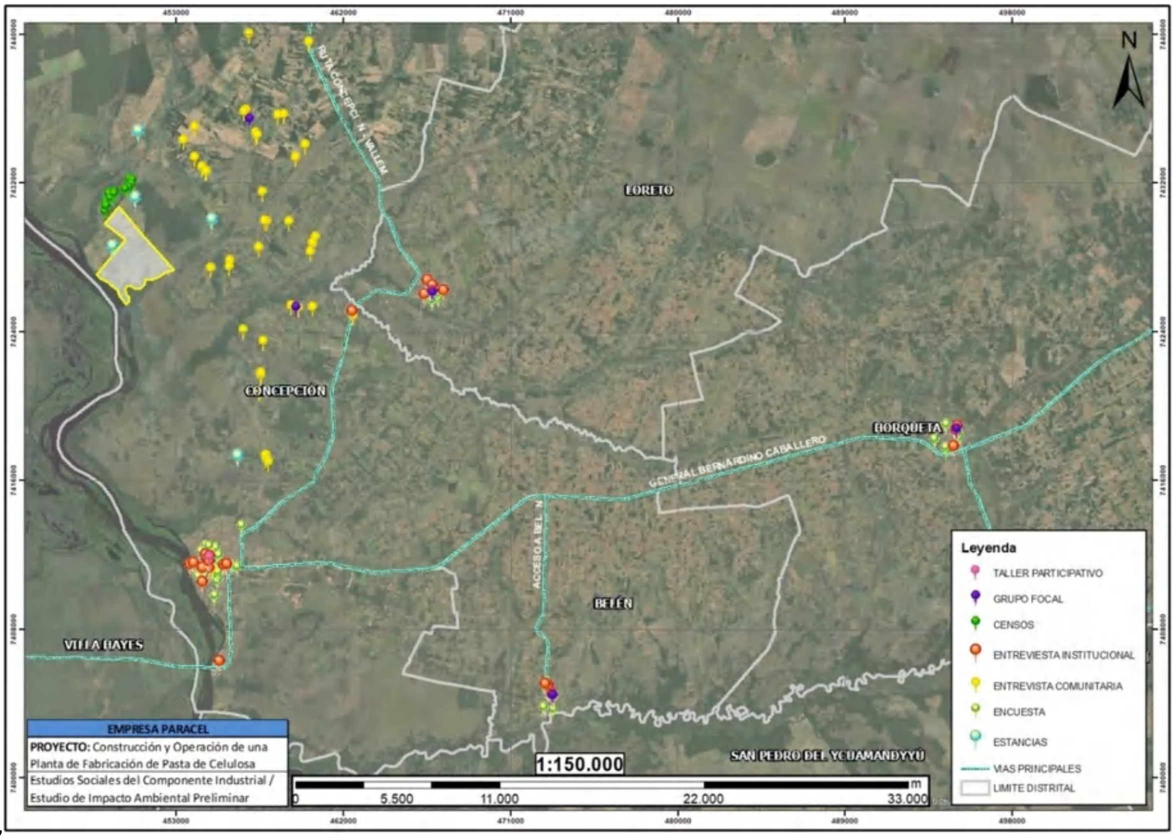
5.1. Presentation of the results of the perception survey

As indicated on the map, and as mentioned in chapter 3 of Methodology for the Preparation of Social Studies, the work carried out in the territory had as a transversal axis the survey of social perception regarding the socioeconomic characteristics of the area and of the mill installation.

This work of collecting both quantitative and qualitative data in the territory was carried out in the ADA and the AID through the use of several techniques that allowed access to individual information, such as a census of families located in the immediate environment of the prospecting area of the draft; interviews with key institutional and community stakeholders, as well as surveys at strategic points in the districts involved. Likewise, community focus groups and a participatory workshop of institutional actors were held in the city of Concepción, capital of the department, spaces from which qualitative information was obtained that was used (in the case of this section) as a complement to the analysis to be presented.

The information gathering process involved all 316 people from the Concepción district, including the Piquete Cue community and ranches located in the ADA; and to the existing micro-territories in the area the accesses to the mil, also in the districts of Loreto, Belén and Horqueta. People who mostly showed openness and predisposition to the queries and the delivery of information made by the team in each of the spaces created for this purpose.

Map 20. Geo reference of hte field survey areas


N
LORETO
CONCEPCIÓN
BORQUETA
BELÉN
VILLA HAYES
SAN PEDRO DEL YCUAMANDYYU
GENERAL BERNARDINO CABALLERO
Leyenda
TALLER PARTICIPATIVO
GRUPO FOCAL
CENSOS
ENTREVIESTA INSTITUCIONAL
ENTREVISTA COMUNITARIA
ENCUESTA
ESTANCIAS
VIAS PRINCIPALES
LIMITE DISTRITAL
EMPRESA PARACEL
PROYECTO: Construcción y Operación de una Planta de Fabricación de Pasta de Celulosa
Estudios Sociales del Componente Industrial / Estudio de Impacto Ambiental Preliminar
1:150.000
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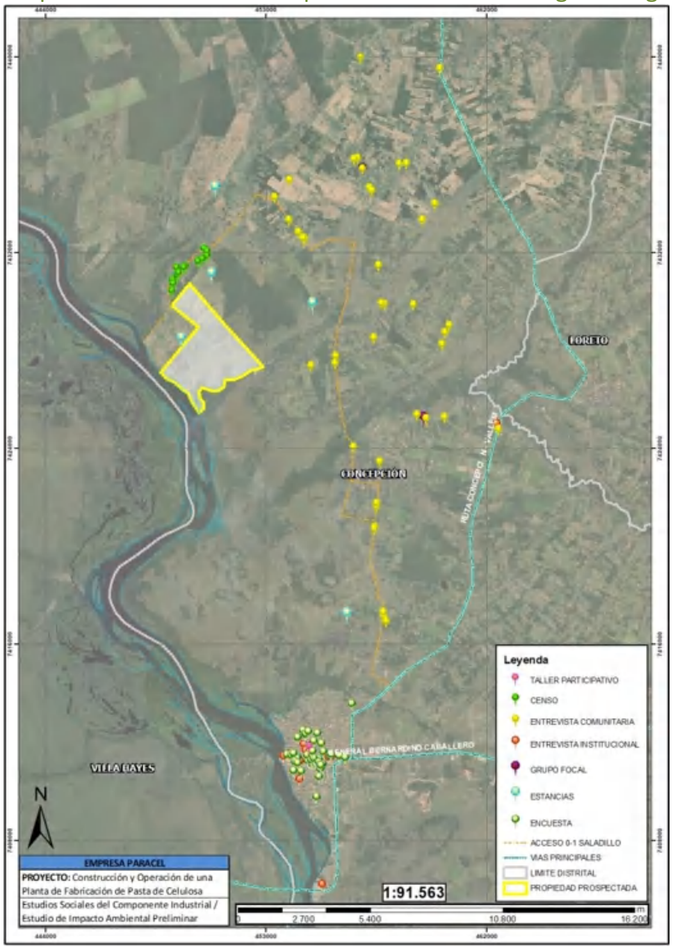
Map 21. Localization of the process of information gathering



Areas where the information gathering process was carried out on people from the Concepción district, includes the Piquete Cue community and stays in the ADA; and to micro-territories in the mill access area

District of Concepción

District of Belén

District of Horqueta

District of Loreto

Chart 90 describes each of the techniques used by area, number of people consulted and the resulting sources of verification.

Chart 90. Techniques used in the intervention

ACTIVITY	Zone/district/ micro-territory	Number of people involved	Sources of verification resulting	Picture Registry
Socioeconomic Census Census records were applied to the families living in the immediate surroundings of the mill.	ADA- Piquete Cue Community	12 heads of household	Census file Worksheets case by case Photographic record	
Interviews in Ranches Semi-structured questionnaires were applied to owners or managers of mostly livestock establishments	ADA- Piquete Cue Community and nearby areas	1 owner and 3 people in charge of the ranches	Photographic record Written record of each interview	
Key stakeholder interviews Semi-structured questionnaires were applied to key actors from public institutions, the private sector, and civil society organizations, among others	AID- districts of Concepción, Loreto, Belén and Horqueta	28 actors/referents of the Government of the department, municipalities, regional offices of ministries and national secretariats, universities, Associations, social and religious organizations, among others.	Photographic record Written record of each interview	
Interviews with community actors Semi-structured questionnaires were applied to referents of the micro-territories identified in the area near the Mill	AID- district of Concepción and 18 Micro-territories located at the margin of the Access roads to the Mill area.	44 actors/referents of educational institutions, small businesses, tourism and recreation enterprises, sanitation boards, neighborhood commissions, among others	Photographic record Written record of each interview	

ACTIVITY	Zone/district/ micro-territory	Number of people involved	Sources of verification resulting	Picture Registry
Participatory workshop with institutional actors from the city of Concepción A program was generated including the delivery of official information by the company and semi-structured questionnaires were applied in working groups during the day	AID- City of Concepción	11 referents from sectors such as the public, private, academia, civil society, among others	Signature sheet Photographic record Written record of the activity	
Focus groups with community actors Semi-structured questionnaires were applied during the development of all 5 focus groups	AID- Districts of Concepción (Micro-territories), Loreto, Belén and Horqueta	67 referents of neighborhood commissions, peasant organizations, water and sanitation boards, educational institutions, small businesses, tourism and recreation enterprises, among others	Signature sheet Photographic record Written record of the activity	 
Perception surveys They were applied by means of the elaboration of an instrument with mostly closed and open questions, interest groups were taken into account according to profile	AID- Districts of Concepción, Loreto, Belén and Horqueta	150 people, students, university students, teachers/directors of educational institutions, merchants, hotel and tourism references, white-collar personnel, people in religious, recreational and organizational spaces	Signature sheet Photographic record	

Source: Own elaboration based on the field work done during December, January and February 2020.

A continuación, se presentan los resultados obtenidos, estos serán expuestos de manera general. Es decir, considerando la totalidad de personas consultadas y cada técnica involucrada por distrito. Sin embargo, es importante resaltar los siguientes aspectos:

- Certain results will be specified by area of influence or group differentiated by technique used whenever it is considered important to highlight aspects; that might otherwise get lost in the generality.
- Although the general results are exposed, the results according to the technique used and area of influence can be consulted in attached documents.

- Certain results will be specified by area of influence or group differentiated by technique used whenever it is considered important to highlight aspects; that might otherwise get lost in the generality.

- Although the general results are exposed, the results according to the technique used and area of influence can be consulted in attached documents.
- The information recorded from the focus groups and participatory workshop has served as a complement when analyzing both quantitative and qualitative results, in most cases, reaffirming positions and/or opinions of responses obtained through the other techniques used.
- The number of factors mentioned by the people consulted were taken into account for the processing of the information and the presentation of results, considering the number of times each one was mentioned, for this reason in many cases the number of responses or factors is greater than the number of people involved.

5.1.1. Social Perception of the Socioeconomic Characteristics of the Area

As part of the survey in the territory, a range of questions was included regarding the way in which people perceive the place they inhabit, social, economic, cultural characteristics, etc.; frequent problems, the strengths of the area, aspects considered by them as fundamental for development, among others. The results will be presented considering the areas of influence in which the field social work was carried out, initially in the ADA and later in the AID.

5.1.1.1. Socioeconomic Characteristics of the ADA – Social Perception

In the ADA, the 12 families and 4 referents of the ranches that adjoin the surveyed area were consulted (Picket Cue).

Main Economic Activities of the District/Locality

Both the registered families located in the immediate surroundings of the Mill and the interviewed referents of the ranches, when consulted regarding the main economic activities in the area, have mainly mentioned Livestock and Agriculture, with a predominance of small-scale livestock (between 10 and 15 heads) mainly for consumption and for sale. In the case of the ranches, the interviewees commented on the roles in the families, “the men work in the neighboring ranches doing specific tasks and others go to ranches in the Chaco while the women stay to take care of the house and the animals.” (Referring to those who work as day laborers). It was also mentioned that there are small businesses in the area; pantries, motorcycle workshop and mini-cargo (for cell phones), among others.

Chart 91 shows the results of the socioeconomic census regarding this item.

Chart 91. Main economic activities of the population

Main economic activities mentioned	Amount
Agriculture	7
Cattle Raising	**12**
Coal/Charcoal	3
Cheese Sell	1

Source: Socioeconomic Census in the ADA - Piquete Cue. January 2020

As can be seen, livestock was mentioned by 100% of the people surveyed, that is; 12 times as the main economic activity in the area and in particular Piquete Cue.

Positive Aspects of Living in the Community

Regarding the positive aspects of living in the community, in the ADA, the people consulted agreed that the “tranquility” factor is a very valuable aspect of the area, being mentioned not only by 100% of the people surveyed but also By all the interviewees from the ranches involved in this area, likewise, “the environment/landscape” was the next aspect considered positive by both groups, followed by “safety” in the case of the people surveyed and “the absence of contamination ”By the people interviewed from the ranches.

Chart 92. Aspects which population mentioned as positive

Positive aspects of living in the community	Amount
Environment/landscape	8
Security	6
Tranquility	**12**
People	4
Little pollution	1
Others: Rooting	1
Total	**32**

Source: Socioeconomic Census in the ADA - Piquete Cue. January 2020.

Problems identified in the community

The people involved in the survey in the ADA mentioned among the main problems identified in the community, emigration and migration (in the first place), the interviewees of the ranches gave the example of workers who are forced to move to the Chaco in the absence of of job offers in the area in which they reside, also those who for the same reasons emigrate to Spain or Argentina, losing the link with their places of origin. Next, both groups mentioned in turn, the low labor supply itself, the problems of access due to poor condition or lack of roads, cattle rustling as a latent difficulty, especially in the case of stays, and also the scarce police presence in the area.

Chart 93. Problems identified by censed families

Main problems identified in the community	Amount
Rustling	2
Emigration and migration (city countryside)	6
Little job offer	4
Alcoholism	2
Little cultural and recreational offer	1
Insufficient communication service	1
Access problems: Lack of more roads and poor condition than there are	3
Insecurity	1
Total	

Source: Socioeconomic Census in the ADA - Piquete Cue. January 2020.

Priority Aspects for Community Development

In the ADA, a prioritization was requested regarding the aspects that people consider important to increase the development of their community, given this, the factor mentioned the most times within the highest range (5) by people Census corresponds to “work” -7-, later the factor “Access to basic services (mainly water)” -3- and finally “Education and Culture” -1-. And most of those interviewed in the ranches referred that the main factor to promote the development of the area is related to the generation of sources of work. The second factor with access to education due to the training need to access jobs and the need to have Family Health Units (USF) according to the needs of the area. Finally, the importance of Rooting and road improvement was mentioned.

Chart 94. Priority aspects selected by censed people in Piquete Cue (ADA)

Priority aspects for their community’s development	Priority Range					Amount
	5	4	3	2	1	
Access to basic services (mainly water)	3(25%)	2 (16.67%)	1 (8.33%)			6
Education and culture	1(8.33%)		1 (8.33%)	1 (8.33%)	1 (8.33%)	3
Job	7 (58.33%)		1 (8.33%)	-	1 (8.33%)	9
Communication and Transportation	-	2 (16.67%)	1 (8.33%)	2 (16.67%)	-	5
Territorial development	-	1(8.33%)	3 (25%)	1 (8.33%)	-	5
Health	-	3 (25%)	4 (33.33%)	2 (16.67%)	1 (8.33%)	10
Agriculture and environment	-	2 (16.67%)	-	1 (8.33%)	3 (25%)	6
Livestock and Productivity	-	1(8.33%)	-	-	2 (16.67%)	3
Waste and collection and treatment system	-	1(8.33%)	-	-	-	1
Social care	-	-	1 (8.33%)	4 (33.33%)	2 (16.67%)	7
Security	-	-	-	1 (8.33%)	2 (16.67%)	3

Source: Socioeconomic Census in the ADA - Piquete Cue. January 2020.

Most Important Recreational and Cultural Activities at the Community Level

In the ADA both groups mentioned various recreational and cultural activities such as: Attending patron saint festivities, lacerated, organizing and attending both male and female soccer tournaments and to a lesser extent, going fishing, going to mass, birthdays in the community and going to the watering places.

Chart 95. Recreational and cultural activities mostly mentioned

More important recreational and cultural activities	Amount	Percentage
Patronal Party	11	91.67%
Lacerated	5	41.67%
Soccer tournament (men and women)	4	33.33%
Fishing	2	16.67%
Mass	2	16.67%
Birthdays in the community	2	16.67%

Watering Places	1	8.33%
Total		**100%**

Source: Socioeconomic Census in the ADA - Piquete Cue. January 2020.

Most Used Media in the Area

All the interviewees of the stays mentioned that the most used means of communication is the cell phone through social networks (WhatsApp, Facebook), the most watched television channel is Telefuturo and one of them mentioned that he uses cable television. Among the most listened to radio stations are: Regional Radio, Aquidabán and Radio Norte. In the case of those surveyed, the responses are shown in Chart 96:

Chart 96. Means of Communication

Means of Communication	Amount
Official radio media and alternative radio media (community radios). (Teko Pyahu Loreto, Regional 660 AM Concepción, Primavera community radio, La Mega)	10
TV: Telefuturo, Cable, Channel 40 of Concepción.	10
Social networks: Facebook and WhatsApp	5
Total	**25**

Source: Socioeconomic Census in the ADA - Piquete Cue. January 2020.

As can be seen, and unlike the group of interviewees from the stays, 83.33% (10 out of 12) mention that the most used media in the area are: official and alternative (community) radio stations, as well as TV that was also mentioned by 10 people (83.33%); the minority 41.67% (5 of 12) responded that the most used media are social networks.

Socioeconomic Characteristics of AID – Social Perception

In the AID, all 300 people were involved in the different consultation spaces already mentioned at the beginning of this section. From this process, the following results have been obtained:

Chart 97. Economic activities

Economic Activity	Concepción	Horqueta	Loreto	Belén	Total
Agriculture	66	16	14	7	**103**
Cattle Raising	76	11	10	10	**107**
Small Cattle	6	1	0	0	**7**
Trade	73	11	18	19	**121**
Laborer/Changa	26	3	2	1	**32**
Tambo	2	2	1	0	**5**
Fishing	4	0	0	0	**4**
Goods and services	12	0	1	3	**16**
Public function	2	2	4	1	**9**
Financial	1	1	0	0	**2**
Industry	7	1	0	18	**26**
Tourism	2	0	0	4	**6**
Retired	0	0	1	0	**1**
Productive cooperatives	0	2	2	0	**4**

Economic Activity	Concepción	Horqueta	Loreto	Belén	Total
Construction	1	2	4	1	**8**

Source: Social work in the field. January and February 2020.

Regarding the main economic activities in the area, the three most indicated categories in the districts of Concepción, Horqueta and Loreto were agriculture, livestock and commerce. In Belén there is a variation considering that the industry is registered as the 2nd most mentioned category.

In general terms, it can be observed that the 4th factor most referred to is the one corresponding to wage work or changa, where those who are inserted in this labor segment are largely employed in the informal sector; receiving a daily or piece rate remuneration. Examples include the work carried out in the ranches (wiring, carp, sowing); the sale of fruit and vegetable products in fairs organized on a weekly basis or the sale of yuyos, chicken, egg, milk, cheese or other remedies on an itinerant basis.

Agriculture and livestock are mostly carried out on a small scale and for the consumption of families. As part of agricultural production, the cultivation of sesame, corn, manioc, pineapple, tomato, watermelon, cotton and spurge are mentioned.

Livestock has the particularity of being an item that operates as a savings system for families since the animals are sold or slaughtered according to need or in case of emergencies. To a certain extent, they supply the refrigerator companies in the area and mostly work for sale and consumption by the families in the places where they reside.

Trade is an activity that has been increasing in recent years. As an example, the following are cited: gastronomic ventures (pizzerias, lomiterías, food park, dining rooms), hardware stores, distributors, transporters, supermarkets, pantries, warehouses and others.

The secondary sector is represented by the cement, lime and refrigeration industries as reported by the people who participated in the consultation process. These industries are initiatives that generate sources of income for the inhabitants of the area and are highly valued because there is a low labor supply and through them demand for labor is generated.

In this area, the participation of both women and men in the neighborhood courts or sports centers of the largest cities stands out. In addition, it should be noted that there are people of all ages who come to support their teams, so it becomes a collective activity attended by several people as spectators; even more so in the official Paraguayan indoor soccer tournaments.

Another of the mentioned edges belongs to the cultural environment, highlighting the reference to Patron Saint Festivities by the consulted actors. These are characterized by integrating a strong religious content in which festive acts are fused with beliefs, customs, and traditions.

The third most noted factor is the traditional livestock, industrial and commercial event called Expo Norte. It has been developed since 1989; under the organization of the Rural Association of Paraguay (ARP) and the Association of Merchants and Industrialists of Concepción (ACIC). It takes place in the first half of September at the Nanawa exhibition ground, located at km 2.5 of Route V.

The North Expo opens its doors to the general population with a great variety of attractions at an artistic, cultural, sporting and social level, in addition to the exhibitions presented by the exhibitors from different areas. Another of the activities referenced mainly at the community level is: assistance to watering places, streams, swimming pools or rivers that exist at the local level; and in the field of equestrian sport the competition of lasso or "laceada" that takes place in a terrain called lasso track where the objective is to link the cattle with a rope or lasso in the shortest possible time.

Chart 98. Recreational Activities

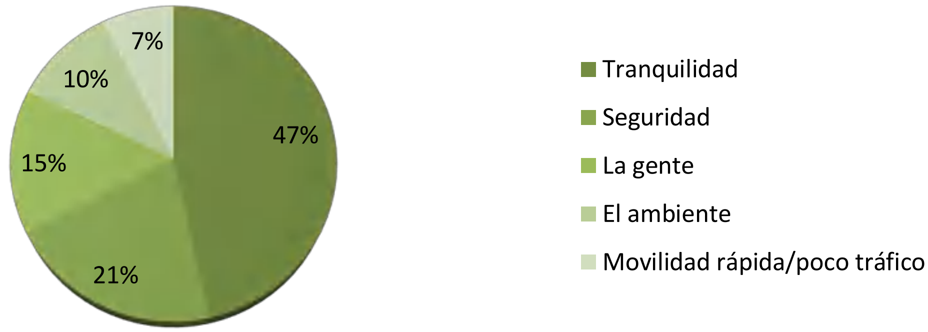
Zone	Concepción	Horqueta	Loreto	Belén	Total
Festivities	34	8	9	7	**58**
Founding party	0	2	0	1	**3**
Night parties (discos)	6	3	2	1	**12**
Arts festivals	9	4	9	1	**23**
Motorcycle/race rides	2	1	0	0	**3**
Soccer tournaments (hall, field)	63	22	13	8	**106**
Volley	10	1	0	0	**11**
Fishing	1	0	0	0	**1**
Boat tour	1	0	0	0	**1**
Skating	1	0	0	0	**1**
Basket	1	0	0	0	**1**
Dance	1	1	0	0	**2**
Swimming	0	1	0	0	**1**
Painting	1	0	0	0	**1**
Open spaces (plaza, parks)	3	0	2	0	**5**
Spas, streams, river, swimming pool	20	3	4	4	**31**
Jockey/horse race	6	2	1	0	**9**
Lacerated	15	1	1	1	**18**
Go to gastronomic sites	2	0	0	0	**2**
North Expo	28	3	1	2	**34**
tourism	1	1	0	1	**3**
Theater	4	0	0	0	**4**
Student Parade	11	2	5	14	**32**
Go shopping	0	1	2	1	**4**
Religious activities	4	2	0	0	**6**
Youth Group Meeting	1	0	0	0	**1**
Fund raising activities for social help	3	0	0	0	**3**

Source: Social work in the field. January and February 2020.

Positive Aspects of Living in the Area

The tranquility, the security, the people, the environment and the little existing traffic are the five most outstanding positive aspects of living in the area according to the data collected in the four districts of the study area. These elements refer to aspects related to the quality of life of the inhabitants.

Graphic 12. Valoration of positive aspects



Source: Social work in the field. January and February 2020.

In addition to the aforementioned aspects, unity and solidarity are also pointed out as part of the organizational component, followed by the importance of having land suitable for agricultural livestock production.

Chart 99. Main positive aspects mentioned of living in the zone

Positive Aspects	Concepción	Horqueta	Loreto	Belén	Total
Tranquillity	68	29	32	30	**159**
Security	21	15	11	24	**71**
Unity / Organization / Solidarity	10	3	2	6	**21**
Fast mobility / low traffic	9	4	1	11	**25**
The environment	25	7	2	2	**36**
The cost of living is lower	4	1	0	1	**6**
Rooting	4	0	0	1	**5**
Productive zone, fertile land	12	3	0	1	**16**
Area close to institutions and communities and access to benefits	9	0	0	0	**9**
Low rate of drug use	0	1	1	0	**2**
Investment area	1	0	0	0	**1**
People	33	6	4	7	**50**
Progress on the way and accesses	1	0	0	0	**1**
Industrial development	1	0	0	2	**3**
Offer of educational institutions	0	1	0	0	**1**
Freedom of expression	0	1	0	0	**1**
Little pollution	0	0	2	0	**2**
Cultural and recreational spaces	2	1	0	0	**3**
Job offer	4	4	3	2	**13**
Development of the commercial sector	1	2	1	1	**5**
Hospitality and Tourism	2	0	0	1	**3**
Water quality	2	0	0	0	**2**

Source: Social work in the field. January and February 2020.

Necessary Aspects for Further Development

The results obtained regarding this item will be initially presented as mentioned by the people consulted through the interviews, including key institutional and community actors, later the response of people who were part of the surveys carried out in the AID will be presented.

Necessary Aspects for Further Development

According to institutional and community actors interviewed: Infrastructure and road safety (17%) considering the importance of improving the state of roads and neighborhood roads; since many communities are isolated in times of rain. The second factor refers to the need to generate Work Sources (16%) in the study area due to the little or almost no existing labor supply, together with the importance of promoting or developing Technical Assistance programs (16%) for local ventures and initiatives with special emphasis on small and medium producers; Linked to this factor, the importance of strengthening peasant agriculture is mentioned (5%) accompanied by a market for the commercialization of existing production at fair prices (5%).

The third factor corresponds to the importance of installation and operation of industries (10%) considering that these can contribute to counteract the lack of job opportunities in the area.

Chart 100. Results of the consult about necessary aspects for development

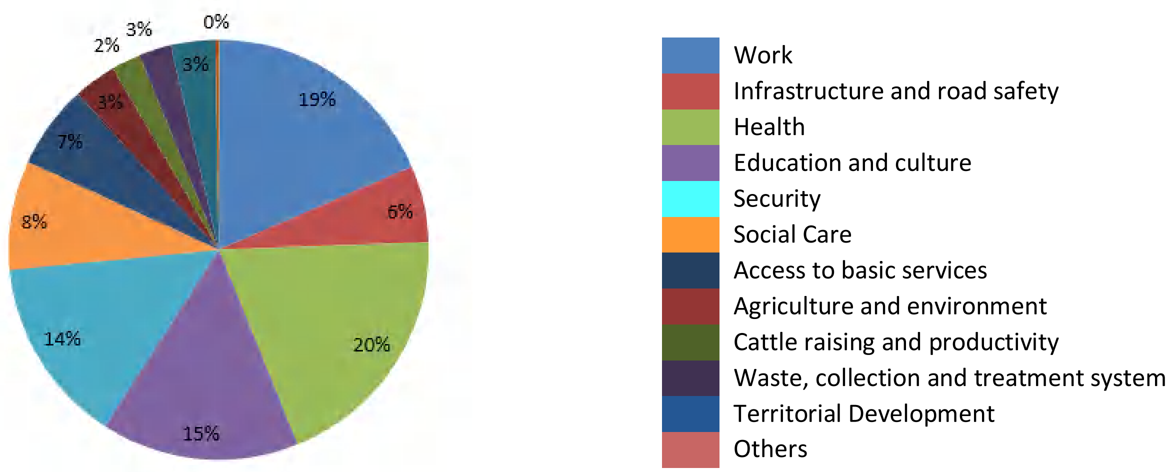
Development	Concepción	Belén	Loreto	Horqueta	Total	%
Education/training	6	1	0	1	**9**	5%
Technical assistance for local businesses and initiatives	24	1	2	0	**29**	16%
Strengthen peasant agricultural production		2	2	3	**9**	5%
Agrarian reform and organization		0	0	1	**2**	1%
Generation of work sources	19	2	3	3	**28**	16%
Health	8	0	0	1	**10**	6%
Market for the commercialization of production at fair prices	3	2	1	3	**10**	6%
Industries	10	0	1	5	**18**	10%
Local investment and new technologies		1	2	2	**7**	4%
Infrastructure and Road Safety	26	1	1	1	**31**	17%
Recreational spaces	1	0	1	0	**3**	2%
Depoliticization	1	0	0	0	**2**	1%
Local government improvement	1	0	0	0	**2**	1%
Dynamization of the local and departmental economy.	1	0	0	0	**2**	1%
Drainage and sanitation.	1	0	0	0	**2**	1%
Lack of political will.	1	0	0	0	**2**	1%
Supply market	0	1	0	0	**1**	1%
Strengthen SMEs	0	1	0	0	**1**	1%
Rooting	2	0	1	0	**3**	2%
Strengthen livestock production.	0	0	0	1	**1**	1%
Transparent competitions to access public office eradicating prebendaries and patronage	0	0	0	1	**1**	1%
Access to basic services	2	0	0	0	**2**	1%

Access to education	4	0	0	0	**4**	2%

Source: Social work in the field. January and February 2020.

Aspects needed for further development according to censed people in the AID

Graphic 13. Priorities for further development



Source: Social work in the field. January and February 2020.

It can be seen that the priority factors are: Health (20%) related to the need to improve access to quality care, the importance of having health units close to the communities and that they have equipment, infrastructure and basic supplies for proper care.

The second factor corresponds again to the need for labor supply in the area (19%). Emphasizing that the districts have a qualified workforce that cannot practice their profession due to the low existing labor supply or the high rate of young workforce that is forced to migrate to other cities for greater employment opportunities.

The third factor with the highest mention is the prioritization of education and culture (15%), linked among other aspects to the possibility of accessing university and improving the educational level of many young people who, due to low family income, are unable to attend. continue with studies.

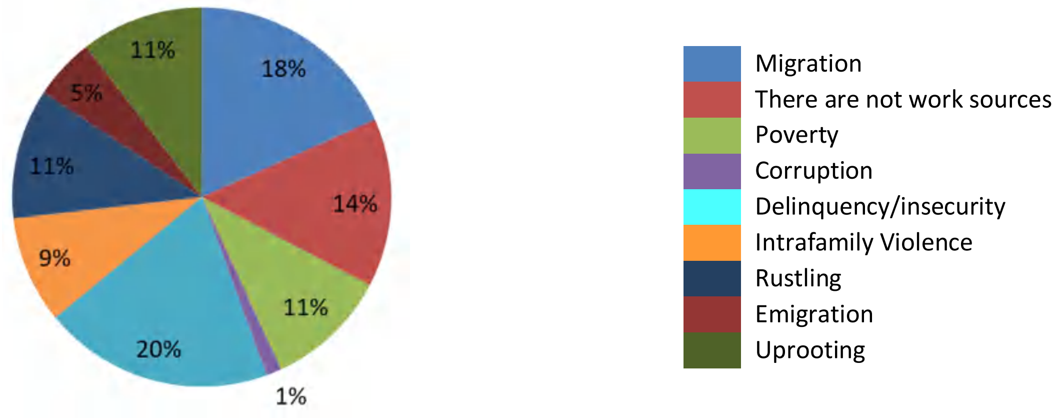
Social Issues

The results that will be presented in this item correspond to the responses of the total number of people who responded to the interviews with institutional and community actors and to the surveys carried out. The analysis is in turn complemented with the conclusions resulting from both the participatory workshop and the focus groups developed in the field.

At the level of social problems, the factor: "Insecurity", the factor "migration" (city countryside) reflected in 18% was mostly mentioned, that is, by 20% of the total interviewees; followed by the "lack of work sources" by 14%.

Poverty, cattle ranching and uprooting occupy the 4th place in importance and the fifth element indicated corresponds to the emigration of women, mostly to countries such as Argentina and Spain.

Graphic 14. Results of the consult about social issues



Source: Social work in the field. January and February 2020.

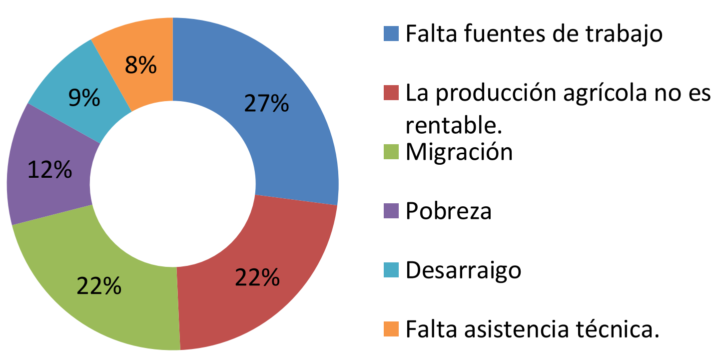
Economic Problems

Among the factors most often mentioned as part of the results of institutional and community interviews, the first is the lack of work at the local level (27%); followed by the low profitability of agricultural production (22%) mainly associated with the difficulty in transferring products for sale, the lack of a secure market for marketing and / or the loss of production; and the country-city migration phenomenon (22%).

As a third factor, poverty (12%) is mentioned, followed by uprooting (9%), which in most cases is identified by the people consulted as a consequence of the permanent migration and/or emigration that occurs in the areas of study.

The fifth element referred to consists of the lack of technical assistance specifically for small and medium producers, both livestock and agricultural as well as for entrepreneurs in general.

Graphic 15. Results of the consult about economic problems



Source: Social work in the field. January and February 2020.

Issues Identified in the District – Survey Results

Of a total of 150 respondents in the AID districts, 9 key factors are mentioned that are repeated in the 4 districts; from which 5 central aspects can be visualized, which are: the low labor supply (38%), drug use (29%), insecurity (17%), emigration (10%) and migration (6%).

In relation to both social and economic problems, it can be observed that the lack of source of work is currently a cause for concern in the area, since it was an aspect mentioned by a large number of people, both in the interviews and in the surveys. Likewise, insecurity and issues related to it (drug use, crime, etc.) and migration were other aspects mentioned. However, it should be noted that, in many cases, these were linked to the lack of employment as the trigger for the other aspects mentioned.

In group spaces such as the participatory workshop with key actors from the city of Concepción, these aspects were reiterated. Likewise, the lack of road access must be underlined, the little decentralization that leaves the area quite isolated at the political and social level, the fracture between the rural and urban areas and the lack of training adapted to the local reality as well as other issues of concern highlighted in that space. It was also possible to access aspects that were highlighted in the community focus groups and that generate concern in rural areas, such as school dropouts, cattle ranching, lack of technical assistance for production, low income and indebtedness, among others.

At the end of this subsection, it is necessary to highlight that, both in the ADA and in the AID, through the techniques used it was possible to access the socioeconomic characteristics of these areas, from the point of view of the inhabitants of the project's areas of influence, also fulfilling the objective of generating an initial information channel with them. It could be evidenced that beyond belonging to an urban or rural area, there are similar visions regarding issues related to their immediate environment and in general, the main economic/productive activities in the area, as well as the positive aspects or the personal appreciation of the community in which they reside, highlighting the "tranquility", "security" and other factors related to the way of life in the department, as well as some similarities in aspects related to common interest such as those that according to them, should be worked so that there is greater development in the community/department. However, in this and other items, in addition to the common themes that were mentioned, such as "Sources of work" and "road improvement", others were also highlighted that refer to more particular issues depending on the area in which it was carried out the survey "access to health service", "access to basic services, especially water".

5.1.2. Social Perception of Entrepreneurship (the mill)

Regarding the social perception regarding the installation of the Mill, the general results are presented, including the various techniques used to reach the population, this by district. The population was consulted about their knowledge regarding entrepreneurship, the means by which they found out, their opinion of an initiative of this magnitude in the area, the positive and negative aspects of it, their expectations, aspects that they it seems important to take into account in the construction and operational stages, among others.

As can be seen in the following chart, the first item consulted is related to knowledge about the installation of the mill, before which, almost 30% of the interviewees and respondents answered affirmatively, that is; they mentioned having heard of the pulp mill. Of the districts involved, Concepción had 45% affirmative responses, unlike the other districts with less than 20% affirmative responses in all cases. It can be seen that in the case of the district of Belén no one had heard about the undertaking.

An important aspect to highlight is that, in the ADA, the people surveyed and interviewed already had 100% knowledge about entrepreneurship and that through the development of focus groups it could also be noted that the people who live in the micro-territories located in the access road to the mill had better knowledge than those in more remote districts.

In the following charts the general results related to the "knowledge about the construction of a pulp mill" can be observed.

People who have claimed to hear about the construction (67) have been consulted about the area in which the construction is planned and, if so, the means through which they found out. To this, more than 80% responded having knowledge of the area in which the construction is planned, stating, for the most part, having found out through friends, neighbors and / or relatives, followed by people who found out through local radio programs.

Chart 101. Result of the surveys, communitarian interviews, institutional interviews and census

Have you heard about the building of a pulp mill?	Concepción	Horqueta	Loreto	Belén	Total	Percentage
Yes	57	6	4	0	**67**	28.63
No	74	29	31	33	**167**	71.37
Total	**131**	**35**	**35**	**33**	**234**	**100%**

Source: Social work in the field. January and February 2020

Chart 102. Result of the survey, communitarian interviews, institutional interviews and census

Do you know the area in which the mill will be built?	Concepción	Horqueta	Loreto	Belén	Total	Percentage
Yes	49	3	3	0	**55**	82.09
No	8	3	1	0	**12**	17.91
Total	**57**	**6**	**4**	**0**	**67**	**100%**

Source: Social work in the field. January and February 2020.

As can be seen in chart 102, most of the people who have knowledge of where the construction of the mill is planned are from the district of Concepción.

Knowledge about what is manufactured and its implications

When consulted regarding what is manufactured and its implications, the results show that in Concepción the majority of affirmative responses were obtained, however, with very little difference from those who responded not knowing them. In the other districts there was a clear lack of knowledge.

Chart 103. Result of the surveys, communitarian interviews, institutional interviews and census

Do you know what is going to be manufactured and the implications of its production?	Concepción	Horqueta	Loreto	Belén	Total	Percentage
Yes	42	2	1	0	**45**	46.39
No	36	6	5	5	**52**	53.61
Total	**78**	**8**	**6**	**5**	**97**	**100%**

Source: Social work in the field. January and February 2020.

Opinion regarding the initiative

Regarding the opinion of the people involved in the survey about the initiative, the majority presented positive opinions. These opinions were linked to the generation of sources of work, to promote the industrial development of the area and to generate progress and development. In terms of negative connotation, although there is a noticeable difference in terms of quantity, the most named factor is related to people's fear of possible damage to the environment that could be caused by the undertaking if the corresponding precautions are not taken.

Chart 104. Results of the consult

What is your opinion regarding the initiative?	Concepción	Horqueta	Loreto	Belén	Total
It is expected that it will be actually implemented (Corruption can create obstacles for the implementation of the initiative)	5				**5**
It will mean the generation of sources of work	36	3	3	3	**45**
It is positive if it does not generate environmental damage (Compliance with environmental laws on care and protection of the environment, reforestation, among others)	12		2	2	**164**
It will promote the industrial development of the area. "Dynamization of the local and departmental economy"	17	6	3	1	**27**
Roads will be improved	2				**2**
Compliance with working conditions "It is important that it is carried out within the framework of decent working conditions"	4				**4**
Social responsibility	4				**4**
"That they take into account the care of the Social Environment"	4	1	1		**6**
It can be a good opportunity for local suppliers	1			1	**2**
It is important that they generate a truthful, transparent and articulated communication system with the public	1	1	1	1	**4**
Dynamization of the local and departmental economy	1				**1**
It is important that they contemplate and comply with the security measures and mitigation of impacts	1			1	**2**
Training	2				**2**
Total	**90**	**9**	**8**	**9**	**116**

Source: Social work in the field. January and February 2020.

Positive Aspects/benefits which might offer to the community/department/country

Chart 105. Result of the counting of answers to communitarian and institutional interviews, census and survey

Positive aspects/benefits that you can offer to the community/department/country	Concepción	Horqueta	Loreto	Belén	Total
Generation of work sources	91	28	31	25	**175**
Dynamization of the economy at the local and departmental level	27	4	6	4	**41**
Access to basic services		1			**1**
Progress and development	22	7	1	7	**37**
Promote industrial development	5		2	1	**8**
Community infrastructure improvement	10	1			**11**
Social responsibility	1				**1**

There will be more useful	1				**1**
Reforestation	3				**3**
Generation of opportunities	1				**1**
Technical assistance to producers in the area	1				**1**
Contemplate and comply with security measures and mitigation of impacts	1		1		**2**
Compliance with labor laws	2	1			**3**
Income generation	5				**5**
It will help reduce the dangerousness index		1	1		**2**
Rooting	1	1			**2**
Compliance with care and protection of the environment	1				**1**
Greater income generation for the municipality	1				**1**
Training		1		2	**3**
Does not respond / Does not reference	6				**6**

Source: Social work in the field. January and February 2020.

As indicated in chart 105, numerous positive aspects or benefits that an enterprise of this magnitude could offer to the community, cities and country were named, the aspect that prevailed during each of the survey activities, in all the districts, was the generation of sources of work, later they mentioned the revitalization of the local and departmental economy, the progress and development and improvement of community infrastructure. When the key actors were consulted in the participatory workshop held in the city of Concepción and the community leaders in the different focus groups developed, they all agreed on the importance of project implementation for the following reasons:

- It will generate sources of work directly and indirectly (merchants, bricklayers and others).
- It will improve the quality of life in the area. When there is income there is an improvement in the quality of life.
- It will improve the quality of road accesses.
- It generates genuine income to the municipality and
- It will contribute to the improvement of community infrastructure.

Negative Aspects that could be generated by entrepreneurship in the community/ department/country

Result of the processing of community and institutional interviews and surveys (In the case of surveys, this item contains only the 31 cases of people who answered affirmatively to the question "*Do you consider that this undertaking could generate negative impacts for the community?*" of the total number of 150 people surveyed).

Given this question, although several factors that could generate negative impacts according to the people consulted were mentioned, the answers reveal, above all, their concern regarding the possible damage to the environment that could be caused by not taking the corresponding precautions, this was the majority in all districts. Likewise, this aspect was mentioned in other spaces such as the focus groups and the participatory workshop with key actors, with the exception of the families registered in the ADA who in their entirety have responded that they did not see any negative aspect with the implementation of the enterprise.

Aspects mentioned during the participatory workshop and in five focus groups carried out

- Environmental impacts/generation of environmental and health damage.
- There may be low absorption of local labor due to not being trained and that can generate complications in the area.
- Threat due to non-compliance with national and international regulations.
- Many industrial projects wanted to be installed and due to political problems, they were unable to advance.
- If there is not good communication it can generate conflict.
- Lack of information that can generate conflict.

Negative aspects that could be generated in the community/department/country	Concepción	Horqueta	Loreto	Belén	Total
Generation of environmental damage	53	7	3	8	71
Little hiring of people from the department	3	0	1	1	5
That they do not take care of the social environment	1	0	0	0	1
Breach of working conditions	3	0	0	0	3
Opposition in the city in the case of not coinciding with a group or sector	1	0	0	0	1
Road insecurity	2	0	0	0	2
It does not promote the dynamization of the economy at the local and departmental level	4	0	0	0	4
Increase in the cost of quality of life	1	0	0	0	1
Control mechanisms for compliance with environmental regulations by weak State institutions.	2	0	0	0	2
Non-compliance with environmental conditions/laws	3	0	1	1	5
Non-compliance with measures for the protection, prevention and mitigation of impacts		0	1		1
Disinterest in or lack of accompaniment from political representatives of the government	1	0	0	0	1
The presence of PPE in the area can be a problem	1	0	0	0	1
Concentration of benefits in a single sector	1	1	0	0	2
Does not reference / Does not respond	5	2	1	1	9

Source: Social work in the field. January and February 2020.

Expectativas con relación al proyecto

The responses obtained in terms of expectations in relation to the project are in line with the responses presented in the previous items (opinion, positive and negative aspects) as can be seen in the following chart, most of the times **the generation of sources of work**, as the main expectation, followed by **care and protection of the environment, progress and development, promoting the development of the department and supporting the growth of the communities in the area.**

Expectations regarding the project	Concepción	Horqueta	Loreto	Belén	Total
Sources of work, hiring local labor and taking into account the young population	73	23	24	27	**147**
Feasibility of the proposal	6	4	5	5	**20**
Road safety	10				**10**
Compliance with working conditions	8	1			**9**

Care and protection of the environment	21	3	1	2	**27**
Progress and development	12	4	8	1	**25**
Higher economic income	4	4	1	1	**10**
Truthful, transparent communication system and articulated work with citizens	8	2			**10**
Could generate contamination	1	1			**2**
Adequate infrastructure	1				**1**
Technical assistance for farmers in the area	4	1	1		**6**
Care of the social environment	5	1			**6**
Contemplate and comply with security measures and mitigation of impacts	4	2		1	**7**
Promote the development of the department and support the growth of the communities in the area	13	2	2		**17**
Installation of the mill in the zones; in places where negative impacts are minor and can be easily accessed	1				**1**
Selection of qualified and honest personnel	2		1		**3**
Training development	5	1			**6**
Contribute with local suppliers	8	2	2		**12**
Promote industrial development	1				**1**
Relative impact on the local economy	1				**1**
Does not respond/Does not reference	5			1	**6**

Source: Social work in the field. January and February 2020.

Expectations and Observations Resulting from the Participatory Workshop

- Fluency of communication regarding the project.
- That society is aware of the implications of the project
- That the labor hired be local professionals.
- That the project becomes a reality in the area
- Report clearly so that misinformation is not spread.
- Dissemination and awareness of environmental safety measures.
- Compensation for the natural resources used.
- Promote synergies with educational institutions on the implementation of training programs.
- That there is a diffusion in the Department, the clearer the impacts and the benefits, the better.

Considering the consultation process related to the perception of people regarding the possible installation of the mill in Concepción and as mentioned at the beginning of this section, it is considered important to **UNDERLINE THE POSITIVE ATTITUDE OF PEOPLE TO ALL ENTREPRENEURSHIP THAT MAY MEAN DEVELOPMENT AND BETTER LIVING CONDITIONS IN HIS DEPARTMENT**. Although institutional actors of the city of Concepción, residents of the ADA and micro-territories mentioned having knowledge about the initiative, in the other districts where the possibility was raised, even showing surprise at the consultations, people were interested in knowing better the Implications of the installation since it could mean **"NEW SOURCES OF WORK"**, possibility of employment of unemployed local labor, especially in the case of young people who even finish university careers and when not being able to work they migrate to other places to look for better/greater opportunities, they also expressed the importance that the project's priority is **"CARE AND PROTECTION OF THE ENVIRONMENT"**.

People interviewed in the districts of Horqueta, **LORETO AND BELÉN REQUESTED THE LABOR OF THEIR COMMUNITIES BE TAKEN INTO ACCOUNT**, commenting that, in previous experiences, although the undertakings meant absorption of labor at the departmental level, at the local level the impact was not feel". In the micro-territories and the ADA, through the implementation of the Census, interviews and focus groups, it was possible to register, among other issues, the expectations of the inhabitants, who expressed hope that the project will support the **DEVELOPMENT OF THEIR COMMUNITIES**, this expressed in technical assistance for farmers, training in general, contribution with local suppliers, road safety, among others. An outstanding aspect registered in various spaces, both in rural and urban areas, has to do with the fear of citizens that the project will not be implemented, since they highlighted that **"MANY TIMES THIS TYPE OF OPPORTUNITIES IS TALKED, BUT FINALLY NOT DONE"** to what in terms of expectation was mentioned as "project viability". Likewise, particular opinions were given by which the importance of fluid communication with the population was highlighted, attention is paid to the interference of partisan politics in the actions and that security measures and mitigation of impacts are contemplated and complied with.

6. Evaluation of Social Impacts

6.1. Presentation

The evaluation of the social impacts of the enterprise is focused on meeting local regulations, and as an industrial activity, it is framed in Law No. 294/93 on Environmental Impact Assessment, and its regulatory decrees No. 453/2013 and No. 954/2013, is that is, in the legislation that regulates obtaining the Environmental Impact Statement (DIA) or Environmental License, regulated by the Ministry of the Environment and Sustainable Development (MADES). In addition, PARACEL is committed to complying with the environmental and social sustainability standards, where in addition to ensuring compliance with the regulations in force in the Republic of Paraguay, its strategy is to abide by the "Principles of Ecuador" (in particular #2 , #3, #4, #5 and #6), the "Performance standards on environmental and social sustainability" (in particular #1, #2, #4, #5 and #8) of the International Finance Corporation, as well such as the World Bank's "Guidelines on Environment, Health and Safety".

Furthermore, the mentioned social standards are congruent with the commitment that the countries adhering to the United Nations have, in order to achieve the goals agreed in the "Sustainable Development Goals - SDGs" for the year 2030.

For the evaluation of social impacts, the process flow of the industrial component is taken into consideration first, as well as the related and related activities, both in the construction and operational stages, since these could generate potential positive and negative impacts, to the social environment.

The social baseline that precedes this analysis already describes the environment, detailing the populations of the area of influence[144] of the undertaking, their demographic, territorial, access to services, infrastructure, among others, which are considered when quantifying the impacts and social risks of the project.

With the baseline data, the social factors that could be impacted by the entrepreneurial processes are defined. These social factors are presented, both for the constructive and operational stages, in section 6.2.1.2. of this report. Social factors that must be addressed in the project or pre-construction stage are also taken into account.

The information gathering was carried out through consultations with secondary and primary sources, the results of which support the evaluation, this in turn made it possible to take the basic "social perception" as a reference,

144 The area of influence of the enterprise is grouped into three specific ones: i) Directly Affected Area (ADA), Area of Direct Influence (AID), Area of Indirect Influence (AII).

accessing social aspects such as the "Expectations" of the population involved, which has made it possible to evaluate the social factor from the early stages of the undertaking, in the project phase or pre-construction phase.

Next, the impact evaluation methodology is presented, and then the impacts identified are evaluated according to the "social environment factors" considered, crossing in matrices correlated with the "environmental aspects" linked to the "activities" or flow of main processes, and related activities, of the venture.

Finally, from the result of the identification of impacts, in those of medium or high significant social incidence that could generate risks, the risks are evaluated, linked to possible contingencies or emergencies that may arise, from the social point of view.

The main results of the evaluation of social impacts indicate that those of a positive nature impact on the factors "employment", "development of the local and regional economy", "development of capacities", this, due to all the contributions that PARACEL will give to the region, considering that the District of Concepción is one of the districts with the highest unemployment rate in the country. In relation to the social factors with the greatest negative impacts, there is “third party health and safety”, “Public/non-public services, infrastructure and/or property”, where the first is related to changes in “quality of life, uses and customs” to which the communities in the immediate surroundings will be subjected, and the second to the impact that public services could have, and in particular the road infrastructure of the area.

6.2. Methodology for the evaluation of social impacts

The social impact assessment follows the principles applied to an Environmental and Social Impact Assessment (ESIA), which in Paraguay is documented in each “Preliminary Environmental Impact Study (EIAp)” in accordance with local regulations and international agreements ratified by Paraguay. In addition, taking into account the nature of the undertaking and the requirements of PARACEL, the IFC performance standards, Equator principles and best practices are taken into account. These were presented in section 1.2 Linked national and international regulatory framework of this document.

Below, in a summarized way, the main activities and chronology in the evaluation of social impacts are cited, taking into consideration the regulatory framework mentioned above:

- Prior to the evaluation itself, the baseline studies are taken as a reference, which provide specific information on the project's area of influence, with emphasis on the population of the Directly Affected Area (ADA).
- An on-site tour is carried out in the communities near the property where the project is planned.
- With the results of the social characterization study, and perception study with secondary and primary Source information, respectively, the social factors that could be affected by the enterprise are defined.
- The social impact assessment matrices, normally used in ESIAs, are structured and adapted to the undertaking and its processes, in order to carry out the factor-aspect crossover, and thus define the potential social impacts and risks. First, a checklist is made that allows to pre-identify which social factors could be impacted by the aspects or activities.
- Then, based on the same matrix, the impacts are quantified following the concept of “social significance”, according to defined social variables.
- A description of each of the identified impacts is made, which will then be addressed by mitigation/compensation measures in the Social Management Plan.

6.2.1. Entrepreneurship activities that generate potential impacts versus potentially impacted social factors

In the impact assessment procedure, the activities of the undertaking are considered, in its various phases, and these are grouped into what is known as "aspects" that could generate impacts, among which the related activities to be considered are taken into account defined below.
Then, these activities are related to the "social factors" of the social environment that could be susceptible to potential impacts. Their correlations are normally crossed in specific matrices, as presented later.

6.2.1.1. Entrepreneurship activities that generate potential impacts

The following chart shows the aspects derived from the activities of the undertaking, in the pre-constructive (or project), constructive and operational stages. The grouping of activities could be subdivided again, but it is considered, from the social point of view, that these encompass the aspects that could generate impacts in this environment.

In the pre-construction or project stage itself, it is considered that the "project design" itself would be the one that could generate two major "aspects" to consider: i) Expectations and perception of the population of the area of influence, in general and in relation to the Project; ii) The possible effects on the social units closest to the project (homes and ranches[145]) located in the immediate surroundings of the industrial mill property.

The grouping of activities, in the constructive and operational stage, could be subdivided again, but it is considered from the social point of view that these encompass the aspects that could generate impacts in this environment.

Although there are aspects that must be considered from the early stages of the project, such as hiring personnel, beginning construction of access roads or housing for staff accommodation, these are evaluated in the construction stage, thus following the methodology commonly used with the matrices that will be presented in the following sections.

Chart 106. Aspects derived from the activities of the entrepreneurship

Aspects in the pre-constructive stage	Aspects in the constructive stage derived from the activities of the entrepreneurship	Aspects in the operative stage derived from the activities of the entrepreneurship
• Perception of the population in general • Units located in the immediate surroundings of the enterprise.	• Hiring of personnel for the construction of the industrial mill and related services • Construction of the industrial mill and related services • Transportation of materials, supplies and machinery • Transportation of personnel/operators linked to the work • Construction and/or adaptation of access roads to the industrial mill • Construction and operation of accommodation • Construction of Transmission Line (LT)	• Hiring of personnel for the operation of the industrial mill and related services • Operation of the industrial mill and related services • Transportation of raw materials, supplies and products • Transportation of workers from the industrial mill • Production and management of emissions (gases, noise and odors) • Production and management of effluents

145 Ranches are called haciendas or properties with land extensions ranging from 200 to 8000 hectares dedicated to livestock and/or agriculture.

Aspects in the pre-constructive stage	Aspects in the constructive stage derived from the activities of the entrepreneurship	Aspects in the operative stage derived from the activities of the entrepreneurship
	• Management of solid waste, effluents, emissions • Closure or completion of the works	• Production and management of solid waste • Maintenance of access roads to the industrial mill • Operation of accommodation of the workers of the industrial mill

Source: Own elaboration

Each of the aspects considered is briefly defined below:

Pre-constructive Stage or Project

- **Perception of the Population**: The perception of the population in relation to the socioeconomic characteristics of the area and the entrepreneurship itself, is the result of the approach methodology of the social study, which consisted of the implementation of various data collection techniques in territory (interviews, focus groups, surveys, among others), the results of which are described in the LBS, summarized in section 3.1 of this document.

- **Units located in the immediate surroundings of the property of the enterprise**: As a result of the data collection, studies of Primary Source, particular social units were identified, in a community known as Piquete Cue, made up of 13 (thirteen) families with a certain degree of kinship, as detailed in the characterization. In addition, 7 (seven) ranches established in the ADA were identified, adjacent to the development site.

Constructive Stage

- **Hiring of personnel for the construction of the Industrial mill and related services:** process by which Paracel hires qualified and unskilled labor, suppliers, others, for the construction of the Industrial mill. This activity will entail a worker influx in the area of influence according to the different activities of the stage.

- **Construction of the Industrial mill and related services:** refers to the civil works related to the construction of the components of the industrial plant, including other related activities, such as possible hydraulic works, foundations, metal structures, concrete, as well as construction and operation of construction sites in the construction area, construction and operation of an electric station, construction of its own port terminal, security services, logistics services, among others.

- **Transportation of materials, supplies and machinery**: refers to the transportation linked to providing supplies, materials, machinery, equipment, for the assembly and construction of the Industrial Mill. It is assumed that most of the transportation will be by land, but the use of the waterway through the Paraguay River is also considered.

- **Transportation of personnel/operators linked to the work**: process by which personnel or workers, professionals, specialists and others are transferred to the work area.

- **Construction and/or adaptation of access or exit roads to the Industrial Mill**: when extending the possible construction of roads for access to the project and exit from it, beyond the limits of the property in question, it is considered as an activity that It could generate impacts beyond those related to the construction of the Mill itself.

- **Construction and operation of temporary accommodation**: this is considered a relevant related activity or installation, considering that the construction of six temporary/permanent accommodation is foreseen for the personnel linked to the works who currently live at a considerable distance, and all will be located in the city of Concepción, according to the Map presented in Chapter 1, and the Annex presents general data on their location and distribution.

- **Construction of Transmission Line** (LT) is considered a relevant related activity or installation, considering that it is planned to build an exclusive transmission line of 220 KV, from the Villa Real substation of ANDE in Concepción, to supply the station electricity in the Industrial Mill. It will be approximately 32.85 km long, and it is expected to follow the route of the existing roads (communal, municipal and in a section of the PY 05 route), passing through the towns of Saladillo, Ko'ê Porâ to San Ramón Alley, and then through private properties to the development site.

- **Management of solid waste, effluents, emissions**: aspects related to the generation, transportation and possible management of waste related to the works, also considering the effluents and emissions that may derive from the works.

- **Closure or completion of the works**: transition process between the completion of the works, including the camps built, and the start of the operation of the Mill. It includes the dismantling of the work fronts in general and - if it were the case - of the temporary accommodation that has been built.

Operational Stage

- **Hiring of personnel for the operation of the Industrial Mill and related services:** as for the construction of the mill, specialists and labor related to the operation of the Mill and other activities related to it will be hired (operation of its own port terminal, security services, logistics services, among others). This activity will entail a worker influx in the area of influence according to the different activities of the stage.

- **Operation of the Industrial Mill and related services:** processes related to the operation of the Industrial Mill, with emphasis on the "pulp" production line.

- **Transportation of raw materials, supplies and products:** all activities related to the transportation of raw materials to be processed at the Mill, supplies and/or related equipment. It also includes the transport of the final products. It can be by land and river.

- **Transportation of workers from the Industrial Mill:** the transfer of personnel linked to the Mill is assumed, which would be less at this stage, but always higher compared to the "without project" baseline.

- **Production and management of emissions (gases, vapors and odors):** refers to the activities derived from the "emissions" treatment line that occur in the industrial process.

- **Production and management of effluents:** activities related to the line of treatment of effluents from the industrial process. These effluents, according to data from similar undertakings, are almost entirely reused and follow international quality standards.

- **Solid waste production and management:** related to waste derived from the "cellulose pulp" production process and other waste from activities at the Mill.

- **Maintenance of access or exit roads to the Industrial mill:** activity linked to the periodic maintenance of the access/exit roads to the mill.

- **Accommodation of the workers of the Industrial Mill:** it is assumed that part of the operating personnel of the Industrial Mill will reside permanently in the temporary/permanent accommodation built in the construction stage.

6.2.1.2. Potentially Impacted Social Factors

The social factors (socio-economic and cultural) considered for all stages are presented in chart 107:

Chart 107. Social factors considering for pre constructive, constructive and operative stage

Pre constructive Factors	Social factors evaluated in the constructive stage	Social factors evaluated in the operative stage
• Quality of life, uses and customs • Economy and jobs • Demographics • Expectations	• Jobs • Demographics • Public/private services, infrastructure and/or property • Cultural heritage	• Jobs • Demographics • Public/private services, infrastructure and/or property • Cultural heritage

Pre constructive Factors	Social factors evaluated in the constructive stage	Social factors evaluated in the operative stage
	• Local, regional and extra regional economy • Real-estate market • Occupational health and safety • Health and safety of third parties • Quality of life, uses and customs, including ecosystem services • Expectations of the population	• Local, regional and extra regional economy • Real-estate market • Occupational health and safety • Health and safety of third parties • Quality of life, uses and customs, including ecosystem services • Expectations of the population • Landscape

Source: Own elaboration

Next, the social factors are defined[146], in order to clarify the scope considered in each of them and linked to potential impacts:

- **Jobs**: favorable or beneficial effects that could be produced by the entrepreneurial activities associated with the increase in employment opportunities and its characteristics.

- **Demography**: Favorable and unfavorable/negative effects that could be produced by the activities of the undertaking on the number of population in the localities of the area of influence.

- **Public/private services, infrastructure and/or property**: favorable and unfavorable/negative effects that could be produced by the activities of the undertaking on access to basic services. These services could be: collection and final disposal of solid waste; provision of drinking water, sanitation, electricity, health care, transportation, security, education, communication and information, etc. The effects that may occur on the infrastructures, such as the land and river communication routes, the leasing capacity (housing rentals) and/or on the existing properties (public and/or private) are also considered.

- **Cultural Heritage**: favorable and unfavorable/negative effects that could be produced by the activities of the undertaking on the set of tangible and intangible assets. This evaluation refers rather to material or tangible heritage (archaeological sites and objects, architecture, documents, works of art from the past).

- **Landscape**: it is related to the perception of the landscape in the communities close to the undertaking, which, although it is usually also analyzed from the environmental point of view, the social focus is linked to the satisfaction of the people with the changes made to the existing landscape.

- **Local, regional and extra-regional economy**: favorable or unfavorable effects on the economic development of the populations in the Area of Direct and Indirect Influence and at the country level. It includes topics related to tourist economic activities and those that make use of resources such as water. Additionally, those effects on employment derived from the indirect actions of the enterprise in the area of influence are identified (increase in businesses, increase in demand for goods and services, generation of new jobs, etc.).

- **Real estate market**: favorable or negative effects on the real estate value of the properties close to the development and the rental price.

146 The definition of social factors is similar in the different stages of entrepreneurship, and their scale can vary according to each stage..

- **Health and occupational security**: favorable and unfavorable/negative effects that could be produced by the activities of the undertaking on the health and physical safety of the workers, personnel or operators linked to the works or to the operation of the Project.

- **Health and safety of third parties**: favorable and unfavorable/negative effects that could be produced by the activities of the undertaking on the health and/or physical safety of people who are not employees of the Project (third parties), both in the communities of the area of influence as from neighboring communities. The topic of citizen security is also included.

- **Quality of life, uses and customs, including ecosystem services**: favorable and unfavorable/negative effects that could be produced by the activities of the undertaking with an effect on the quality of life, uses and customs of the communities in the area of influence. Regarding quality of life, aspects valued by local people, such as tranquility and comfort, have been considered. In relation to the uses and customs, those daily practices carried out by the communities are taken into account, such as leisure/recreational activities, activities related to the use of water (artisanal or subsistence fishing) or soil (self-consumption) and the use of ecosystem services, areas that involve social relationships (use of spas, for example), among others. The uses and customs also refer to intangible or intangible cultural heritage, which includes manifestations of popular culture.

- **Expectations**: favorable and unfavorable/negative effects that could occur due to the activities of the undertaking on the expectations and perceptions of the communities in the area of influence, both positive and negative. It is related to all the aspects that the communities could perceive as feasible to improve/worsen as a consequence of a project of this magnitude.

Each of the factors could be subdivided again, but this grouping is the result of the analysis of the LBS and the Particularities of the social environment. It is worth mentioning that the particularity of indigenous populations is not considered in any of the aforementioned factors, since this specialty is served by a particular study that complements the present analysis.

6.2.2. Criteria for the impact assessment

In the environmental and social impact assessment process there are several formulas for assessing impacts, where normally those linked to the one known as the Leopold et.al (1971) Matrix, adapted Leopold or similar formulas are used, which require characterizing the importance and magnitude of the impacts. For the present study, criteria similar to those of Leopold are used, but where the variables considered have a greater focus on the social environment, adopting the indicator of "Social Significance" of the impacts. The “nature” (NA) of the impacts can be positive (+) or negative (-), depending on the effect they produce, that is, depending on whether they are favorable or unfavorable.

Chart 108. Nature of the social index

Nature of the impact (NA)	Denotation	Meaning
Positive Impact	IP (+)	Results in favorable effects and benefits
Negative Impact	IN (-)	Indicates unfavorable or negative effects

The social index of each identified impact is calculated from a formula that relates the estimate of number of affected (ICA), the distance of the impact (ID), the importance (II) and the occurrence (PO), that is, four variables, according to the following equation:

$$\text{Social Index (SI)} = \frac{(ICA + ID + II) \times PO}{3}$$

The value range of each of the variables, and their explanation, is defined according to the following detail, and they were taken by virtue of the undertaking and criteria adopted at the regional level in similar projects[147]:

Chart 109. Variables of the social index and their assessment

Variable	Initials	Value of the variable	Detail
Number of affected (according to areas or equivalent population)	ICA	1 to 3	ADA: Direct workers and/or neighbors of the property where the industrial mill is developed, including Piquete Cué, Laguna Plato, Saladillo, Mongelós, L. Petit, and the other micro-territories defined in the LBS
		4 to 6	AID: Concepción, Loreto, Horqueta and Belén
		7 to 9	AII (even extra region or country)
Distance	ID	1 to 3	ADA
		4 to 6	AID
		7 to 9	AII
Importance	II	1 to 3	Unimportant: will not involve a significant effect on stakeholders
		4 to 6	Medium importance: the effect will be of considerable magnitude
		7 to 9	Very Important: it will generate significant or irreversible changes in stakeholders
Frequency	PO	0.1 to 0.39	Unlikely
		0.4 to 0.69	Medium Probability
		0.7 to 0.99	High Probability

Source: Own elaboration

After crossing the aspects/activities of the Project with the social factors of the environment and, according to the formula presented above, the result of the social index of the identified social impacts is obtained, where the impacts are finally quantified in high, medium and low significance social, according to the scores presented in chart 110:

Chart 110. Social index and impact cathegory

Tipy of Impact	Social Significance	Social Index
High Impact	HIGH	From 6.01 to 9
Medium Impact	MEDIUM	From 3.01 to 6
Low Impact	LOW	From 0.1 to 3

Impacts of **low and medium** significance can be minimized with preventive measures and best practices, while those of **high** significance must be addressed in a particular way, considering that they could entail not only mitigation measures but also compensation and/or contingency measures. However, it may also be the case that, as the affected population, as well as its distance of affectation "low", the result of social significance is "low", but

147 Source: Environmental Impact Assesment of the Pulp Mill UPM (Environmental Engineer Study, UPM, 2018).

nevertheless refers to a vulnerable group, so that at the discretion of the evaluators, it must also attend to particular measures that will be specified in the Social Management Plan.

The risk analysis presented in section 6.4 identifies those potential impacts that could generate social risks and complements the impact assessment.

6.3. Evaluation of Social Impact

6.3.1. Social Impact Assessment – project or pre constructive phase

The evaluation of social impacts in the pre-construction stage is qualitative and descriptive.

This section is divided into two items, on the one hand, the result of the general perception of the opinions, perceptions and expectations raised in the Directly Affected Area (ADA) and Area of Direct Influence (AID) of the project, in relation to what people perceive the project, and another focused on the socio-economic and cultural characteristics of the immediate surroundings of the property.

6.3.1.1. Perception Results – perception results report

The results of the study of "Social Perception" allow to have in the pre-project stage the opinion/perception of the communities about the socioeconomic characteristics of the area and also about the installation of the industrial mill. This information was obtained from approximately 316 people from the ADA and AID through the use of various techniques such as a census of families located in the immediate environment of the project implementation area, interviews with key institutional and community stakeholders, and as a complement They carried out community focus groups and a participatory workshop in the city of Concepción, capital of the department, as well as surveys at strategic points in the districts involved.

In order to be able to identify the potential impacts, this section focuses on the results obtained from the expectations of the population regarding the installation of the industrial mill and their opinion regarding the socioeconomic characteristics of their community.

In order to understand the foregoing, the people consulted have expressed as their main concern in relation to the problems of the area, both the ADA and the AID, the lack of employment, which in turn leads to migration/emigration people (they migrate to the Chaco or other regions of the country and they emigrate to Argentina and Spain). This is related to the response that communities give to what they expect from entrepreneurship, where the majority have responded that they expect “Generation of sources of work”, that the project would bring “Progress and development”, as well as “Promote the development of the department and support for the growth of the communities in the area”.

It is considered, therefore, that impacts could be generated linked to the communities consulted having higher expectations than the project can cover, which, although it expects to directly hire between 6,000 and 8,000 personnel for the construction stage, certain profiles to be hired require knowledge and specialties related specifically to this type of undertaking.

Likewise, it is important to note that Paracel has initiated alliances from an early stage with the Ministry of Labor, Employment and Social Security (MTESS), in order to promote training through the National Professional

Promotion Service (SNPP)[148], as well as with educational institutions present in the department, with the objective of promoting the employment of local labor and the development of capacities.

After analyzing the responses received from the people and stakeholders consulted, it is concluded that among the main expectations/observations/perceptions in relation to the project, the following can be mentioned, correlating them with potential positive/negative impacts, as summarized below:

Chart 111. Main expectations/observations/perceptions in relation to the Project and potential associated impacts

Expectations/observations/perceptions in relation to the Project	Potencial associated impact
Fluency of communication regarding the project	Poor information for the community (-) Local referents consulted without follow-up (-)
That society is aware of the implications of the project	Poor information for the community (-) Uncertainties in the communities (-)
That the hired labor be local professionals	Employment generation and local development (+) Skills building (+)
Report clearly so there is no misinformation	Poor information for the community (-)
Dissemination and awareness of environmental safety measures	Poor information for the community (-)
Compensation for natural resources used	Poor information for the community (-)
Promote synergies with educational institutions on the implementation of training programs	Consulted Institutions (-)
That there is a dissemination in the Department, the clearer the impacts and benefits, the better	Poor information for the community (-)

Source: Own elaboration

Each of the identified impacts is described below, which will be addressed by specific programs and measures of the PGS from the early stages, in compliance with Paracel's sustainability policies and principles.

Poor Information for the Community

The communities consulted mention the need to have information in relation to the project. Likewise, they have expressed concern about the need to care for the environment, and this could not only be a concern of the communities, but also of non-governmental organizations (NGOs) that usually monitor this type of undertaking. Weak communication in the early stages, or not making adequate broadcasts in plain language could lead to uncertainty and concern.

In the interviews carried out, the people living in the ADA zone state that they use local radios as the main means of communication, whether they are official or alternative (community) radios, with television representing the most relevant medium (83.33%) and the minority (41.67%) responded that the most used media are social networks. In relation to the ADA stays, the majority manifested the use of social networks (WhatsApp, Facebook) to obtain information.

Therefore, different communication channels with the populations should be provided, as well as different key messages, in order to minimize this potential negative impact. Furthermore, this is related to the Consultation and Informed Participation process, as indicated by the Equator Principle 5 and IFC's performance standards.

148 https://www.mtess.gov.py/noticias/cerca-de-10000-empleos-generara-empresa-de-produccion-de-celulosa-que-se-instalara-en-concepcion

Consulted Institutions (-)

During the interviews, information has been collected from local referents, and among the needs evidenced or "negative aspects" of the project, the possible "road insecurity" has been raised. Considering that the process of interviews and consultations was carried out in the period of "school holidays", the possible impact that may occur to educational centers from the early stages is identified, noting that three educational centers have been identified in the ADA, and others in the area of micro-territories, which could have risks related to road safety once the works begin.

This is also reflected in the fact that one of the main characteristics revealed about the community is the "tranquility" of the area, this in response to the low vehicular traffic in the area, which will be drastically changing with the beginning of the project.

This impact is related to addressing health and safety issues for the population, anticipating from the early stages measures that minimize this impact in later stages of the project.

In addition to the schools, there is also a significant presence of UFS in the area, to which the residents go to receive primary care for health conditions, and which could be important when maintaining a continuous consultation process.

Uncertainty in the communities (-)

The uncertainty in the communities needs to be monitored. The results of the perception study not only raised the “expectations” in relation to the project, but also the opinions that the community could have in relation to the industrial mill. There is a concern related to possible damage to the environment.

In the participatory workshop, and in the five focus groups developed, the following uncertainties related to the project were mentioned: i) There may be low absorption of local labor due to not being trained and this can generate complications in the area; ii) Threat due to non-compliance with national and international regulations; iii) Many industrial projects wanted to establish themselves and due to political problems they were unable to advance; iv) If there is not good communication, it can generate conflict; v) Lack of information that can generate conflict.

This impact is closely related to that of "deficient information to the community", and the degree of dissemination and permanent consultation that can occur from Paracel will depend on whether these are minimized.

Generation of employment and local development (+) and skills (+)

Both impacts are positive, and must be duly addressed from previous stages. In the perception study, job creation is the population's highest expectation. This responds to the data from the socioeconomic characterization of the AID districts and the AII departments.

Currently, in the AID the same employment pattern is observed according to productive sectors as at the departmental level, with the predominance of livestock, commerce and agriculture, and followed by day laborer/changa type jobs. Fifth, employment in industries has been mentioned, especially in the districts of Belen (there is a meat processing industry) and Concepción. Finally, employment in the goods and services sector follows.

The need expressed by the communities, in relation to hiring local labor, was also linked to the importance of generating and strengthening capacities in the area, these in two directions; one on improvement issues in general issues and the other on issues related specifically to this type of undertaking, which in the long term will mean a benefit for creating new capacities installed in the department.

6.3.1.2. Environment immediate to the property of the Enterprise – social units closest to the enterprise

The community of Piquete Cue is located in the immediate surroundings of the surveyed area where 13 families (43 people) reside; of which 11 women and 10 men are heads of household, these have a rooting of between 6 and 94 years. Likewise, seven (7) predominantly livestock establishments (ranches) were identified.

In the case of the homes of the 13 families of Piquete Cue, they are located along approximately 3 km, on the left margin of the project's property area, and at a distance between 0.36 and 1.49 km from said area, is entirely family dwellings, of which 11 are their own. The predominant economic activity in the area is livestock and the inhabitants work mainly by season/day in nearby ranches (several in the Cerrito ranch), they are also engaged in the production of milk, cheese and animal husbandry.

Currently 16 people (7 women and 9 men) have work activity and income, 4 women are housewives and 11 people are unemployed and looking for work. 16 people currently attend an educational institution (primary, secondary and tertiary level).

Regarding basic services, 100% of the homes have electricity (ANDE) and cellular telephony, 53% have internet, but not with drinking water service. There is also no sewer drainage network or garbage collection service (currently they go to the burning).

The motorcycle as a means of transport is widely used in the absence of public transport service. There is only one road that is used by its inhabitants to move to other communities. As mentioned by the people surveyed, the community does not have health services in place.

In the design stage of the project, several alternatives of access/exit roads to the Industrial Mill were analyzed. These alternatives were based on two main scenarios:

1. Access to the mill entering through the area of the town of San Ramón, specifically through the Pyrenda ranch.
2. The second scenario, where the access would be by Piquete Cue, directly affecting 13 families that inhabit said community, and even with the possibility of physical displacement.

IFC Performance Standard 5 recognizes that land acquisition and land use restrictions associated with a project can have adverse impacts on the communities and people who use the land. Involuntary resettlement refers to both physical displacement (relocation or loss of housing) and economic displacement (loss of property or access to property resulting in loss of sources of income or other means of subsistence) as a result of the acquisition of land.

ND5 raises among its objectives: "*Avoid displacement or, when this is not possible, reduce it to a minimum by exploring alternative project designs*".

In line with this standard, the preliminary data and results obtained in the field on this community were taken into account in the design alternatives review process, which were considered, thus ruling out the main entrance to the mill by Piquete Cue.

Chart 112. Potential socioeconomic impacts identified

Social Aspect	Social Factors Impacted	Impacts
Piquete Cue Community	Quality of life, uses and customs	Economic displacement (-)
		Affection of the community social network (cultural, linkage around the rooms, family disintegration) (-)
	Demography	Migration risk of the families dependent on ranches (-)
	Expectations	Generation of favorable expectations (+)
		Generation of fear and uncertainty (-)
Ranches	Economy	Economic displacement and impact on land (+/-)
	Job	Migration of workers from one sector to another (-)
	Expectation	Generation of favorable expectations for the community (+)
		Generation of fear and uncertainty (-)

Source: Own elaboration

Economic Displacement, (Income, Livehood and employment)

Although the option of physical displacement to the homes of the Piquete Cue families has been avoided, the effects that could occur on the economic activities and way of life of these families must be addressed and compensated. These families work mainly by season/day in nearby farms and are also dedicated to the production of milk, cheese and animal husbandry for self-consumption and/or sale. Most of these families have only the property on which they reside and produce. Factors such as the availability of land to develop their subsistence/income activities and the current traffic dynamics on the road that the community uses, should be monitored to avoid any type of impact on their livelihoods and economy; either because of its proximity to the mill or because of the use of this road as a secondary road. This situation should also be addressed mainly for the communities near the main access/exit road to the mill, such as San Ramón.

In addition, the people surveyed have stated that they are “small producers”, both for self-consumption and for eventual sale to third parties. This is also related to the "problems" manifested in the AID, where they have stated that in the area there is a lack of technical assistance specifically for small and medium producers, both livestock and agricultural as well as for entrepreneurs in general.

Likewise, the personnel linked to the ranches in the area could have some economic impact (foreman, day laborers, others). From the data collected, there is information linked to five of the seven stays, where a total of 52 permanent workers are registered, and approximately 41 people work indirectly in them.

Impact of the land or properties of the immediate surroundings of the mill

The loss of the land and related economic impact is thought of the owners of the ranches, but as it is expected that they will have an economic compensation, and that there would not be a total loss but a small impact compared to the surface that they occupy, it is considered a positive impact for the owners. This is indirectly linked to the negative impact of the economic impact suffered by the employees linked to the ranches.

It could be assumed that the loss is related to use, and not to property, in the event that a right-of-way agreement is reached that does not precisely involve the sale of land. This will depend on the agreements that Paracel reaches with said owners, prior to the start of works.

Affection of the community social network (cultural, bonding around the ranches, family desegregation)

This impact is related to changes in the quality of life, uses and customs of the communities in the immediate surroundings of the mill.

In gathering information, one of the main characteristics manifested by the community is the "tranquility" of the area. They also stated, both in the ADA and in the AID, living in those localities for "the people". There is a strong rooting to the area and a family social network linked to Piquete Cue, where almost all belong to the same genealogical line, and in turn all have direct dependence on the ranches in the area. These aspects could be altered either by the proximity to the mill or by the use of the Piquete Cue path as a secondary road. All these aspects will be monitored by Paracel within the framework of the measures proposed in the PGS in order to avoid any type of impact on the way of life, uses and current customs of these social units.

Migration risk of the families dependent of the ranches

The families (43 people) of Piquete Cué are related to the estancias in the area, and if one of them leaves the area, it could imply that some of the families decide to migrate to other areas, being also a practice rooted in the zone, considering that the LBS mentions that many people migrate to the Chaco or other areas in search of better conditions or for work reasons.

Migration of workers from one sector to another

This impact is linked to ranches, considering that their workers could be attracted from the early stages to change their category, or if this is not the case, the indirect impact of early migration to other areas could be had, anticipating what is projected in the industrial mill.

Generation of favorable expectations

Expectations in the population could result in both positive and negative effects. This section focuses on the favorable ones.

From the positive point of view, already identified from the early stages, it is associated with the need for work in the area, as they have stated in the “Preception Study”. People from both the ADA and AID have stated that the project will provide sources of work, economic development, and even hope that the project will improve the conditions of public services in the area. This should be monitored throughout the project cycle.

Generation of fear and uncertainty

The uncertainties of the population consulted regarding the project have been identified, although the majority have stated as the main aspect in favor the fact that it generated sources of work, fear could be evidenced in relation to issues such as the change in the current way of life, little or no absorption of local labor and possible damage to the environment. The fear regarding the change in the way of life was mentioned mostly in the areas close to the one surveyed; micro-territories and ADA.

The specific measures will be addressed in the PGS, and the impact can be minimized if the related to the impact of "Deficient information for the community" mentioned in the previous section is addressed.

In addition, there are other fears related to possible damage to the environment. It is a point to address, since, if at the local level such fear is had, this could be extrapolated to other areas or to other actors, such as NGOs dedicated to environmental issues (national or international).

6.3.2. Evaluation of Social Impacts – Constructive Phase

6.3.2.1. Matrix of Interaction Between Factors of the Social Environment and Social Aspects of the Construction Stage

From the interaction of the aspects derived from the activities of the undertaking in the construction stage, as presented in chart 113; and of the social factors mentioned in 98; an interactive matrix is prepared, which allows previewing which activities could generate impacts, whether positive or negative.

Chart 113. Matrix of qualitative interaction, social factors and aspects derived from activities in the constructive phase

MEDIUM		STAGE / SOCIAL FACTORS \ FORESEEN ACTIVITIES	CONSTRUCTIVE								
	RESOURCE	FACTOR	Hiring of personnel for the construction of the Industrial Mill and related services conexos	Construction of the Industrial Mill and related services	Transportation of materials, supplies and machinery	Transportation of construction workers	Construction and/or adaptation of access roads to/out of the Industrial Mill	Construction and operation of accommodation	Construction of Transmission Line (LT)	Management of solid waste, effluents, emissions	Closure or completion of works, dismantling of workshop and/or homes
SOCIAL	Social - Economic and Cultural	Employment	●	●							●
		Demography	●	●	●		●				
		Public/private services, infrastructure and/or property	●	●	●	●	●	●	●		●
		Archaeological, historical and / or cultural heritage		●			●	●	●		
		Local and regional economy	●	●	●	●	●	●	●	●	●
		Real-estate market	●	●	●	●	●	●	●	●	
		Occupational health and safety		●	●	●	●	●	●	●	●
		Third party health and safety	●	●	●	●	●	●	●	●	
		Quality of life, uses and customs, including ecosystem services	●	●	●	●	●	●	●	●	●
		Expectations	●	●	●	●	●	●	●	●	●

Source: Own elaboration

According to the interaction matrix of factors and aspects in the construction stage, it can be seen that the social factors "employment", "services, infrastructure and/or public or private property", "expectations", followed by "occupational health and safety" And "health and safety of third parties" could be affected, positively or negatively, by the various activities of the undertaking. Likewise, the impacts derived from the expectations generated by the project are considered in all aspects.

6.3.3. Social Impacts in the Construction Phase

The impacts derived from the intersection of social environment factors and entrepreneurial activities are listed below. First, in chart 114 the impacts are cited, their relationship with the activities, and to what social factor they are linked, later, in chart 115 the valuation of them is presented, following the methodology indicated above.

It should be noted that the aspect/activity of “Construction of the Industrial Mill and related services” has been used to refer to the impacts that derive from the construction of the Project as a whole, which are not linked to a particular activity of the same. For example, when speaking of the expectation of "development and progress" of the ADA/AID communities with the Project, this has been crossed or correlated with the aspect/activity of "Construction of the Industrial Mill and related services" in the impact identification chart 106. In addition, it is noted that two related activities relevant to the Industrial Mill are attended, "Construction and operation of accommodation" and "Construction of Transmission Line (LT), the first due to the potential impacts derived from the worker influx in the area, and the second due to the expectations that may arise in the area for large-scale electrical works, and both to be installed outside the property of the project itself.

It can be verified that they have been identified and grouped into thirty-four (34) potential social impacts in the construction stage. Descriptions of each of them are presented below. Although several of the impacts may occur in different aspects related to the activities of the undertaking, in the previous chart they were considered in relation to only one aspect –where they have the greatest incidence–, in order not to make the quantification repetitive, however, in the description of the impacts mentions all the activities that cause/could cause them and that, therefore, require attention to prevent and/or minimize them. In addition, the impacts have been grouped by factors of the social environment, this allows identifying the particular modalities or disciplines that need to be addressed when establishing the measures in the Social Management Plan programs.

It should be noted that, in some cases, there may be social impacts with "low" social significance but that, nevertheless, they must be addressed because they affect vulnerable or sensitive groups, in order to comply with current regulations, as well as regulations of an international nature, cited above, based on international best practices and standards.

Chart 114. Social impacts identified in the constructive stage

Aspect or activity	Social Environment Factor	Social Impact
Hiring of personnel for the construction of the Industrial Mill and related services	Employment	Generation of Local Employment
	Employment	Salary Increase
	Employment	Formalization of labor ties
	Employment	Migration of workers from other productive sectors
	Employment	Capacity building
	Demography	Transitory population increase
	Public/private services, infrastructure and/or property	Increase in demand for public and non-public services
	Public/private services, infrastructure and/or property	Increase in demand for housing
	Real-estate Market	Increase in the price of properties and rentals
	Third party health and safety	Impact on the health of third parties
	Expectations	Generation of expectations and fears in the local population
Construction of the Industrial Mill and related services	Employment	Possible loss of employment and/or source of income
	Demography	Definitive population increase
	Archaeological, historical and/or cultural heritage	Affection of materials of archaeological, historical and/or cultural interest
	Local, regional and extra regional economy	Development of the local, regional and/or extra-regional direct economy (associated with construction) and
	Local, regional and extra regional economy	Increase in visitors to the area
	Occupational health and safety	Occupational health impairment
	Occupational health and safety	Impairment of occupational safety
	Third party health and safety	Affecting the levels of local citizen security
	Quality of life, uses and customs	Affection of the social network
	Expectations	Generation of negative perception and/or fears in the local population
	Expectations	Generation of positive expectations at the regional and extra-regional level
	Expectations	Generation of negative perception and/or fears at regional and extra-regional level
Transportation of materials, supplies and machinery	Public/private services, infrastructure and/or property	Increase in vehicular traffic
	Public/private services, infrastructure and/or property	Impact on road infrastructure
	Public/private services, infrastructure and/or property	Impact of land properties
	Public/private services, infrastructure and/or property	Impact on river and port traffic
	Third party health and safety	Impact on road safety
	Quality of life, uses and customs	Increased discomfort or restlessness
	Quality of life, uses and customs	Changes in customs and uses
Construction and operation of temporary accommodation	Public/private services, infrastructure and/or property	Improvement in the quality of housing and in the provision of basic services
Closure or completion of the works	Employment	Possible increase in unemployment in the area of influence
	Public/private services, infrastructure and/or property	Possible improper closure of temporary accommodation
	Local, regional and extra regional economy	Possible decrease in commercial activity and/or services

Source: Own elaboration

Chart 115. Assessment of social significance of social impacts identified in the construction phase

Social Impact	Social Variables					Social Index	Impact
	Sign	ICA	ID	II	PO		
Generation of Local Employment	1	7	7	7	0,99	6,93	HIGH
Salary Increase	1	3	7	6	0,69	3,68	MEDIUM
Formalization of labor ties	1	3	7	6	0,79	4,21	MEDIUM
Migration of workers from other productive sectors	-1	7	7	4	0,69	-4,14	MEDIUM
Capacity building	1	7	7	9	0,99	7,59	HIGH
Transitory population increase	1	6	6	6	0,99	5,94	MEDIUM
Increase in demand for public and non-public services	-1	6	6	8	0,99	-6,60	HIGH
Increase in demand for housing	-1	6	6	6	0,99	-5,94	MEDIUM
Increase in the price of properties and rentals	-1	6	6	7	0,69	-4,37	MEDIUM
Impact on the health of third parties	-1	6	6	6	0,79	-4,74	MEDIUM
Generation of expectations and fears in the local population	1	8	8	7	0,89	6,82	HIGH
Possible loss of employment and/or source of income	-1	1	1	7	0,79	-2,37	LOW
Definitive population increase	1	6	6	4	0,49	2,61	LOW
Affection of materials of archaeological, historical and/or cultural interest	-1	8	1	6	0,69	-3,45	MEDIUM
Development of the local, regional and/or extra-regional direct economy (associated with construction) and	1	7	9	7	0,99	7,59	HIGH
Increase in visitors to the area	1	5	5	5	0,59	2,95	LOW
Occupational health impairment	-1	3	3	5	0,39	-1,43	LOW
Impairment of occupational safety	-1	3	3	9	0,39	-1,95	LOW
Affecting the levels of local citizen security	-1	6	6	7	0,49	-3,10	MEDIUM
Affection of the social network	-1	3	3	7	0,79	-3,42	MEDIUM
Generation of negative perception and/or fears in the local population	-1	6	6	7	0,79	-5,00	MEDIUM
Generation of positive expectations at the regional and extra-regional level	1	9	9	7	0,69	5,75	MEDIUM
Generation of negative perception and/or fears at regional and extra-regional level	-1	9	9	6	0,49	-3,92	MEDIUM
Increase in vehicular traffic	-1	6	7	7	0,99	-6,60	HIGH
Impact on road infrastructure	-1	7	7	7	0,99	-6,93	HIGH
Impact of land properties	-1	2	2	7	0,99	-3,63	MEDIUM
Impact on river and port traffic	-1	3	9	4	0,49	-2,61	LOW
Impact on road safety	-1	6	7	8	0,99	-6,93	HIGH
Increased discomfort or restlessness	-1	6	7	7	0,99	-6,60	HIGH
Changes in customs and uses	-1	6	7	7	0,69	-4,60	MEDIUM
Improvement in the quality of housing and in the provision of basic services	1	2	2	6	0,99	3,30	MEDIA
Possible increase in unemployment in the area of influence	-1	7	7	7	0,99	-6,93	ALTA
Possible improper closure of temporary accommodation	-1	3	5	6	0,49	-2,29	BAJA
Possible decrease in commercial activity and/or services	-1	6	6	7	0,89	-5,64	MEDIA

Source: Own elaboration

JOB

Generation of local employment

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services.

Employment opportunities will be generated from the construction works of the Industrial Mill and related services. The types of employment will be skilled and unskilled labor, professionals, specialists, etc. that will carry out the construction of civil and road works, the assembly of equipment and machinery, as well as those related to the logistics of materials, supplies, machinery, equipment, human resources, waste, etc.

It is estimated that the Project will directly employ between 6,000 and 8,000 people in the construction phase, so the workers influx will increase, of which 10% will correspond to professionals, 30% to technicians and 60% to qualified. These direct jobs include people hired directly by PARACEL and people from contractors and subcontractors hired for construction and assembly. The Project must comply with the principles of IFC's Performance Standard ND 2 on “Labor and working conditions”, clearly defining the labor links, depending on whether the employees are direct, contracted, or supply chain workers, as the case may be. Likewise, FSC Principle 4 on “Community relations and workers' rights” will be considered.

According to the socioeconomic data, the people of the department of Concepción will be able to cover the demand for unskilled employment, since there is a wide availability of people who could be suitable. In the department of Concepción, a large part of the population is young, of which 72% is under 35 years of age, and with an average of 7.61 years of studies. The Project may also contribute to increasing the employment of women, since 53% of the department's population is made up of women. Likewise, it is observed that most of the department's population, some 182,000 people, is concentrated in the four districts that make up the Project's AID and have a young population, following the trend of the department. For its part, the working-age population (WAP) is 186,627 people, of which 58.33% are economically active. With these data, it is estimated that a large part of the unskilled labor that will be employed by the Project could be local, from the same department of Concepción.

Likewise, the department of Concepción could also provide a certain amount of qualified labor, since the LBS revealed data that different types of technical courses are taught in the department with quick job opportunities, especially in the urban areas of the department, and that there are several public and private training centers.

Also the departments of Amambay and San Pedro, considered within the Project IIA, will be able to provide labor, mainly unskilled, for the Project. In both departments, most of the population is young, under 35 years of age (68% Amambay, 70% San Pedro), with averages of 8.48 and 7.21 years of study. Women make up about half of the population of the two departments.

The generation of jobs at the local level will contribute to the reduction of unemployment, which is 6.66% (about 7,247 people) in the department of Concepción, higher than the national average rate, and of income poverty and structural poverty , which in the department of Concepción are high, more than 40% in terms of income poverty and more than 50% in terms of at least one (1) Unsatisfied Basic Need (UBN), above the national average. Likewise, the creation of a source of employment, although transitory, may contribute to reducing the levels of migration from rural to urban areas observed in the department of Concepción, which would be motivated by work, study and, lately, due to the lack of security.

Salary Increase

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services.

The Project could grant higher salaries than the current average per capita income in the AII departments, taking into account the related national regulations and the profiles or qualifications demanded. The average per capita income is Gs 896,026 in Concepción, Gs 981,516 in San Pedro and Gs 1,530,906 in Amambay, all below the current legal minimum wage of Gs 2,112,562. Although the quintiles with the highest incomes make up more than 50% of the population, they are around the minimum wage in force in Concepción and a little more than the minimum wage in force in San Pedro. Furthermore, according to the economic characterization of the area of influence, the total income poverty level in Concepción and San Pedro is above 40%.

Most of the population of the three departments of the IIA is rural (Concepción 57%, San Pedro 80%, Amambay 33%), with agriculture and extensive cattle ranching being an important sector of employment of the population, although behind the tertiary sector (commerce and services). Compared with these productive sectors, especially the primary one, the Project is expected to offer better paid jobs.

In addition, the supply of jobs associated with the Project work may produce an upward effect on salaries in the AID, which would benefit not only those employed by the Project but also those employed in other productive sectors in the area.

It is considered a positive impact because the increase in the level of income means a priori an increase in the purchasing power and debt capacity of the employed persons and their dependents, contributing to a greater consumption of goods and services and, therefore, to a greater development of the local economy and quality of life, expecting a decrease in the level of poverty, not only due to income, but also structurally.

Formalization of labor ties

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services.

The construction phase of the Project will create direct formal jobs, that is, in accordance with current national legislation. This will be comparatively beneficial in the IIA, since only a little more than a third of the salaried population employed in the three departments of the IIA have formal working conditions, in the sense that they are registered and make contributions to a retirement system. In absolute values, as of 2017, this involved only 13,969 people (38.41% of the population) in the department of Concepción, 19,171 people (38.24%) in the department of San Pedro, and 14,167 people (35.36%) in the department of Amambay.

Access to formal employment conditions is beneficial for workers and their dependents, since the system of pension contributions and social security is now integrated, access to other labor rights and guarantees, all of this contributing to a better quality of life of the worker (greater peace of mind regarding the future, etc.) and their dependents.

Migration of Workers from Other Productive Sectors

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; transportation of materials, supplies and machinery; transportation of construction workers; construction and operation of temporary accommodation.

It is expected that the industrial component of the project may have an impact on the migration of people, attracted by the project, as well as due to the increase in the workers influx in the area.
The employment opportunity generated in the construction phase of the Project may attract people who currently already have a job in another productive and/or service sector and promote migration to the Project, due to various factors that could make the job offer of the Project more attractive than the existing job offer, such as: better salaries, formalization of employment, related benefits, proximity to the home, desire for experience in a project with such characteristics, etc.

The impact would be positive if migration means an increase in the level of income and quality of life of the people who have migrated to the Project sector. The impact will be negative for the productive/service sectors that will lose employees and will have to hire new personnel and train them, or that will stop producing due to the lack of labor. Likewise, in the medium term the impact could be negative for the “labor migrants” themselves, given the temporary nature of the jobs in the construction phase of the Project, which will mean that once this phase is finished, a significant number of people could be left without a job and will have to seek either a new job or return to your previous job, with the difficulties that this could entail.

On the other hand, the economic development that may be induced by the Project in the AID during the construction of the Mill, may generate attractions for people, both local and foreign, who are currently engaged in certain productive areas, to migrate to productive sectors that may be indirectly promoted by the Project, such as shops and/or services (tertiary sector, in general). In these cases, the impact would be similar to that described.

In the department of Concepción, the main productive items historically have been agriculture and extensive cattle ranching, remaining predominant even before the authorization in recent years of industries such as: two meat processing plants, cement companies, service provider companies, the processing industry of dairy products. Also, in the departments of Amambay and San Pedro, the predominant productive activities have been agriculture and extensive cattle ranching, maintaining this way at least in San Pedro. Regarding occupation levels, as of 2017, most of the population of the department of Concepción were employed as private employees/workers and self-employed, the majority in the tertiary sector (47%) and then in the primary sector (36.2%).

In the AID the same pattern of employment is observed according to productive sectors as at the departmental level, with the predominance of livestock, commerce and agriculture, and followed by day laborer/changa type jobs. Fifth, employment in industries has been mentioned, especially in the districts of Belen (there is a meat processing industry) and Concepción. Finally, employment in the goods and services sector follows.

Regarding the ADA, which includes the area close to the area where the Mill is located, the main economic activity is livestock, followed by agriculture. The people of the Piquete Cue community are predominantly engaged in livestock sector activities, these being small producers, where men work in ranches in the area and/or the Chaco and women are dedicated to caring for the home and small herds of cattle (between 10 and 15 heads) for self-consumption or sale. A third source of income is commerce and service (pantries, minor sales, motorcycle workshop, sale of telephone credit).

It is estimated that the main migration of workers may occur from the extensive and small-scale agriculture and livestock sector, as well as from self-employed workers –formal and informal– to the Project. According to the surveys carried out with residents in the AID, the "low profitability of agricultural production" is the second most mentioned aspect regarding the economic problems that affect the communities, which may give an idea that, in the face of better opportunities income, people would choose to change their productive area. On the other hand, it is likely that people who are already employed in other specific areas (for example, refrigerator manufacturers, dairy, etc.), and depend on type of employment, they may have fewer incentives (comparative salaries and/or working conditions, they already have specific training for their field) to abandon their current jobs.

According to the data from the AII characterization, the departments of Concepción and San Pedro are the ones with the highest levels of pendular migrants (migration of a periodic nature and that does not result in a change of residence), generally for work reasons and at the intra departmental level.

Additionally, it is observed that the industrial sector in San Pedro is better paid than the industrial sector in Concepción. At the level of the ADA and AID residents, in the field information surveys they indicated “migration” due to lack of job opportunities as one of the social and economic problems that most afflict the communities. All this could indicate a favorable context for people interested in migrating from their productive sectors or from their current jobs to the Project sector to be mostly from the department of Concepción.

Possible Loss of Employment and/or Sources of Income

Activities or aspects that generate the impact: Construction of the Industrial Mill and related services.

The possible loss of sources of employment and/or income would take place due to the change in land use that the location of the Mill will produce, from the current use (predominantly livestock) to that of housing the Industrial Mill. This will affect the employees currently working in the aforementioned territory, almost mostly linked to stays. Although there are approximately 93 workers (52 direct and 42 indirect according to the ADA studies), these must be considered. The owners of the land are not considered, since they will have the freedom of decision and negotiation for the sale of the land.

Likewise, as already identified in the pre-construction or project stage, this impact could affect the social units of the Piquete Cue community, given its proximity to the enterprise and the alteration that could occur to their way of life due to the use of the current road as a secondary access road, and attending to the dependence of some families on activities related to the ranches in the area.

Possible Increase in Unemployment or Loss of Income in the AID

Activities or aspects that generate the impact: closure or completion of the works.

At the end of the construction phase of the industrial mill, there may be a significant decrease in jobs in the AID due to the completion of the phase itself, due to:

- The cessation of the need for qualified and unskilled labor for construction activities and industrial facilities, since the Mill will go into the operation phase.
- The cessation of the demand for materials, supplies, machinery, equipment, personnel and waste and their logistics, associated with the construction activities of the Project.

It is estimated that the project will go from 6,000 to 8,000 direct jobs in the construction phase, to around 600 to 1,000 direct jobs in the operational phase.

It is possible that to cover some of the needs of the operational phase, the services of part of the personnel who were already employed in the construction phase may be available, however, this number will be very limited.

The effect of this impact may be negative to the extent that unemployed people are or are not based in the AID (they have bought houses, their relatives are working in the area, etc.), since this will prevent them from returning easily to their places of origin or move to other geographical areas where they can access other job offers or return to their old jobs.

The effect of the impact will also depend on the expectations that part of the local and/or foreign population may express regarding the jobs that the construction phase of the Project will generate, since these will be temporary and will not offer guarantees or promises of rehiring for the operational phase, being able to cause frustration in the affected population and social tensions.

Both the decrease in jobs and commercial activity may have effects of economic stress on the households that remain in the AID after completion of the works, which will demand from these households' adjustments in their living conditions, in their access to goods and services and other aspects related to the greater liquidity they had during the construction phase.

Skills Development

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; closure or completion of the works.

The Project will train interested persons who may be employed in the construction phase of the Industrial Mill. This will be in order to counteract, to a certain extent, the lack of locally existing skilled labor and to enhance the existing one in accordance with Paracel's specific technical needs, highlighting that this could occur from the early stages of the project, that is, in project stage (pre-construction). On the other hand, this training will address what was referred to by the AID population in the field survey, the fear that there is a “low absorption of local labor” due to “not being trained”. In this line, the training offered by Paracel will have a positive impact on the personal training of future construction workers and on the level of hiring of local labor, and as already mentioned in previous sections, this has already been initiated through of alliances with the MTESS and the SNPP, and with local educational institutions.

Along these same lines, unlike the negative impact that unemployment could generate and the decrease in commercial activity at the end of the construction phase, the positive impact of leaving “installed capacity” in the area of influence of the Project is considered, especially the ADA/AID. Although in the operational stage, a large part of the qualified workforce linked to civil works and assemblies will no longer be able to have continuity in the undertaking, the people who have been trained by the Project and who have settled in the area and intend to settle In any of the AID or AII municipalities, they will have greater possibilities of hiring in other enterprises in the area, or in those that are projected in the department of Concepción or San Pedro, especially. It is highlighted that the project will establish alliances with the public and/or private technical training centers/institutions for rapid job opportunities in the AID, so that, in addition to the people trained for the construction of the Mill, the capacities of the local technical training centers/institutions.

It is worth mentioning that in the surveys carried out among the population of the AID districts, the third aspect most highlighted as a priority for a greater development of the communities was the possibility of improving the educational level of young people. In relation to this, one of the expectations of the population is that the Project promote synergies with educational institutions for the implementation of training programs. In this context of need and expectation, the Project's actions in this area will generate a very important positive impact on local technical capacities.

Furthermore, the development of the project is expected to have long-term multiplier effects on the economic development of the area of influence, even beyond the AID, and to attract new investments. For this scenario, the installed capacity in the area would be key, and it is estimated that the items related to construction, electrical and electromechanical assemblies, among others, could have a rapid labor insertion.

DEMOGRAPHY

Transitory Population Increase

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mil and related services; construction of the Industrial Mill and related services; transportation of materials, supplies and machinery.

There will be an increase in the population, due to an increase in the workers influx, as a result of the project's need for between 6,000 and 8,000 skilled and unskilled labor for the construction of the mill, plus the families that these people could bring. I get to live in the ADA/AID communities. This increase will be temporary, during the period that the works last, which will be 2 to 3 years.

The population may be local or foreign. Local population will refer to people from the ADA/AID and the department of Concepción. Foreign population will refer to the population of the rest of the IIA (San Pedro, Amambay), of the other departments of the country and of foreign countries.

It is estimated that a large part of the qualified personnel during construction will be foreign, due to construction specialties that do not have similar antecedents in the area. In addition, specialized assemblies will use foreign labor due to the need to guarantee compliance with specific standards for which local personnel with international experience are not available.

Additionally, a transitory population increase is expected in the ADA/AID due to the arrival of people not directly related to the construction of the Project, but who see opportunities to generate income through shops and/or services in the area.

In general, AID districts are medium and small depending on the size of their population. There are about 85,876 people in Concepción, 62,008 in Horqueta, 18,791 in Loreto and 13,014 in Belén, distributed in urban and rural areas, with a predominance in rural areas with the exception of Concepción. The population density is low, from 18 to 80 people/km^2.

The ADA or environment closest to the location of the Mill is the area known as Piquete Cué, in which 13 families live and 7 rooms are located. A little less close are the populations of the micro-territories identified in the area of the access points to the mill. These amount to 1,634 people and 425 homes in the communities L. Petit, Cnel. Mongelós, Jhugua Zarzo, Laguna Plato, Mongelós Pirity and Piquete Cue; 532 people and 156 homes in Jhugua Gonzalez; 2,450 people in Callejón San Luis, Mbocayaty, San Ramón Alley, San Antonio, Curuzu Ñu, Costa Pucu, Paso Ita, Ko'ê Porâ and Saladillo; and approximately 250 people and 80 homes in Colony Primavera.

These data would indicate that the population associated directly and indirectly with the construction of the Project could be important compared to the local population according to the current size of the populated centers where they could settle, especially in the case of the closest communities mentioned and Loreto, which It is one of the two cities closest to the Industrial Mill area of the four AID cities. However, it is presumed that, due to the existing population density, the location of the temporary additional population is physically feasible.

In addition, in relation to the transitory population, directly linked to the project, it will be settled in buildings in the city of Concepción, where the construction of six temporary/permanent accommodations for Paracel personnel is planned.

Definitive Population Increase

Activities or aspects that generate the impact: construction of the industrial mill and related services (the project as a whole); construction and/or adaptation of access roads to/from the Industrial Mill; transport of materials, supplies and machinery.

The direct workers of the project, as a result of the increased workers influx linked, in case of being people outside the AID, would become part of the AID on a more permanent basis than the seasonal workers, and these will be installed in the accommodation at be built by Paracel, all in the city of Concepción.

In addition, in line with the aforementioned impact, the construction phase of the project will constitute an attraction not only for those interested in being employed in the works and/or related services of the Project, but also for local or foreign people who could obtain a commercial benefit and service development that the Project could induce in the ADA/AID communities, such as, for example, the creation of demand for basic goods and/or services and the creation of jobs associated with them; also, for people who see opportunities for a better quality of life in the vicinity of the Project, due to the potential increase in the area of basic services, greater consumption options, etc. These people would come to increase the definitive population of the AID communities.

Likewise, the increase in vehicular traffic by project vehicles, particularly those with heavy loads, and the construction and/or adaptation of communication routes for use by the Project may attract people, locals or foreigners, who seek to settle in the vicinity immediate access of these roads, due to the economic opportunities that the greater dynamism of vehicles and people could generate along these roads. These would also go on to increase the definitive population in the AID.

SERVICES, INFRASTRUCTURE AND/OR PUBLIC/NON-PUBLIC PROPERTY

Increase in Demand for Public and Non-public Services

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; transportation of materials, supplies and machinery; transportation of construction workers; construction and operation of temporary accommodation; construction of LT.

The increase in the transitory and permanent population in the ADA/AID communities, generated by the hiring of personnel and consequent increase in the workers influx in the area, for the construction of the industrial mill, as well as the construction of accommodation and line of distribution, and by the potential arrival of other people attracted by the indirect effects of the project, as well as the needs of the construction of the mill itself and the increase in people visiting the area, will produce an increase in the demand for public services and not public, both existing and currently non-existent.

These services are: collection and final disposal of solid waste, drinking water, sanitation, electricity, transportation, health care, police and security, emergencies, education, communications and information, lodging.

Regarding existing services, the increase in project demand could affect the current service levels in the ADA/AID, since if their development does not adequately accompany the population increase and construction demands (even if they are temporary), the capacity of the services will be exceeded.

Regarding the currently non-existent services that are basic for human populations, the lack of these, together with the temporary and definitive increase in the population, could generate situations of deterioration of the urban environment in the affected communities and living conditions with unsatisfied basic needs.

It has been indicated that there is a problem in the supply of social services in the department of Concepción, which could be due to factors such as:

- Inefficient geospatial distribution of the same (for example, along important communication routes), in the quality of the provision (for example, the number of schools is not an indicator of the quality of education), in the slow growth in their coverage (which does not accompany population growth) and in the lack of adherence to anthropocentric drivers (population or socio-economic growth) for the development of services (development depends more on the political will of the moment than on Development plans). In this context, a fundamental impact of the Project will be the pressure of the temporary and definitive population associated with the Project on the existing services and on the environment, due to insufficient or lack of these.

This impact by service is analyzed below.

Solid Waste Collection and Disposal

In the department of Concepción, only a third of the population has access to the collection and final disposal of solid waste, while more than 50% burns and/or buries them as a final disposal method. The municipality of the city of Concepción provides the collection service to 8,500 taxpayers and disposes of the waste in a landfill from which it is mentioned that it is no longer capable of receiving any more waste. The Municipalities of Belén, Loreto and Horqueta, which are the largest after Concepción in the AID, do not have or have very limited collection and final disposal services, so most of the population resorts to burning or burial. Given that the population associated with the construction phase of the Project will settle within the department, in the localities closest to the Mill, and the workers in the accommodations to be built in the city of Concepción, it is most likely that this population cannot count on the solid waste collection and disposal service offered by the municipalities, since the current service, even in the departmental capital, is insufficient.

The increase in population will add to the already existing problem of solid waste, which may aggravate the situation of inadequate solid waste management in the ADA/AID communities, promoting the practices of burning, burial, proliferation of collection sites in streets and/or vacant lots, etc. with potential effects on the health and quality of life of the communities, especially by vector-borne diseases (linked to rats, dengue-transmitting mosquitoes or similar, others).

Regarding the waste to be generated in the construction of the Mill, these would exceed the current capacity of the collection and final disposal services existing in the AID, already identified from the early stages of the project, this is why Paracel foresees the construction of a final disposal site (SDF) of solid waste within the industrial property (ZC) as a mitigation measure to this impact, which will already be operational in the construction stage of the Industrial mill and will serve also for the disposal of waste generated in the temporary/permanent accommodation of the operators.

Drinking Water

In the AII departments, most of the drinking water is provided by Sanitation Boards, community networks, and wells. The Sanitary Services Company of Paraguay S.A. (ESSAP) only supplies the central part of the city of Concepción and Pedro Juan Caballero, the latter being outside the Project's AID. The levels of access to running water are for the district of Concepción 83.2%, Belén 80.6%, Loreto 72.2% and Horqueta 69.9% (STP/DGEEC, National Population and Housing Census, 2012). Although there is no detailed data on the drinking water systems in the Project AID, such as maximum capacity, useful life or others, it can be estimated that the increase in demand for the service by the transitory and definitive population associated with the phase construction of the Project may imply a significant load on the capacity of the current supply systems, and may cause frequent shortages in case it is not accompanied by development works of these systems.

According to data collected in the field in the ADA, access to potable water provision services is considered the second priority aspect for community development. The mention of this aspect may indicate that the current level of service in the ADA is low, or even null in the community of Piquete Cue (they use individual wells without treatment), therefore increasing the demand on an existing shortage could generate a significant negative impact on service capacity.

Considering that the need for drinking water consumption in the construction work fronts of the Industrial Mill would also put pressure on the current supply systems, the project foresees as a mitigation measure to this impact the construction of its own supply system of water, already from the construction stage of the undertaking; the same is envisaged for three temporary/permanent accommodations for Paracel staff.

Sanitation

In the department of Concepción there is only a small percentage, 18.2%, of the population with access to a sanitary sewer network for the collection and final disposal of domestic water in the central part of the city of Concepción. Most of the population has a cesspool, with or without a septic chamber, for the disposal of its sewage and wastewater. The data indicate that more than 50% of the homes in the department of Concepción have at least one (1) Unsatisfied Basic Need (UBN), and that most of these have UBN in sanitary infrastructure. Access to improved sanitation is 69.1% for the district of Concepción, 43.4% for Belén, 24.4% for Loreto and 32.8% for Horqueta (STP / DGEEC, National Population and Housing Census, 2012). The low coverage of the final disposal service and the increase in the transitory and definitive population related to the construction phase of the Project may generate an unhealthy environmental situation in the AID communities where the population will settle, if the contingent of associated persons is not accompanying the Project with the development of the housing infrastructure and essential basic services. This could lead to settlements of people in a precarious state, and the deterioration of the general living conditions of the AID communities.

Although there is news of a project for wastewater collection networks and treatment mill for the city of Horqueta, under the Ministry of Public Works and Communications (MOPC) it is not possible to guarantee that this project will be available when the project of the construction phase of the industrial mill begins, so the sanitation services will most likely remain as they are.

For its part, given the need for sanitation in the construction work fronts of the Mill and the lack of collection and final disposal service in the area where it is located, the Project plans to address the correct disposal of effluents both in the construction/operational stage of the Industrial Mill as well as the three temporary/permanent accommodations for Paracel's personnel.

Electricity

It is estimated that the increase in the temporary and definitive population associated with the construction of the Mill may generate pressure on the current capacity of the electrical system in the ADA/AID.

In general, the level of electrical energy coverage is high in the department of Concepción, equal to 97.79% in 2017. In addition, there is a project to improve the electrical system in the department, which will implement improvements in the supply system for electricity in the cities of Concepción, Loreto and Belén. In general, the provision of electric power is the service that expands the fastest geographically, currently reaching around 99% of the country's population.

In addition, there is a history of medium and large-scale undertakings that use the public energy supply system in the country, such as the National Cement Industry (INC), Cervepar, Paresa, ADM, among others.

In view of the above, Paracel has already begun negotiations with the National Electricity Administration (ANDE), in order to provide the facilities required for supplying from the public network, planning the construction of an exclusive Transmission Line (LT) from the sub power station in Villa Real (Concepción) to the Industrial Mill.

Public Transport

The presence of a significant amount of transitory population associated with the construction of the Mill, in addition to their families, will imply an increase in the demand for means of transportation for the daily movement of people, both within their communities of residence in the ADA/AID such as from these to the Project work fronts.

Currently there are local and inter-departmental private transport services that connect the city of Concepción with Loreto, Horqueta and Belén, as well as with more distant cities such as Vallemí, Pedro Juan Caballero and Asunción. Regarding interurban public transport, the cities of Concepción and Horqueta do not have this service and the population mostly uses motorcycles (60% of the enabled vehicles); this being the predominant means of transport in all the departments of the IIA. In Belén and Loreto there is interurban public transport, however, the use of motorcycles is also very widespread.

As there are no public transportation services that connect the area where the Mill is located with the main ADA/AID population centers, one option will be for the Project to provide daily means of transportation for construction workers (from their homes to the work and back), and another alternative is that the workers have their own means of transport, which is presumed to be preferably motorcycles.

Regarding the transitory and/or definitive population indirectly induced by the Project, it will also require daily public transport services, but as these are either non-existent or limited, a considerable increase in the circulation of motorcycles and other vehicles is expected for private use in all ADA/AID communities.

Health

The ADA/AID health services may be affected by the increase in the temporary and permanent population associated with the construction of the Project, which will settle in the ADA/AID communities. This could translate into a lower average attention span per person.

The most relevant data are those of the department of Concepción, as it is expected that most of the population will settle in the communities near the Mill, within the department. Concepción had 214 hospital beds in 2017 and 76 public health facilities in 2018, throughout the department. In the AID districts, there are the following numbers of establishments of different types, dependent and not dependent on the Ministry of Public Health and Social Welfare (MSPBS): Concepción 21 dependents and 16 non-dependents, Belén 3 dependents, Horqueta 15 dependents and 1 non-dependent, Loreto 5 dependent and 3 non-dependent. The care centers with the highest demand are those located in the district of Concepción, due to the degree of complexity, where 5,295 cases were attended in 2019; in Belén 343 were treated, in Horqueta 1,985 and in Loreto 116 cases.

According to the surveys carried out in the AID districts, “health” is the aspect most mentioned as a priority for a greater development of the communities. They consider that it is necessary to improve: access to quality health care, the number of health units close to the communities, the provision of the necessary equipment, supplies and resources for adequate care. This constitutes an indicator that, despite the numbers currently available in terms of health care units in the AID, these are not sufficient for the current population and would not be, even more so, if the population were to increase in AID districts and/or communities. Added to this is the COVID-19 pandemic, which is a threat that increases the demand for hospital beds.

Information has been accessed on the expansion and/or new opening of Family Health Units (USF, dependent on the Ministry of Public Health) in the AID districts, with a care capacity of between 2,500 and 3,000 people each. In the micro-territories closest to the location of the Industrial Mill, there is information on the short-term installation of a USF in the community of Roberto L. Petit, and the management for the installation of a health post in the community of Plato Lagoon. It is estimated that the existence of these by the beginning of the construction phase of the Project may contribute to decompressing the demand for more basic health services in the ADA/AID.

On the other hand, the Project will be able to provide better preventive health conditions to direct employees in the construction phase and to their families, while the work lasts, since to date only up to 15% of the department's population has medical insurance, either private or IPS. This impact is associated with the formalization of labor ties, since, since the jobs are not formalized, people do not have compulsory social security.

Security

Public services for the protection of the safety of the population may also be affected by the presence of a greater number of people in the ADA/AID communities associated with the construction of the Project.

According to the data obtained, there are police stations, sub-police stations and police posts in the AID. As for police stations, there are 5 in Concepción and one in each of the cities of Belén, Horqueta and Loreto. Sub police stations there are 5 in Concepción, 1 in Belén, 8 in Horqueta, 5 in Loreto.

The consulted ADA population has referred to the "little police presence" as one of the aspects of concern in the community. If this is the case, the effects induced by the construction phase of the Project may further increase the pressure on the currently existing police backup capacity.

The property of the industrial enterprise, as well as the forestry component, will have its own security personnel, which is common in private enterprises. In this sense, the need for the project to have the support of the public police/security service is reduced. However, as it is a sensitive aspect that could involve the violation of human rights, the project will observe, at a minimum, IFC PS 4 on "Community Health and Safety", regarding the safeguarding of personnel and properties; on the one hand, and the minimization of security risks for the surrounding communities, ensuring that these personnel do not exercise "abuses of power" as an extortion measure or pressure on workers and/or the community; Paracel will have a specific area, under the human resources area, which will implement a "Security Policy" at the business level.

Emergencies

In the Concepción district, the Concepción Volunteer Firefighters Corps is the entity that helps in cases of accidents of various kinds and also provides services to the neighboring areas of the district. However, it has been indicated that their capacity is very limited, mainly due to lack of budgetary resources. The increase in the transitory and permanent population associated with the construction of the Mill may further affect the attention span of the Fire Department, as the probability of accidents and/or emergency events could increase, both due to the presence of the population as well as by the construction works of the Mill and related services, and by the increase in vehicle traffic due to the Project.

Education

There will be an impact on the capacity of the educational services, since it is estimated that the workers associated with the construction of the Mill could settle in the communities of the ADA/AID of the Project with their families, and due to their relative age, it will be it presumes that they would have children of school age, who would need to be inserted in the local educational context.

There is a total of 398 State institutions and 32 subsidized private institutions that offer Basic School Education in the department of Concepción, of which 21% are in urban areas. Only 42% of all institutions offer all educational cycles (first, second and third cycles).

Regarding Secondary Education, there are 111 institutions at the department level, of which 35% are in urban areas. It is observed that in 2015 55.7% of high school students were enrolled in urban areas, which indicates a greater demand for educational places in these areas.

In the districts of the Project AID, there are the following approximate numbers of educational institutions, as of 2016: Concepción, 60 in urban areas and 50 in rural areas; Belén, 3 in urban areas and 22 in rural areas; Horqueta, 20 in urban areas and 113 in rural areas; and Loreto, with 9 national schools and 32 basic schools.

Communications and information

In the department of Concepción, less than half of the population (46.05%) had access to the Internet in 2017, but of that percentage, around 97% accessed through a cell phone. On the other hand, it is indicated that 96.63% of the department's homes have a cell phone. Therefore, it is estimated that the low level of access is more related to the possibility of households to access certain types of durable goods such as smart cell phones, computers, etc., that allow Internet access, than with limitations in the service coverage.

Although the increase in the temporary and definitive population associated with the construction of the Project will demand the telecommunications service, it is considered that the Project will not imply a negative impact on the current provision capacity in the ADA/AID. It should be noted that telecommunications coverage is the private service that has been most easily expanded in the national territory in recent years, so that, in the event of a need for greater capacity, it is expected that the service goes together with the demand increase.

Hosting Services (rental capacity)

Regarding accommodation, there are currently approximately 1,107 beds in different accommodation establishments in the cities of the AID, which are distributed as follows: 960 beds in 20 establishments in Concepción, 52 beds in 3 Belen establishments, 43 beds in 5 establishments in Horqueta and 52 beds in 2 establishments in Loreto. Although it is expected that the majority of the transitory population will opt for lodgings in Concepción, there could be cases (due to the distance to the project) that the lodgings need to be promoted in the localities near the Project.

Increase in the demand of household

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services.

There will be an increase in the demand for housing in the ADA/AID due to the increase in the workers influx, and the consequent increase in the temporary and permanent population associated with the construction phase of the Project, both from the 6,000 to 8,000 people directly employed by the Project –and their families– in different stages of construction, as well as by the population that could reach the AID induced by the economic expectations that the construction of the Mill would generate.

Most of these people will be geographically located according to factors such as leasehold capacity (the existing offer of accommodation, rentals and housing) and the relative distance to the work fronts of the mill.

The site where the land is located for the mill is located about 20 km from Loreto, 22 km from Concepción, 50 km from Belén, and 60 km from Horqueta. Regarding lodging, there are currently approximately 1,107 beds in different lodging establishments in the cities of the AID, with the majority in establishments in Concepción. Therefore, it is expected that the majority of the transitory population that opts for lodging will stay in the city of Concepción. There is no data on homes that are for rent or sale in the ADA/AID cities.

The Project will provide accommodation to an important part of the workers in its construction phase who do not currently live in the ADA/AID, and these could also be used by people who live more than 45 minutes from the mill site. The construction of six lodgings has been defined, and the dwellings located there may be used permanently or temporarily.

Both in the case that the houses provided by the Project are not sufficient and, in the case, that the induced population cannot access houses with minimum habitability criteria - both due to the scarcity of the supply and due to lack of resources to acquire or rent them. There is a risk of the establishment of irregular and precarious settlements in the ADA/AID communities, contributing to the deterioration of their urban environment and the quality of life of the people in these settlements.

Currently, according to data from the Ministry of Social Development, within the framework of the national government program called "Tekopora", settlements have been identified in the city of Concepción (Aquino Kue settlement located between Route 5ta and Route Vallemí; Santa María settlement located in the airport area; San Francisco settlement, located in the airport area, Niño Salvador settlement, located in the Telefuturo antenna area, on the way to Loreto; Villa Redención settlement, located in the Cancha Obrerito area; New settlement in the Fatima neighborhood; New settlement in the Santo Domingo neighborhood).

Increase of vehicular traffic

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; transportation of materials, supplies and machinery; transportation of construction workers; construction and/or adaptation of access roads to/from the Industrial Mill; solid waste management, effluents, emissions.

There will be a significant increase in vehicular traffic in relation to that currently existing in the area of influence and especially in the ADA/AID, due to the transportation needs of materials, supplies, machinery, equipment, personnel and waste and/or effluents that will have the construction phase of the Project.

On the other hand, the increase in the transitory and definitive population will also contribute to the increase in traffic in the ADA/AID, as well as the increase in the workers influx linked to the project, since they will have transportation needs that, considering the context, and These will have transportation coverage through buses that will have hourly itineraries to be transferred to the site of the Industrial Mill and to the city; eventually, some operators could use their own, mainly motorcycles.

This increase in traffic may lead to a decrease in service levels (speed, travel time, freedom of maneuver, interruptions, comfort) or traffic flow on the affected roads, during peak hours of use of the roads. According to observations of the existing roads in the ADA/AID, the national routes and branches (such as those that connect Concepción and Belén with Loreto) are paved, have widths of up to 10 meters and two traffic lanes; other secondary roads are made of dirt (in some cases gravelly) and wide that allows two traffic lanes; these will be the routes shared by the Project with other users in the ADA/AID..

The determination of the access/exit path to the surveyed area was studied by Paracel, having had two options, but discarding the access by the Piquete Cue community, as a measure to minimize potential impact on the families of the same (resettlement was thus avoided of families).
Thus, the access will be made through the area of the town of San Ramón (Southeast area), passing through the Pyrenda ranch. The access road extends to a certain point within private property, so Paracel will adapt said access,

and also has the advantage that this section of the road would not be used by other users except the owners, thus minimizing road safety risks to third parties.

Due to all of the above, the increase in vehicular traffic would particularly impact the communities settled on the AID roads before reaching the access point to/from the Mill.

Likewise, the Project may require the construction of certain sections of new roads and/or adapting the existing roads in the AID beyond the access road to/from the Mill. If this is the case, it is not ruled out that the construction and/or adaptation of communication routes for use in the construction and operation phases of the Mill produce an effect of increasing traffic on said roads, due to the theoretical proportional relationship. that the greater the supply of roads, the greater the demand for vehicular traffic.

Impact on road infrastructure

Activities or aspects that generate the impact: transport of materials, supplies and machinery; transportation of construction workers; construction and/or adaptation of access roads to/from the Industrial Mill; solid waste management, effluents, emissions.

In the event that the existing road network is not adapted for the transit of materials, supplies, machinery, equipment, personnel and waste vehicles in the construction phase, the roads may suffer a negative impact in terms of their conservation and their life. useful, affecting not only the transit of Project vehicles but also other users of these roads, such as people who use them on a daily basis, the logistics of other productive activities in the area, the logistics of materials and/or products passing through, etc.

However, even with the roads that the Project could condition in its immediate surroundings, it is clear that there will be greater vehicular circulation on the roads beyond this environment, since materials, supplies, machinery and equipment will be received from central towns outside the district and/or the department of Concepción itself. The vehicular loads of the Project in its construction phase must be communicated to the local and national road authorities, in order to establish a strategy for the least affectation of the existing roads.

The duration of the causes of this impact is temporary, as it is expected that only during a few months of the total of the 2 to 3 years that the construction will last, there will be peaks in the circulation of heavy vehicles, according to each stage of construction (example: excavations, concreting, roads). It is estimated that the types of vehicles that would produce the greatest impacts are conventional and unconventional cargo trucks and, if any, personnel transport buses.

According to the data available regarding improvement works on bridges and roads, the department of Concepción does not plan to improve neighborhood roads in the National Program of Neighborhood Roads and Bridges, executed by the MOPC, but only improvement of bridges. Regarding asphalt paving works and improvement of sections of national routes, some works are planned that will improve access to the city of Concepción from different parts of the country, in particular of route No. PY05, which would directly benefit the urban area of the city of Concepción.

On the other hand, in case of adaptation of existing roads, on the one hand, it will temporarily affect the pedestrian and/or vehicular traffic that currently uses said roads, since the space of the same will be physically occupied to carry out the works, and on the other It will contribute to improving the conservation of the roads, thus improving the service levels of these, and consequently improving the comfort in their use. The section where new roads will be built for the Project, which in one sector would pass through private ownership, will be conditioned for the exclusive use of the project, but which is also considered a positive contribution in terms of the conservation of said road.

It should be noted that "infrastructure and road safety" is the aspect most mentioned by the representatives of institutions and communities of the AID in relation to the aspects necessary for a greater development of their communities/districts. In this sense, they have highlighted the need to improve the state of the roads and neighborhood roads. The inadequate state of some roads in the ADA/AID plus the already existing perception regarding these in the AID and the load of the vehicles of the construction of the Project give the notion that the impact of the Project will be important on the road infrastructure from the social perspective.

Impact of land properties in the immediate surroundings of the Mill

Activities or aspects that generate the impact: transport of materials, supplies and machinery; transportation of construction workers; construction and/or adaptation of access roads to/from the Industrial Mill; construction of Transmission Line (LT); solid waste management, effluents, emissions.

This impact occurs by enabling a road to reach the mill 's land through the land properties adjacent to it, either for the passage of part or all of the vehicles of the construction phase of the Project, which will include vehicles transport of loads, construction personnel and waste and/or effluents generated in temporary accommodation. It is worth mentioning that properties will be affected, whether private or whose ownership will be confirmed according to public records, always safeguarding compliance with local regulations regarding land tenure and affectations that require some type of compensation.

This affectation of properties, as already described in the pre-construction stage, could generate rights of way that must be agreed with each of the owners of the affected properties. In a private legal agreement environment, there would be less difficulty in defining the precise precautions, mitigations and/or compensations that the Project must implement to be in compliance with the requirements of the affected owners.

The choice of access/exit to/from the Project's land through properties, via right-of-way, will mean - comparatively with access via the existing road through the Piquete Cue community - less alteration of the existing public roads and the living conditions of the populations located in the immediate proximity of these roads. As mentioned, Paracel has ruled out access by the Piquete Cue community, in order to avoid impacts due to resettlement (physical displacement), as established by IFC Performance Standard 5, which has as one of its objectives: Avoid displacement or, where this is not possible, minimize it by exploring alternative project designs.

In relation to the Transmission Line (LT), which will supply the Paracel station from the Villa Real substation, it will require a security and service strip in the public and private domain properties subject to the easement of the electroduct, and for 220 kV TL this is *25 meters measured perpendicularly from the geometric axis of the line, on each side (Art. Nº 1 of Law 6681/2020)*[149]. In this security strip, grazing or agricultural use is not prohibited, but in general, the other uses are incompatible. In addition, in accordance with IFC ND 5, the necessary compensation provisions will be made for these cases, with emphasis on private properties close to the development site, as well as those that may be affected along the electrical lines of the TL. Compensations are given only once, assuming that they later come under the jurisdiction or domain of ANDE.

Likewise, for all the above, following the principles of Ecuador and ND 5 of the IFC, the measures related to the temporary/permanent affectation or obstruction of properties should be considered.

149 Recent Law which modifies article 1° of the Law 976/82.

Impact on River and Port Traffic

Activities or aspects that generate the impact: transport of materials, supplies and machinery.

In addition to land transit, the project provides for the transportation of materials, supplies, machinery and equipment for the construction of the Mill by waterway, the loads of the Project may put pressure on the current capacity of the waterway and the existing ports in the proximity of AID. The charges for river traffic would be made from material from Brazil, in the early stages of the project, setting sail from Puerto Murtiño (Brazil), to the Port of Concepción.

In the AID and AII they have several ports on the Paraguay River, highlighting in addition to the Port of Concepción the more than fifteen ports located upstream of the city, considering that the Paraguay River is navigable by vessels of greater draft, in the section that goes from the confluence with the Paraná River to Asunción, and with intermediate draft (to overcome the known obstacles) until reaching the port of Concepción, this water course being part of the Paraguay-Paraná waterway, the main axis of the country's transport with exit to the sea.

In addition, the pressure that could be exerted on river traffic and the port capacity of the area, it should be considered that this potential impact indirectly derives in others linked to the safety of personnel and/or third parties, or potential inconveniences that it may cause in the "use of water", bearing in mind that there are fishermen in the area, who fish either for their own consumption or for sale. The practice of “sport fishing” is also registered in the Department of Concepción, which could also be classified as a potential conflict in the use of water, as there are several activities related to water resources in the project's area of influence. These sub-impacts are detailed in the social factor “quality of life, uses and custom, including ecosystem services”, to be presented in later sections.

Improvement in the Quality of Housing and in the Provision of Basic Services

Activities or aspects that generate the impact: construction of the Industrial Mill and related services; construction and operation of temporary accommodation.

The construction of temporary/permanent accommodation planned for part of the construction workers will meet habitability criteria and could be of better quality compared to the average homes of the IIA, since it is observed that in the departments of Concepción and San Pedro more than 50% of the population has at least one (1) UBN and that most of this population has UBN in quality of housing and/or in health infrastructure.

The planned accommodations will be in the city of Concepción, whose location and distribution details are presented in the Annex. These facilities, once the construction stage is completed, could continue to be used by project personnel who will be linked in the operational stage, but part of them could be posteriori projected to adapt to the urban plans that the Municipality of Concepción has. This will be taken care of by Paracel, as part of the inter-institutional coordination and corporate responsibility strategies, already initiated in the early stages of the project.

Possible Improper Closure of Temporary Accommodation

Activities or aspects that generate the impact: closing or culmination of the works.

Inadequate management of temporary accommodation could produce negative impacts in the closing phase of the construction of the Industrial Mill, as part of the population will return to their places of origin and the accommodation could be left to the discretion of spontaneous occupations, having as consequent, the emergence of irregular and precarious settlements, social and visual deterioration, as well as pollution and the shelter of people dedicated to criminal activities. In summary, improper management of these sites could turn them into marginal neighborhoods that will degrade the current living conditions of the AID communities and of the people themselves who remain occupying these accommodations.

This impact could be avoided, or minimized, taking into account what was stated above, regarding the possible management that would be done with the Municipality of Concepción, in later stages, in order for Paracel to respond to the urban plans of the local government.

CULTURAL HERITAGE

Affection of Materials of Archaeological, Historical and/or Cultural Interest

Activities or aspects that generate the impact: Construction of the Industrial Mill and related services; Construction and/or adaptation of access roads to/from the Industrial Mill; Construction and operation of temporary accommodation; construction of transmission line (LT); Management of solid waste, effluents, emissions.

This impact is considered here in accordance with the "Concepción Heritage Report", specifically prepared by another Consultant (Bragayrac, February 2020).

The aforementioned study highlights properties with cultural and historical value, located in the urban centers of the cities of the AID, not in the vicinity of the property prospect for the undertaking. According to the information available on the land where the Project will be implemented, the site is used for livestock and agricultural activities, which implies that the subsoil of the site has not been intervened before.

The construction phase of the Project will carry out important soil movements for the construction of the civil works of the Industrial Mill, as well as of the accommodations in the city of Concepción and along the route of the projected TL, a phase in which it could be found in the subsoil materials of archaeological, historical and/or cultural interest that have not been found before due to the use that has been given to the soil in the place. These materials, although they could be found within the property/ies, would constitute materials of public value, so they must be rescued through safe procedures and delivered to the national authority responsible for the preservation of the national heritage. If these precautions are not taken, the existing material in the subsoil could be permanently affected. Therefore, the Project must design a construction method that already takes into account the potential for finding materials of archaeological, historical and/or cultural value in the intervention area.

Finally, if the Project carries out the extraction and/or exploitation of the construction materials for the Mill (stones, sand, etc.), also during these activities the impact of valuable materials may occur.

Paracel, for both the forestry and industrial components, will have an operating procedure for eventual finds, within the framework of the Archaeologic Finding Chance Program.

LOCAL AND REGIONAL ECONOMY

Development of the local, regional and/or Extra-regional Direct (associated with construction) and Indirect Economy

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; transportation of materials, supplies and machinery; transportation of construction workers; construction and/or adaptation of access roads to/from the Industrial Mill; construction and operation of temporary accommodation; construction of transmission line; solid waste management, effluents, emissions.

Direct Economy, associated to the construction of the industrial mill.

The hiring of local labor for the construction of the Mill and related services, and other associated activities such as accommodation and transmission lines, as well as for the transport of cargo, waste and/or personnel will contribute to the development of the local economy by the greater purchasing power that these will have for the consumption of goods and services, and even investment in their own businesses, considering the increase in the workers influx in the area.

The demand for materials, supplies, machinery, equipment, construction services and logistics of cargo and people for the construction and related services of the Industrial Mill will generate a greater dynamism of the local and regional economy, depending on the local/regional feasibility of production and/or provision of these.

It will require the acquisition of significant volumes of construction materials, construction supplies, conventional and specialized equipment and machinery, and vehicles and their parts, as well as repair and maintenance services for these. Transportation services for these loads and construction personnel will also be required. All of these will be for the mill and its related services, as well as for the temporary/permanent accommodations, transmission line, and the construction and/or adaptation of roads for the Project.

It is observed that in the department of Concepción there are sectors of the secondary sector (industry) that carry out activities related to the materials that the construction of the Project may require: extraction of stone, sand and clay; wood sawmill; manufacture of non-metallic mineral products; manufacture of metal products for structural use; manufacture of other fabricated metal products and metal working services; furniture manufacturing; maintenance and repair of fabricated metal products, machines and equipment.

Indirect Economy

The increase in the temporary and permanent population, as well as the increase in the workers influx, associated with the construction phase of the Project will generate a demand for local goods and services that will necessarily be higher than the current one, due to the same number of people who will install or spend time at the ADA/AID.

This will generate higher income and investment stimuli for the establishment and/or expansion of providers of goods and services of different types (food, communication, vehicles, transportation, recreation, education, health, etc.), formal and informal. As examples, we can mention the opening of commercial and/or service premises with products for the workers of the construction of the Mill, in the vicinity of it (dining rooms, supermarkets/pantries, telecommunications, mechanical workshops, etc.); the opening of new commercial and/or service premises along the communication routes used, with the expectation of selling products to carriers; the expansion and/or authorization of currently insufficient or non-existent public transport services; the creation of jobs by the aforementioned enterprises, which will be able to employ more local people.

The greater dynamism of the local economy has as positive effects the increase in household income associated with the provision of goods and services, the possibility of accessing goods and services that are currently non-existent, limited, insufficient or inaccessible.

In the tertiary sector, it is observed that commercial and/or service activities are carried out in the department that could be required to a greater or lesser extent during the construction of the Project and that could be enhanced with this: trade, maintenance and repair of vehicles (including motorcycles) and its parts and accessories; food and beverage trade; fuel trade; trade in cultural and recreational goods; land transportation service; temporary accommodation service; restaurants, bars and the like; telecommunications; financial services;

real estate services for sale and lease; administrative support services for businesses; amusement and entertainment services. Regarding the AID, according to data collected in the field, it is observed that commerce is the activity that has expanded the most in recent years, including gastronomic businesses, supermarkets and pantries, beverage warehouses, places for the sale of household items, among others. All of these may benefit from the increase in population in the AID associated with and/or induced by the construction of the mill.

Finally, the temporary and definitive increase in the population, both during work at the Mill and during daily life in the homes, will generate volumes of municipal solid waste that could create an opportunity for collection and sale activities for recycling waste. This activity may, in turn, contribute to reducing the pressure of the waste generated on the collection services and on the existing final disposal sites.

Greater dynamism in the local economy will be very beneficial for local communities, since the total poverty rate by income in the department of Concepción is above 40%.

Increase in Visitors to the Area

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; transport of materials, supplies and machinery.

The construction of the Industrial Mill, the first of its kind and magnitude in the area, may attract people with diverse interests to the site, such as, for example, media workers, national and/or local authorities, academic groups, tourists, curious people, etc.

Likewise, the presence in the ADA/AID of foreigners who work for the Project, particularly foreigners and/or from other departments of the country, and of the people who will settle in the area due to the expectations of the Project, may imply the visit frequent ADA/AID of people related to them (relatives, close friends).

It is also foreseen the transitory presence in the ADA/AID of non-local people related to the logistics of materials, supplies, machinery and equipment for construction, representatives of suppliers, personnel of international certifiers, etc.

These events, although even more transitory than the presence of construction workers, may contribute to energize various sectors of the local economy, such as food, accommodation, recreation, tourism, etc. In this context, it is expected that most visitors will stay in the city of Concepción (with greater rental capacity) and that they will make the transfer to the works area for visits.

Possible Decrease in Commercial Activities and/or services

Activities or aspects that generate the impact: closing or culmination of the works.

The end of the construction phase of the Project may also mean a decrease in commercial activity in the ADA/AID, because the direct jobs of the work will be reduced and, therefore, the population itself will be reduced (abandonment of the ADA/AID to migrate to other areas that offer jobs or income opportunities) and the demand for these for goods and services for daily life.

This decrease in commercial activity and/or services will lead to a decrease in the jobs associated with it and, in general, in income in the ADA/AID.

Both the decrease in jobs and the commercial and/or service activity may have effects of economic stress on the households that remain in the ADA/AID after completion of the works, which will demand from these households' adjustments in their living conditions, in their access to goods and services and other aspects related to the greater liquidity they had during the construction phase.
However, it should also be considered that during the operational phase of the Project, the area attracts other enterprises due to the availability of qualified and unskilled labor, commercial activities/services and/or basic services/infrastructures already developed in the AID during the construction phase of the Project, which would offer advantages to new ventures for their installation. This could contribute to counteract the decrease in direct jobs due to the closure of the construction phase of the Project and the indirectly associated commercial and/or service activity.

REAL-ESTATE MARKET

Increase in the Price of Properties and Rentals

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; transportation of materials, supplies and machinery; transportation of construction workers; construction and/or adaptation of access roads to/from the Industrial Mill; construction and operation of temporary accommodation; solid waste management, effluents, emissions.

An effect of increasing the price of rents and properties could occur due to the limited supply of housing existing in the ADA/AID and the high demand for housing that will be generated by the number of employees that the construction phase of the Project will have. Also, considering that the Project will develop temporary/permanent accommodation for its employees, the price of the properties could also increase due to the perception that the owners may have of a wide availability of capital from the firm responsible for the Project.

This effect would be negative on the local or foreign population that requires a home, whether or not it is associated with the construction phase of the Project. The approximate housing demand data in the three AII departments is 27.6% for Concepción, 26.2% for San Pedro and 25.9% for Amambay. It is observed that the majority of the population in the IIA prefers their own home (between 68.6% and 87.6%), but it is estimated that, for the duration of the construction phase, it will be between 2 and 3 years, many of the people employed in the Project would opt only for rent.

It can also be estimated that, in general, the value of the properties closest to the land where the Industrial Mill is located, to the communication routes that will be used by the Project's vehicles for various transports, to the communication routes for the Project that will be built and/or adequate, and the construction and operation sites of the temporary/permanent accommodations of the Mill workers, may be increased. This situation could occur as a result of the owners' expectations that the Project will provide greater dynamism to these areas, related to opportunities for greater economic development and provision of basic services infrastructure in the medium and long term. This effect would be positive for land and/or home owners.

On a lesser scale, a devaluation effect of the land price could occur on properties close to the transmission line to be built as part of the project. In similar works, there is experience of the loss of the value of the land in areas of installation of high voltage electrical conduits, for which the Project will make the necessary provisions, in coordination with ANDE, to meet the provisions of the ND IFC 5.

Finally, considering that the Project foresees the construction of a site for the final disposal (SDF) of solid waste within the industrial property (ZC), the location of this must be considered, in order to minimize impacts related to the possible devaluation of the nearest properties.

OCCUPATIONAL HEALTH AND SAFETY

Occupational Health Impairment

Activities or aspects that generate the impact: construction of the Industrial Mill and related services; construction and/or adaptation of access roads to/from the Industrial Mill; construction and operation of temporary accommodation; construction of transmission line; solid waste management, effluents, emissions; closure or completion of the works.

During the construction phase of the Project, the health of construction personnel could be affected by the following dangerous activities and/or events: the handling of powdery construction materials and/or toxic and/or dangerous supplies; exposure to disease vectors (dengue, chincungunya, chagas disease, among others); exposure to solar radiation and heat; exposure to high noise levels; exposure to stings or bites of wild animals; exposure to work at height and electrical risk; etc., which are dangerous activities and events present in any medium and/or large-scale construction site, and which vary according to the environmental context in which the work takes place.

These incidents affecting occupational health could occur in any of the construction activities, both at the mill and its related services, as well as on the roads necessary for the Project, the temporary accommodation, the transmission line and during the dismantling of the infrastructures. Temporary that were used in the construction, once these have been completed.

Likewise, occupational health may be affected during the management of solid waste, effluents and emissions from construction, in the case of contact with contaminated substances and/or materials that could have adverse effects on human health, for example, solid waste. organic, inert and powdery solid waste, solid waste and/or hazardous effluents (oils, paints, chemicals, etc. or materials contaminated with them), sewage effluents, paint emissions or other constructive chemical agents, among others.

Likewise, taking into account the pandemic declared by the World Health Organization, zoonotic diseases, such as COVID-19, could spread, and specific measures must be established to avoid or minimize contagion between workers.

However, this impact is preventable and/or mitigable through specific measures to protect occupational health. Consider IFC Performance Standards 2 on Labor and Working Conditions, as well as World Bank Group EHS Guidelines.

Paracel, both in its industrial and forestry component, plans to implement the best operational practices in order to minimize risks in OHS, as well as to have the necessary number of technicians specialized in the subject.

Impairment of Occupational Safety

Activities or aspects that generate the impact: construction of the Industrial Mill and related services; construction and/or adaptation of access roads to/from the Industrial Mill; construction and operation of temporary accommodation; construction of transmission line; transportation of materials, supplies and machinery; Transportation of construction workers; Management of solid waste, effluents, emissions; closure or completion of the works.

The construction phase of the Project will entail risks of affecting the safety of the personnel employed in this phase, in each of its activities, just like any other project that involves civil works of medium and/or large scale, assembly of equipment and machinery and different types of transport.

The impact on personnel safety could occur in this phase due to the following events: traffic accidents on and off the Project site; accidents of the type of falls to the same level, from places in height and/or inside excavations; blows by fallen objects and/or by the use of tools, equipment and/or machinery; cuts by equipment and/or machinery; electrocution during electrical installations; weld burns; hazards associated with manual handling of loads; eye damage; fires; among others.

The activities in which there would be risks of affecting occupational safety are all the activities involved in the construction: the works of the Mill and its related services; the logistical transport of materials, supplies, machinery, equipment and personnel; the construction and/or conditioning of the communication routes for the Project; construction of accommodation; construction of transmission line; the management of residues, effluents and emissions; the dismantling of temporary infrastructures that have been used during construction.

The impact on the safety of the personnel may present different degrees of severity, depending on each case, from minor damages to the death of the personnel. However, this impact is preventable through specific occupational safety protection measures. In all cases, the prevention established in IFC Performance Standard 2 on Labor and Working Conditions, as well as the World Bank Group guidelines on environment, health and safety, should be chosen first, and only afterwards, for the mitigation of this impact.

Paracel, both in its industrial and forestry component, plans to implement the best operational practices in order to minimize risks in OHS, as well as to have the necessary number of technicians specialized in the subject.

THIRD PARTY HEALTH AND SAFETY

Impact on Road Safety

Activities or aspects that generate the impact: transport of materials, supplies and machinery; transportation of construction workers; construction and/or adaptation of access roads to/from the Industrial Mill; solid waste management, effluents, emissions.

The transport of materials, machinery and equipment inputs, as well as the increased workers influx; and the management of waste and effluents from the construction of the Mill will produce an increase in vehicular traffic in the area of influence and particularly in the ADA/AID, increasing in turn the probability of accidents occurring and affecting people, infrastructures and domestic and/or farm animals of the communities that are crossed by the roads that will be used by the Project. In 2017, there have been 29 cases of death due to traffic accidents aboard motorcycles in the department of Concepción; In 2018, 7.9% of deaths from various types of accidents were recorded, without specifying the types of accidents.

In addition to the increase in the level of vehicular traffic itself, the probability of accidents is also increased by the existence or not of signs and by the behavior of the carriers or drivers of the vehicles in question. If these do not have a requirement from the Project to comply with certain strict rules of road behavior, the probability of inappropriate behavior and, therefore, accidents and/or conflicts with the communities in the area of influence could increase. Regarding the signaling, according to the available data on works in progress to improve the road infrastructure, there is a project for the Improvement of Road Safety in several Sections of the Road Network for the department of Concepción, with emphasis on school zones, which is executed by the MOPC, although the details of which areas of the department it will cover are not available.

Also, the improvement of the access roads to the Mill may, on the one hand, temporarily affect road safety, since it will involve construction work on existing roads that are used daily by pedestrians and/or drivers (bicycles, motorcycles, cars, etc.), and, on the other hand, contribute positively to avoid traffic accidents that could have their origin in potholes or other damage to the roads to be used.

Impact on the Health of Third Parties

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; construction and/or adaptation of access roads to/from the Industrial Mill; construction and operation of temporary accommodation; construction of transmission line; transportation of materials, supplies and machinery; transportation of construction workers; solid waste management, effluents, emissions.

The increased workers influx will lead to contact between the current AID communities and the temporary and definitive local and/or foreign population, which could increase the transmission of contagious diseases (examples: HIV, hepatitis, other sexually transmitted diseases, etc.). Likewise, taking into account the pandemic declared by the World Health Organization, zoonotic diseases, such as COVID-19, could spread, and specific measures must be established to avoid or minimize the contagion of communities and populated areas.

Likewise, the increased demand for health services due to the presence of additional population during the construction of the works could not be accompanied by an increase in health care capacity, so that both the current local population and the additional population may suffer impacts from their health due to lack of sufficient care.

On the other hand, the increase in vehicular traffic through the Project vehicles (cargo, personnel, waste) and the construction and/or adaptation of access roads to/from the Mill may produce higher noise emission levels and dust and air pollution due to combustion gases from vehicles, which may affect the health of people located or who carry out daily activities in the immediate proximity of the communication routes to be used/intervened. In 2018, 9.4% of deaths from diseases of the respiratory system were registered in the department of Concepción, without knowing the specific cause; however, the possible increase in air pollution could worsen the health conditions of people who already have respiratory problems. On a smaller scale, taking into account the low population that lives in riparian areas near the industrial mill property, there could be a risk in people who are engaged in fishing, or who use small boats in the area, due to related activities to be developed, as well as the river traffic that would transport machinery and supplies by said route.

Regarding the construction activity of the Mill itself, it could happen that third parties settle in the immediate vicinity of the Project property, with the expectation of economic income by providing goods and services to the construction employees. These people could be affected by noise and dust produced on construction sites. Similarly, although on a smaller scale, the construction of temporary/permanent accommodation will produce noise, dust and the emission of combustion gases from vehicles and machinery, with an impact on the populations that are in the vicinity of the construction sites.

Also, the potential improper disposal of waste, effluents and/or emissions from the construction of the Mill and/or the ease of third-party access to the final disposal sites could generate effects on the health of these people due to contact with substances and/or contaminated materials, for example, organic solid waste, inert and powdery solid waste, solid waste and/or hazardous effluents (oils, paints, chemicals, etc. or materials contaminated with them), among others. Or by generating environments conducive to the proliferation of insects and/or vermin that could be vectors of diseases.

It is important to consider all preventive measures set out in IFC Performance Standard 4 on Community Health, Safety and Security.

Impact of the Levels of Local Citizen Security

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services;

The establishment of a transitory and definitive population in the AID associated with the construction phase of the Project may increase the probability of crime and/or violence events in the ADA/AID due to the increase in population and the workers influx, since this will be significant in relation to the size of the current local population, due to cultural differences and the greater commercial and service dynamics that the Project is expected to produce, with the consequent increase in the circulation of money and assets. This could be favored if the public police service is insufficient for the size of the population to be had in the AID.

An increase in crime and violence levels cannot be properly estimated because the characteristics of the population that will settle in the AID are unknown.

Likewise, there is a risk that people who come to the area solely to commit criminal acts will settle in the AID, in view of the aforementioned conditions that would be generated by the presence of the Project. The increase in the workers influx, many times also leads to an increase in gender violence, attending to local sexist cultures, or due to the expected influx of a large number of male personnel.

According to the information collected in the field, both in the ADA and in the AID, “security” is the third and second most valued aspect, respectively, by the interviewees in terms of the positive aspects of living in their communities. Likewise, according to those surveyed in the AID, “violence” appears as one of the least mentioned aspects in terms of the problems identified in the territory. This indicates that people currently feel that there is an important level of citizen security and low levels of violence, so the alteration of these, induced by the Project, could be abrupt.

The baseline data indicate that in the entire department of Concepción an average of 22.25 intentional homicides have been committed for every one hundred thousand inhabitants, per year, between 2010 and 2017. Regarding punishable acts against property, has registered 82.76 events in 2017, visibly decreasing from the levels registered in previous years. At the regional level (departments of Concepción, San Pedro and Amambay), there is 18.2% of the population that has been the victim of crimes against the home, with theft at home being the most recurrent event (second area, after Asunción, where there are more complaints made about theft in homes); also 18% of the population has been the victim of crimes against people, due to extortion.

However, the perception of good security levels mentioned above, another perception of the communities of the micro-territories closest to the location of the Mill is that crime is increasing and is associated with the lack of employment, especially in the young population, as well as the consumption of alcohol and narcotic substances. They also commented that the improvement of the roads contributed to the increase in robberies in the area since it facilitates the rapid exit of those who commit the crime. In this sense, the offer of jobs by the Project to local people could in turn contribute to counteracting the trend of increased crime.

The property of the industrial enterprise, as well as the forestry component, will have its own security personnel, which is common in private enterprises. In this sense, the need for the project to have the support of the public police/security service is reduced. However, as it is a sensitive aspect that could involve the violation of human rights, the project will observe, as a minimum, IFC PS 4 on "Community Health and Safety", regarding the safeguarding of personnel and properties; on the one hand, and the minimization of security risks for the surrounding communities, ensuring that these personnel do not exercise "abuses of power" as an extortion measure or pressure on workers and/or the community; Paracel will have a specific area, under the human resources area, which will implement a "Security Policy" at the business level.

QUALITY OF LIFE, USES AND CUSTOMS

Increase of Discomfort or Restlessness

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; construction and/or adaptation of access roads to/from the Industrial Mill; transportation of materials, supplies and machinery; construction and operation of temporary accommodation; construction of transmission line; transportation of construction workers; solid waste management, effluents, emissions; closure or completion of the works.

At this stage of the project, the quality of life of the AID population could be affected, mainly due to the increased workers influx linked to the enterprise. The quality-of-life aspects affected would be, mainly, the tranquility and comfort of the current inhabitants, attending to the manifestations of high valuation of these characteristics of the area by the people interviewed in the information survey in the field.

The increased workers influx and the presence of an unusual number of people associated directly and indirectly with the Project's works in the ADA/AID communities may promote the appearance (or increase) of activities such as sale and consumption of alcohol and drugs, sex work or prostitution, gender violence, crime, disrespect for the vulnerable population, disturbance of public peace due to a greater number of recreational and/or night-time activities (parties, leisure groups, etc.) on public roads and/or in homes within the communities, disrespecting the current levels of tranquility of the ADA/AID.

On the other hand, the current level of access to entertainment spaces for the local population may be diminished by an increase in demand for the use of these spaces, since the temporary and definitive population associated with the Project will be installed in the ADA/AID, generating competition for use between the different groups.

A third point implies the possible emergency or increase of union activities of workers in the area, given the number of people that will be employed in the construction phase of the Project and their interactions with the daily life of the communities where they will settle/work, since they will be able to carry out events in public (or even private) spaces that could alter the tranquility. On the other hand, the existence of these groups could also be positive for local communities, since it can instill in them notions of public participation, groups to defend rights or promote legitimate interests, etc.

Also, the increase in vehicular traffic due to the Project (cargo, personnel, waste) may affect the tranquility and comfort of the people in the area of influence and especially the ADA/AID, since this will cause higher levels of noise, vibrations and air pollution by dust and combustion gases, affecting the people who live or carry out daily activities in the immediate vicinity of the roads that will be used by the Project vehicles, within a minimum radius of 100 meters from the roads. Likewise, the increase in vehicular traffic, especially heavy traffic, may generate uneasiness regarding the potential impact on the structural condition of the homes or buildings located on the roads to be used.

In the event that the Project builds new communication routes, these could affect the current tranquility and comfort of the populations through which these routes will cross, due to the same impacts related to traffic, but more severely, since it would pass from a situation from non-existent annoyances to another situation of permanent annoyances such as those that can be caused by vehicular traffic. These annoyances could even generate opposition to the opening of the roads of interest. In case of adaptation of the roads, the works carried out may also generate temporary nuisance due to dust and noise affecting the population adjacent to these roads.

Other annoyances due to dust, noise and vibrations could occur in the direct proximity of the mill's work fronts and the handling and final disposal sites for solid construction waste, as well as the construction of temporary/permanent accommodation for operators, with an impact on the population that is adjacent to such sites.

According to the data collected in the field in the ADA and the AID, “tranquility” is the aspect most valued by the interviewees when they were asked about the positive aspects of living in their respective communities/districts. This seems to indicate that the current levels of tranquility are high, therefore, the impact of the construction of the Mill could be significant, given all the aforementioned changes that the Project will introduce in the medium.

Another aspect valued in the ADA and AID is “people”, referring, in general, to the fact that the population feels comfortable and satisfied with their neighbors and other people in their communities/districts, also pointing out that there is unity and solidarity. This could be greatly altered by the arrival of large numbers of non-local people.

In the AID, the “little existing traffic” has also been mentioned as a positive aspect of the communities. This gives an idea of the importance of the impact that the Project's vehicular traffic (especially cargo traffic) will have in the construction phase on the communities through which it will pass.

Finally, the closure of the work will return certain levels of comfort and/or tranquility to the local population of the AID, especially in relation to the abandonment of the AID of a large part of the population hired directly by the Project for the construction phase and for the cessation of some of the activities that increase the levels of dust and noise in the local environment. However, in the event of improper delivery of temporary accommodation, new levels of discomfort or unease may be generated in the local AID population if these are occupied by people who turn them into “marginal settlements” or “slums”. The latter is expected to be minimized, taking into account the steps that Paracel is already carrying out with the Municipality of Concepción, in order to adapt to the urban plans that the local government has. This will be taken care of by Paracel, as part of the inter-institutional coordination and corporate responsibility strategies, already initiated in the early stages of the project.

Changes in Customs and Uses

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction and/or adaptation of access roads to/from the Industrial Mill; Transportation of materials, supplies and machinery; Transportation of construction workers; solid waste management, effluents, emissions.

The increase in the workers influx, and the consequent increase in the transitory and definitive population associated with the construction phase of the Project will force the interaction of the customs, uses and current values of the local ADA/AID communities with those of the additional population in the zone.

This could result in a negative impact if these customs, uses, values and habits are changed by the predominant ones that emerge from said interaction, thus losing the sense of identity, belonging, community and mutual respect.

Also, the possible alterations in the tranquility, comfort and even the security of the current population of the AID may lead to the need to change their daily habits, customs and ways of life to adapt to the new conditions that the presence of additional population would generate, due in large part to the increase in the workers influx linked to entrepreneurship. The impact would be adverse if it implied a deterioration of the freedoms enjoyed by the current communities and/or the normalization of acts contrary to the tranquility and harmony of the communities (for example, annoying noise, lack of respect towards vulnerable members of the local communities, with an emphasis on women and children, lack of respect for the property of third parties, etc.).

The existing data at the regional level (departments of Concepción, San Pedro and Amambay) indicate that people adopt practices such as security measures due to the perception of insecurity. For example, some practices are reduced, such as allowing minor children to go out alone (54.4%), going out at night (48.9%), leaving the house alone (48.2%), visiting relatives or friends (42.9%), frequent shopping centers (35.3%), among others, which generally reduce people's freedom of movement, the habits of cultivating interpersonal relationships that could be important for supporting families and even affect to trade.

On the other hand, the increase in vehicular traffic due to the construction of the Project (cargo, personnel, waste) may also generate changes in the practices and habits of the ADA/AID populations that are located in direct proximity to the roads used, such as, for example, stop attending sites or take greater precautions to safeguard their physical safety by avoiding the use of the roads, reducing the use of sidewalks as a place for recreation or meeting with neighbors, etc.

The recreation and leisure to which the inhabitants are currently accustomed is largely related to the spas on the shores of natural water courses. There are 17 watering places in the AID of which only 5 are authorized by the national authority. Other options are recreational fishing activities and boat trips on the Paraguay River. It is estimated that the leisure/recreation sites will be visited by the temporary and permanent population associated with the construction of the Project, with potential negative impacts on their carrying capacity and natural state, the forms of use and the frequency of visits of the locals to/from these sites.

In turn, another aspect related to water uses, and that is related to the provisioning ecosystem services, are those related to fishing for self-consumption and/or sale on a smaller scale. IFC PS 4, on "Community Health and Safety", establishes that the decline or degradation of natural resources, such as adverse impacts on the quality, quantity and availability of fresh water, can cause risks and impacts. related to the health of the communities, as well as their livelihoods. Considering that the implantation of the industrial mill takes place on the Paraguay River, and although the ADA communities do not directly source water for consumption, we do not want to fail to mention a small number of people who are dedicated to artisanal fishing for consumption and/or sale on a smaller scale. These could be minimally affected by construction activities linked to associated activities in the river, as well as by the transport of materials by river.

Impact of the Social Network

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; transportation of materials, supplies and machinery; construction and operation of temporary accommodation.

The impact on the customs and uses of the ADA/AID population due to the Project may have consequences on the networks/interconnections of the communities. For example, in the event that people decreased their visits to recreational sites or the homes of relatives/neighbors due to fears caused by the increase in the workers influx, and the additional population associated directly and indirectly with the project, and/or the potential impacts Due to the increase in traffic through the Project cargo, it is possible that there will be a gradual erosion of relationships between people, due to the decrease in encounters and direct contact between them.

Likewise, once the direct workers of the Mill -and their families- and/or the population that has come to the ADA/AID indirectly induced by the Project decide to leave the area due to the completion of the works, the social networks that will be created in the course of the 2 to 3 years of the construction of the Industrial Mill may be affected, having to face the challenge of restarting daily life in another place, without these networks.

It should be noted that social networks are important factors for the subsistence of, above all, families with limited economic resources, since through them the burdens of family expenses, housework and raising children are shared.

EXPECTATIONS

Generation of Positive Expectations in the Population

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services;

The construction phase of the Project may generate expectations in the population that could result in positive effects for the Project.

On the one hand, there are the expectations of the population of the ADA and the AID regarding the improvements and/or opportunities that the Project would bring to the area of influence, especially the AID, such as the generation of direct and indirect jobs, dynamization of the economy at the local and departmental level, enhancement of industrial development and, in general, progress and development. These expectations may generate feelings in favor of the Project in the local population.

According to data collected in the field in the ADA, half of the interviewees referred to "emigration and migration" (regionally and abroad) associated with the "little labor supply" as one of the problems in their community. Along the same lines, “work” is the aspect that they consider a priority for the development of the community. Also, the interviewed representatives of institutions and communities of the AID indicated the "generation of sources of work" as one of the preponderant aspects to achieve greater local development, as well as the "importance of the installation and operation of industries" in view of the lack of job opportunities in the area. And in the surveys carried out in the AID, “migration (country-city)” and the “lack of sources of work” are the most mentioned aspects in terms of social and economic problems. In this sense, the expectation related to job creation by the Project is expected to be very high, especially at the local level. In this regard, AID people also observed that they expect the hired labor and suppliers to be local.

Generation of Negative Perception and/or Fears in the Local Population

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; construction of the Industrial Mill and related services; construction and/or adaptation of access roads to/from the Industrial Mill; construction and operation of temporary accommodation; construction of transmission line; transportation of materials, supplies and machinery; transportation of construction workers; solid waste management, effluents, emissions; closure or completion of the works.

In addition to the expectations considered positive, expectations may be generated in the population related to desires for support from the Project to cover certain basic needs deferred from the ADA/AID communities in terms of infrastructure and services, thus supplying the functions of provision of services and/or care that should be provided by local and national governments. The survey in the AID showed that the "improvement of community infrastructure" is a positive aspect or benefit that people believe that the Project will be able to offer the community, as well as "supporting the growth of the communities in the area" is a of the most mentioned expectations in relation to the Project.

However, if the expectations generated in the population were not satisfied in reality, conflicts and/or feelings of rejection towards the Project could be generated; for example, in the event that local workers are not “sufficiently” employed, that the existing infrastructure is not improved and that it is exceeded in its capacity to share it, in its current conditions, with the demands of the Project, etc.

Likewise, the Project may generate negative perceptions and/or fears in the ADA/AID population in relation to various aspects. According to the field survey, to date, the AID population states that their main concerns regarding the Project are “possible damage to the environment and/or human health”, the “low absorption of local labor”, “Non-compliance with national and international regulations”, the possibility of “generation of conflicts if there is no good communication” or “lack of information”. For its part, the ADA has not revealed perceptions of negative aspects in relation to the implementation of the Project, but they could appear over time.

In addition, it should be considered that the following negative perceptions and/or fears may also appear in Projects of this magnitude:

- Regarding the number of foreigners who will arrive and settle in the ADA/AID to be employed in the work and/or establish businesses and/or services,

- The increase in citizen insecurity and/or addiction problems (mainly the problem of alcoholism was mentioned in the ADA and the AID),
- The decrease in the capacity of basic services (drinking water, health, etc. that are already referred to as insufficient in the ADA and AID),
- The deterioration that construction activities could cause on existing infrastructures (roads, etc. that are already in a state of deterioration according to the ADA and AID),
- The potential increase in traffic congestion and the risks of road accidents, the potential opening of new roads that would alter current living conditions,
- Potential changes in daily habits and customs and quality of life in general (tranquility, comfort, public safety, etc. which are currently highly valued in the ADA and AID), among others.

These negative perceptions and/or fears could be generated by the Project's lack of attention or information on these aspects.

For its part, the final stage of construction, which will involve the demobilization and abandonment of temporary accommodation, may generate both expectations and fears among the population and local authorities.

The closure stage of the work may also generate a negative perception of the population and local authorities due to the potential social impacts that they have already described before such as: the increase in unemployment in the AID, the decrease in commercial activity, the closure and potential improper delivery of accommodations.

The ultimate consequence of these impacts would be support for and/or rejection of the Project and potential social conflicts.

Generation of Positive Expectations at the Regional and Extra-regional Level

Activities or aspects that generate the impact: hiring of personnel for the construction of the Industrial Mill and related services; Construction of the Industrial Mill and related services; Construction and/or adaptation of access roads to/from the Industrial Mill; Transportation of materials, supplies and machinery; construction and operation of temporary accommodation; construction of transmission line.

The Project may generate expectations in the population of the districts and departments outside its AID, for reasons similar to those set forth in terms of expectations of the local population: generation of direct and indirect jobs, creation of demand for trade/services in the ADA/AID and along the roads used by the Project, improvement of infrastructure and existing services, etc. According to these expectations, the arrival of foreigners in search of new and/or better employment conditions, higher income, improvements in habitability, etc. may be presented.

The age, socioeconomic and migratory conditions of the inhabitants of the department of Concepción beyond the AID, which are similar to the conditions found in the department of San Pedro mainly and to a lesser extent of Amambay, provide a propitious context for expectations to be generated at regional level on the possibility of getting a job in the construction phase of the Industrial Mill.

Likewise, the Project may generate expectations at an extra-regional level in suppliers of goods and/or services due to the demands that the different construction activities of the Project will have (Mill and related services, temporary accommodation, construction and/or adaptation of roads) of materials raw materials, supplies, machinery, equipment, specialized engineering and assembly services, cargo logistics by land and/or river, etc.

Generation of Negative Perception and/or Fears at the Regional and Extra-regional Level

Activities or aspects that generate the impact: construction of the Industrial Mill and related services; transport of materials, supplies and machinery.

In general, it should not be ruled out that there may be a negative perception of the Project by people, groups, organizations and/or institutions at a regional or national level in relation to environmental issues, due to the belief that the Project will cause environmental damage, for example, to the Paraguay river, to air quality. It should be noted that at the national level there are problems of trust on the part of the general population towards the management of national and local public institutions that must ensure the well-being of the population, so it could be argued that the Project will not comply with national regulations nor international standards with the endorsement of these institutions.

Other uncertainties may emerge in other road users, land and/or fluvial that will be used to transport raw materials and supplies for the construction of the Mill, in terms of potential increase in traffic congestion and deterioration of the condition and useful life of the road network.

6.4. Social Impact Assessment – Operational Phase

6.4.1. Interaction between factors of the social environment and social aspects of the operational stage

From the interaction of the aspects derived from the entrepreneurial activities in the operational stage, as presented in chart 106 and the social factors cited in chart 107, an interactive matrix is elaborated, which allows to preview which activities could generate impacts, whether positive or negative at this stage of the project.

Chart 116. Matrix of qualitative interaction, social factors and aspects derived from the activities in the operational phase

	STAGE		OPERATIVE								
MEDIUM	SOCIAL FACTORS / FORESEEN ACTIVITIES		CHiring of personnel to operate the Industrial Mill and related services conexos	Operation of the Industrial Mill and related services	Transport of raw materials, supplies and products	Transport of workers of the Industrial Mill	Production and management of emissions (gases, vapors, odors)	Production and management of effluents	Production and management of solid waste	Maintenance of access roads to/from the Industrial Mill	Accommodation of the Industrial Mill workers
	RESOURCE	FACTOR									
SOCIAL	Social - Economic and Cultural	Employment	●	●							
		Demography	●	●							
		Public/private services, infrastructure and/or property	●	●	●	●				●	
		Archaeological, historical and / or cultural heritage		●							
		Landscape		●			●				
		Local and regional economy	●	●	●	●	●	●	●	●	
		Real-estate market	●	●	●	●			●	●	●
		Occupational health and safety		●	●	●	●	●	●	●	
		Third party health and safety	●	●	●	●	●	●	●	●	
		Quality of life, uses and customs, including ecosystem services	●	●	●	●	●		●	●	●
		Expectations	●	●	●	●	●	●	●		●

Source: Own elaboration

According to the interaction matrix of factors and aspects in the operational stage, it can be seen that the social factors "services, infrastructure and / or public or private property", "local and / or regional economy", followed by "health and safety occupational "," health and safety of third parties ", as well as" quality of life "and" expectations ", could be affected, positively or negatively, by the various activities of the undertaking.

6.4.2. Social Impacts in the Operational Phase

The impacts derived from the intersection of social environment factors and entrepreneurial activities are listed below. First, in chart 117 the impacts are cited, their relationship with the activities, and to which social factor it is linked, and later, in chart 118 the evaluation of these is presented, following the same structure presented in the construction phase.

It can then be verified that thirty-one (31) potential social impacts have been identified and grouped in the operational stage. Descriptions of each of them are presented below. Although several of the impacts may occur in different aspects related to the activities of the undertaking, in the previous table they were considered in relation to only one aspect –where they have the greatest incidence–, in order not to make the quantification repetitive, however, in the description of the impacts mentions all the activities that cause/could cause them and that, therefore, require attention to prevent and/or minimize them.

In the description of the social impacts identified for the operation phase of the undertaking, it is important to note that several of the impacts already identified for the construction phase are also present in the operation, but with some differences derived from the nature of the activities involved. Therefore, many of the data already provided in the description of the social impacts of the construction phase are not repeated in this section, such as, for example, the aspects of the socioeconomic characterization that help to magnify and/or understand the impacts.

In the case of similar impacts in the construction and operation phases, their differentiation, if applicable, is reflected in the assessment they have received, since this depends on the scores of each variable that makes up the social significance.

As in the description of impacts in the construction phase, in the operation phase the activity of “Operation of the Industrial Mill and related services” is also used to refer to the impacts that derive from the conception of the Project as a whole, that are not linked to a particular activity of the same.

Chart 117. Social impacts identified in the operational stage

Aspect or activity	Social Environment Factor	Social Impact
Hiring of personnel for the operation of the Industrial Mill and related services	Employment	Generation of local employment
	Employment	Salary increase
	Employment	Formalization of labor ties
	Employment	Migration of workers from other productive sectors
	Employment	Capacity building
	Demography	Definitive population increase
	Public/private services, infrastructure and/or property	Increase in demand for public and non-public services
	Public/private services, infrastructure and/or property	Increase in the demand for housing
	Expectations	Generation of positive expectations in the local population
Operation of the Industrial Mill and related services	Public/private services, infrastructure and/or property	Provision of electrical energy
	Archaeological, historical and/or cultural heritage	Management and enhancement of local and national heritage
	Landscape	Landscape affectation
	Local, regional and extra regional economy	Development of the local, regional and/or extra-regional direct economy (associated with the sector) and indirect
	Local, regional and extra regional economy	Increase in visitors to the area
	Real-estate Market	Increase in the price of properties and rentals
	Health and Safety of third parties	Impact on the health of third parties
	Health and Safety of third parties	Affecting the levels of local citizen security
	Expectations	Generation of positive expectations at the regional and extra-regional level
Transportation of raw materials, supplies and products	Public/private services, infrastructure and/or property	Increase in vehicular traffic
	Public/private services, infrastructure and/or property	Impact on road infrastructure
	Public/private services, infrastructure and/or property	Impact of land properties
	Public/private services, infrastructure and/or property	Impact on river traffic and/or ports
	Occupational Health and Safety	Impairment of occupational safety
	Health and Safety of third parties	Impact on road safety
	Quality of life, uses and customs	Increased discomfort or restlessness
	Quality of life, uses and customs	Changes in customs and uses
	Quality of life, uses and customs	Affection of the social network
	Expectations	Generation of negative perception and/or fears in the local population
Production and management of emissions (gases,	Occupational Health and Safety	Occupational health impairment
Effluent production and	Local, regional and extra regional economy	Affecting the local and regional economy with the use of water
	Expectations	Generation of negative perception and/or fears at regional and extra-regional level

Source: Own elaboration

Chart 118. Assessment of the social impact of identified social impacts in the operational phase

Social Impact	Social Variables					Social Index	Impact
	Signo	ICA	ID	II	PO		
Generation of local employment	1	7	7	5	0,99	6,27	HIGH
Salary increase	1	2	7	6	0,69	3,45	MEDIUM
Formalization of labor ties	1	2	6	6	0,99	4,62	MEDIUM
Migration of workers from other productive sectors	-1	7	7	4	0,39	-2,34	LOW
Capacity building	1	5	5	9	0,99	6,27	HIGH
Definitive population increase	1	5	5	4	0,99	4,62	MEDIUM
Increase in demand for public and non-public services	-1	5	5	5	0,99	-4,95	MEDIUM
Increase in the demand for housing	-1	5	5	4	0,99	-4,62	MEDIUM
Generation of positive expectations in the local population	1	8	8	6	0,79	5,79	MEDIUM
Provision of electrical energy	1	6	6	8	0,99	6,60	HIGH
Management and enhancement of local and national heritage	1	8	8	4	0,99	6,60	HIGH
Landscape affectation	-1	3	3	6	0,99	-3,96	MEDIUM
Development of the local, regional and/or extra-regional direct economy (associated with the sector) and indirect	1	7	9	8	0,99	7,92	HIGH
Increase in visitors to the area	1	5	5	5	0,49	2,45	LOW
Increase in the price of properties and rentals	1	4	4	6	0,69	3,22	MEDIUM
Impact on the health of third parties	-1	5	5	6	0,69	-3,68	MEDIUM
Affecting the levels of local citizen security	-1	5	5	7	0,39	-2,21	LOW
Generation of positive expectations at the regional and extra-regional level	1	9	9	7	0,69	5,75	MEDIUM
Increase in vehicular traffic	-1	6	7	8	0,99	-6,93	HIGH
Impact on road infrastructure	-1	7	7	7	0,99	-6,93	HIGH
Impact of land properties	-1	2	2	7	0,99	-3,63	MEDIUM
Impact on river traffic and/or ports	-1	3	9	4	0,49	-2,61	LOW
Impairment of occupational safety	-1	3	3	9	0,39	-1,95	LOW
Impact on road safety	-1	6	7	9	0,99	-7,26	HIGH
Increased discomfort or restlessness	-1	6	7	8	0,99	-6,93	HIGH
Changes in customs and uses	-1	6	7	7	0,69	-4,60	MEDIUM
Affection of the social network	-1	6	7	6	0,49	-3,10	MEDIUM
Generation of negative perception and/or fears in the local population	-1	6	6	8	0,79	-5,27	MEDIUM
Occupational health impairment	-1	2	2	8	0,39	-1,56	LOW
Affecting the local and regional economy with the use of water	-1	6	5	7	0,39	-2,34	LOW
Generation of negative perception and/or fears at regional and extra-regional level	-1	9	9	7	0,69	-5,75	MEDIUM

Source: Own elaboration

JOB

Generation of Local Employment

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services.

Between 600 and 1,000 direct jobs will be generated for the operation of the Mill, in the operation phase, which is why a decrease in the workers influx is expected. Qualified and unskilled labor will be required for the production of cellulose, for the maintenance of equipment and machinery, for administrative tasks, cleaning, transportation, security, and other related services. It is estimated that 20% of those hired will be professionals, 70% technical and 10% suitable. Regarding qualified and/or specialized labor, depending on the specialty, possibly foreign personnel will be hired, even foreign personnel, if necessary, since there is possibly no specific experience related to the pulp production sector in the area of influence. Along the same lines, local people will be able to cover the demand for employment that does not require specialized training for the production and/or maintenance of equipment and machinery; therefore, it is expected that most of the unskilled labor may come from the local population.

It is possible that part of the jobs in the operation phase do not require recruiting new personnel, but may be able to rehire the personnel that already intervened in the construction phase of the Project.
In addition, the jobs offered will provide staff training, which is a positive aspect of the hiring itself.

The Project will comply with the principles of IFC's Performance Standard ND 2 on “Labor and working conditions”, clearly defining the labor links, depending on whether the employees are direct, contracted, or supply chain workers, as the case may be. Likewise, FSC Principle 4 on “Community relations and workers' rights” will be considered.

Salary Increase

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the Industrial Mill and related services.

The Project could provide higher salaries than the current average per capita income in the AII departments, according to certain criteria, as described for the construction phase. The effect would be an increase in the purchasing power and debt capacity of the employed persons and their dependents, with the possibility of reducing the poverty of the families in question.

Likewise, the supply of jobs associated with the operation of the Project may produce an upward effect on salaries in the ADA/AID, which would be beneficial for more people than those directly hired by the Project.

Formalization of Labor Ties

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services.

It is expected that the Project will provide formal labor links, that is, in compliance with current national legislation, thus improving working conditions with respect to the existing job offers in the IIA, whose characteristics have already been described for the construction phase.

The formalization of labor ties, which will be less in quantity, but of medium and long-term duration (during the operation of the Mill), will improve the quality of life of direct employees and their dependents, by increasing the level of security labor and social present and future.

It is key that the venture considers IFC Performance Standard 2, as well as the work standards and working conditions recommended by the World Bank.

Migration from Workers from Other Productive Sectors

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the Industrial Mill and related services.

The operation of the Project may generate an attraction for people currently employed or producing in other productive sectors, and promote migration to the Project. The impact would be positive for the people who manage to be employed in the Project, since it is expected that this migration is due to a comparative advantage in terms of income levels and/or working conditions with respect to their current jobs/occupations and also because the jobs they would be permanent and/or long-term. On the contrary, the impact would be negative for the productive sectors that will lose workers, including small producers; However, it should be noted that this impact will be less than in the construction phase, due to the more limited supply of jobs.

Indirectly, the expansions and/or new business and/or service undertakings that could be generated within the framework of the expected economic development induced by the Project, may mean the migration of workers from the existing productive sectors to the new undertakings/extensions. Similarly, this impact would be positive for people who migrate from the sector since it is expected that they are motivated by greater comparative advantages, but it would be negative for the productive sectors that would lose workers.

In the analysis of the probability of occurrence of this impact and of the area from which the “labor migrants” could come, the same aspects of the socio-economic characterization of the ADA, AID and AII are considered as already described for the phase of construction.

Skills Development

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services.

As in the construction phase, the Project will promote the training of interested persons who may be employed in the operation phase of the Industrial Mill. This will be in order to counteract, to a certain extent, the lack of locally existing skilled labor and to enhance the existing one in accordance with Paracel's specific technical needs.

On the other hand, this training will address what was referred by the AID population in the field survey, the fear that there is a “low absorption of local labor” due to “not being trained”. Along these lines, the training offered by Paracel will have a positive impact on the personal training of future workers in the operation and on the level of hiring of local labor.

DEMOGRAPHY

Increase of the Definitive Population

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the Industrial Mill and related services.

A certain increase in the definitive population could be expected in the ADA/due to the hiring of between 600 to 1,000 people for the operation of the Mill for the medium and/or long term, which, it is estimated, will live in the ADA/AID of the Project, in order to optimize the daily distance, they must travel from their homes to the Mill. It is important to highlight that part of the personnel that will be linked in this stage could already be residing in the area from previous stages, but it is relevant to consider the workers influx in the area compared to the current situation.

Consideration should also be given to the families that each person might have with them in the ADA/AID. Compared to the construction phase, this impact will be less as the number of employees is reduced to approximately 15% of the number of employees in the construction phase. However, the length of stay in the ADA/AID is considered longer, since in the operation the jobs would be long-term and/or permanent.

In addition to those directly hired by the Project –and their families, it is estimated that other people will settle in the ADA/AID motivated by the expectation of greater economic opportunities with the population, commercial and service dynamism that the Project would generate.

PUBLIC/NON-PUBLIC SERVICES, INFRASTRUCTURE AND/OR PROPERTY

Increase in Demand for Public and Non-public Services

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the Industrial Mill and related services; transportation of raw materials, inputs and products; transportation of workers from the Industrial Mill.

The services referred to are the same as those described for the construction phase: collection and final disposal of solid waste, provision of drinking water, sanitation, electricity, transportation, health care, police and security, emergencies, education, communications and information, lodging.

The increase in the definitive population by the direct employees of the Mill operation - and their families, generated by the hiring of personnel and consequent increase in the workers influx in the area, as well as by the population induced by the Project, will cause an increased demand for all basic public and non-public services in the ADA/AID, which could affect current service levels in the area. Although the pressure on each of the services is expected to be less compared to the construction phase (due to the lower number of direct jobs, first), if the current conditions of the services were maintained and/or they were exploited or used after the phase of 2 to 3 years of construction of the Mill, these may also be affected by the increase in the population during the operation phase.

Also, the temporary increase in visitors to the area associated with the Project and non-local people related to the logistics of materials, supplies, machinery and equipment for the operation and final products, representatives of suppliers and/or customers, personnel international certifiers, etc., will generate temporary demands for all services, contributing to pressure on them.

For its part, the operation of the Mill itself will require the provision of some of these services, such as transportation, communication/information, health, and emergencies. In accordance with the existing capacities in the ADA/AID, the Project plans to self-manage some services, such as water supply and sanitation, final disposal of effluents and solid waste. Regarding electrical energy, the Project foresees the self-provision of energy from fuel oil type fuel for one of the processes and from renewable Sources (biomass) with a production of around 200 MW, with which it is not expected to generate pressure on the public electricity supply service. In addition, at this stage, the 220-kV transmission line would already be active, already under the operational responsibility of ANDE.

In relation to security, it will have its own security personnel, which is common in private enterprises. However, as it is a sensitive aspect that could involve the violation of human rights, the project will observe, as a minimum, the IFC PS 2 and PS 4, regarding the safeguarding of personnel and property; on the one hand, and the minimization of security risks for the surrounding communities, ensuring that these personnel do not exercise “abuse of power” as a measure of extortion or pressure on workers and/or the community; Paracel will have a specific area, under the human resources area, which will implement a "Security Policy" at the business level.

The transportation related to the operation of the Mill, both of raw materials, inputs and final products as well as of the employees of the Mill, may require public emergency care services in the event of any occurrence, such as volunteer firefighters and of the national police, which according to their current conditions –as described for the construction phase– could be insufficient to serve the current ADA/AID population and the final and transitory additional population.

The operation of the Mill will also require an increase in the level of public transport services, in the event that the Project does not itself provide means of transportation for the workers (special buses that pick up the workers from their homes or specific points and redistribute them at the end of the working day). Using existing public transportation to get closer to the ADA may imply congestion in the capacity of transportation units during peak hours, which include the start and end of the workday.

As for the solid waste that will be generated during the operation phase of the Mill, these will be disposed of at the final disposal site that will be built within the industrial premises, exclusively for the Project. Therefore, pressure on the existing public and/or private services for the collection and final disposal of solid waste is not expected in the ADA/AID.

Increase in the Demand for Housing

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the Industrial Mill and related services.

The demand for housing could increase, in relation to the current baseline, due to the increase in workers influx, and the consequent increase in the temporary and definitive population associated with the operational phase, whether of purchase or rent, due to the increase of the population directly associated with the operation of the mill, between 600 and 1,000 people - and their families - during the medium and long term, although it is important to note that part of these people would already be settled in the ADA/AID from stages previous. This impact will be less than that of the construction phase of the Project, since the number of employees will be more limited and because it is expected that during construction the number of homes available in the ADA/AID will already increase and that these will be vacated once the construction is finished, to give place to the personnel of the operation phase, with this last statement it could even cover the needs.

The population estimated to be able to reach the ADA/AID, induced by the expectation of greater economic opportunities, with the population, commercial and service dynamism that the operation of the Project would generate, will also contribute to the increase in the demand for housing.

Increase in Vehicular Traffic

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; transportation of raw materials, inputs and products; transportation of workers from the Industrial Mill; production and management of solid waste.

The presence of a larger population due to the hiring of Project personnel, and the consequent increase in the workers influx compared to the current situation –and their families– will produce an increase in vehicular traffic in the ADA/AID, since the population will have transportation needs that, considering the context, could be covered with the use of own vehicles, mainly motorcycles.

On the other hand, the transportation needs of materials, supplies, machinery, equipment, personnel, waste and/or effluents and final products that the Project's operation phase will have will contribute to a significant increase in vehicular traffic in relation to that currently existing in the area of influence and especially in the ADA/AID, particularly on the roads that connect the national routes with the access to the Industrial Mill property. Both the number of vehicles and their type, medium (buses, vans) and large (cargo trucks) that could only circulate at low speed, may affect the capacity of the roads during peak hours, contributing to increased congestion in local vehicular traffic.

The access road to/from the Mill, already detailed in the construction stage, will adapt a new road for the use of the Project and the owners of said lands, in order to minimize the impact on the part of the ADA communities.

It is emphasized once again that this is an issue already identified from the early stages, as one of the main concerns expressed by the people consulted in the "Perception Study".

Impact on Road Infrastructure

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; transportation of raw materials, inputs and products; transportation of workers from the Industrial Mill; production and management of solid waste; maintenance of access roads to the Industrial Mill.

The increase in vehicular traffic through the Project vehicles may affect the structural condition, the state of conservation and the useful life of the communication roads, particularly in the event that the necessary maintenance is not carried out on the roads that will be used, which they are for non-exclusive public use by the Project.

The Project vehicles will be of different types, but it is estimated that those that may cause the most impacts are heavy-duty trucks, which are estimated to circulate in the ADA and AID at the rate of one truck for every four minutes during the working day.

The periodic maintenance of the access roads to/from the Mill will have a positive impact on these roads, but to a limited extent that would mainly benefit the Project. However, it is highlighted that the project would improve the levels of road services, taking into account the coordination carried out by Paracel with the MOPC, from the early stages of the Project.

In addition, once the roads are adequate, compared to the current situation, the benefit of the structural improvement and paving of all the public routes used to transport wood/machinery/others to the Industrial Mill will imply a drastic and positive change in the current situation, reducing travel times, improving road safety, as well as facilitating access to/from emergency services (ambulances, police, firefighters).

It is worth highlighting once again what was described for the construction phase of the Project, that the current AID population considers that “infrastructure and road safety” is the most priority aspect for the development of their communities/districts, precisely because part of the roads current ones need to be improved. This may indicate that, if the current roads are not improved, the impact of the Project on them will be very high.

Impact of Land Properties in the Immediate Surroundings of the mill

Activities or aspects that generate the impact: transportation of raw materials, supplies and products; transportation of workers from the Industrial Mill; production and management of solid waste; maintenance of access roads to the Industrial Mill.

Considering that access to the Industrial Mill property will be through the rooms adjacent to the Mill's land, the right-of-way will be maintained for the vehicles associated with the Project to transit through these properties, to enter/exit the mill.

Taking care of the easement already defined in the construction stage, throughout the operational stage, and as long as these roads are maintained through said properties, the agreements reached in the construction phase of the Project must be maintained. The measures to be adopted must comply with the recommendations of IFC Performance Standard 5.

Impact on River Traffic and/or Ports

Activities or aspects that generate the impact: transportation of raw materials, supplies and products.

The Project will carry out part of the transportation of materials, supplies, machinery and equipment for the operation of the Mill, as well as the final products by river. In this sense, the transportation of the Project's cargo may put pressure on the current capacity of the Paraguay River waterway.

In this context, the Project plans to build its own port for the loading and unloading of its raw materials, inputs and final products, so the impact on other AID ports is expected to be low.

In this case, if the necessary improvements are not made to the navigation lane and/or the adjustments in the port terminals and warehouses - if necessary, to absorb the demand of the Project - favorable conditions could be created for potential conflicts with other users of the roads and ports, due to fears of possible delays in navigation and/or in the embarkation/disembarkation processes, with the consequent associated costs.

As mentioned in the construction phase, in addition to the pressure that could be exerted on river traffic and the port capacity of the area, where there would be an increase in barges in the area of the project, it should be considered that this potential impact, indirectly It leads to others linked to the safety of personnel and/or third parties, or potential inconveniences that it may cause in the "use of water", bearing in mind that there are fishermen in the area, who fish either for their own consumption or for sale. The practice of “sport fishing” is also registered in the Department of Concepción, which could also be classified as a potential water use conflict, as there are several activities related to water resources in the project's area of influence. These sub-impacts are detailed in the social factor "quality of life, uses and custom, including ecosystem services", and rather there could be a "competition" for such use in a sector close to the enterprise.

Provision of Electrical Energy

Activities or aspects that generate the impact: operation of the industrial mill and related services.

The Project will generate approximately 200 MW of energy, from fuel oil type consumption and from renewable Source from wooded biomass. This energy will be used for the Mill's own consumption and the surplus will be delivered to the public service for the provision of electricity, for the benefit of the communities in the area of influence.

It is estimated that the energy surplus will be in the order of 100 MW, which could supply up to approximately 200,000 homes. Considering the current quality of the public energy supply service, of which frequent cuts in the supply are reported, with the consequent inconvenience to the population, the delivery of excess energy to the area of influence will imply a positive social impact, since it could be reinforced the current provision of electrical power.

CULTURAL HERITAGE

Management and Enhancement of Local and National Herigate

Activities or aspects that generate the impact: operation of the industrial mill and related services.

Once the industrial mill is operational, no negative impacts on the cultural heritage are expected, beyond the possible effects that may occur on the “intangible heritage”. However, taking into account the baseline, the Project plans to take care of all the necessary measures to avoid damage to the heritage, and if necessary, provide support for the enhancement of the local cultural heritage (Bragayrac, March 2020).

This enhancement will constitute a positive social impact of the Project due to its contribution to eventual rescues that may occur in the construction stage, and its possible systematization and making available to the competent institutions. Likewise, other measures such as the dissemination of the results of specific studies, linked to the component of local, regional and national historical heritage, with effect in the medium and long term, could contribute to people from the education, academia and tourism sectors, both local and foreign (even nationally).

LANDSCAPE

Landscape Impact

Activities or aspects that generate the impact: operation of the industrial mill and related services; production and management of emissions (gases, vapors, odors).

There will be a specific alteration of the current local landscape, perceived from the Paraguay River and from the ADA, due to the location of the Mill facilities, given their proximity to the river coast and the ADA communities, their physical dimensions and lighting that this will have at night.

Likewise, during the process of production and management of emissions in the operation of the Mill, the emission of water vapor from the chimneys and exchangers will also contribute to the alteration of the local landscape, perceived from the Paraguay River and from the towns and/or ADA and AID locations, according to their proximity to the Mill.

From a social point of view, the impact on the landscape is important when it is perceived by the population. It is estimated that the affected people would be those who take boat trips on the Paraguay River and/or use the beaches on its coast, as well as the people who live in nearby towns.

According to the data collected in the ADA, the "environment/landscape" is the second most mentioned aspect by the population that lives there regarding the advantage of living on the site. Therefore, the introduction of the Industrial Mill in the middle may imply a significant negative impact for the people of the ADA, who should get used to observing the Mill for the long term.

LOCAL, REGIONAL AND EXTRA REGIONAL ECONOMY

Development of the Local, Regional and/or Extra Regional Directa (associated to the sector) and Indirect Economy

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the Industrial Mill and related services; transportation of raw materials, inputs and products; transportation of workers from the Industrial Mill; production and management of emissions (gases, vapors, odors); effluent production and management; production and management of solid waste; maintenance of access roads to/from the Industrial Mill.

Direct economy, associated to the pulp production sector

The employment of people for the operation of the mill, which entails an increase in the workers influx compared to the current situation, will directly contribute to the individual and/or family economy of the people employed in the mill and its related services, granting them greater purchasing power and the possibility of access to goods and/or services that should be provided, for the most part, locally.

For its part, the operation of the mill itself and the maintenance that must be carried out on the access roads and/or other communication routes as the case may be, will require raw materials, supplies, equipment and related services, as well as the transportation service of the same and of the final products, generating a greater dynamism of the local and regional economy in the medium and long term, depending on the local/regional feasibility of production and provision of the same.

The aforementioned transport will also require the acquisition of different types of vehicles, both for the mobility of employees and cargo. This will also entail the acquisition of spare parts and the need for periodic maintenance and repair services. Additionally, it should be noted that the increase in the definitive population will produce a greater demand for mobility itself, which will promote the acquisition of individual-type vehicles (motorcycles, bicycles, automobiles, buses) and their parts, as well as maintenance services and vehicle repair.

The specific lines of operation of the mill related to the management of emissions and effluents will in turn require specific inputs and specialized services for maintenance and repair of the facilities. As for solid waste, these will be managed and disposed of in a specific area within the industrial premises, promoting the development of certain related items.

Indirect economy

The definitive increase in the local population, both by the mill's employees and by the induced population, will generate an increase in the demand for goods and services and the opportunities to offer these goods and services, generating income that does not exist today, thus boosting the local economy ADA/AID and contributing to the reduction of local poverty levels.

It is estimated that the project will produce an incentive to open commercial and/or service premises with products for the workers of the Mill operation, in the vicinity of it (dining rooms, supermarkets/pantries, telecommunications, mechanical workshops, etc.)

Likewise, the greater movement of vehicles in the area of influence, and particularly in the ADA/AID, could encourage the opening of new commercial and/or service premises, especially along the communication routes used, with the expectation selling products to carriers and to the general user population of these roads.

For its part, the increase in the definitive population and its demand for transport could motivate the expansion and/or establishment of currently insufficient or non-existent public transport services.
Related to all of the above, the increase in the demand for goods and services, in addition to contributing to the economy of entrepreneurs and investors, will contribute to the generation of new jobs in all these areas, with the possibility of employing a greater number of people from local people.

Additionally, it is estimated that part of the municipal waste that will be generated in greater quantity in the ADA/AID could constitute an additional or main source of income for ADA/AID people who could dedicate themselves to its collection and sale for recycling.

Already in the medium and/or long term, the greater economic development in the ADA/AID, induced by the Project, may contribute to the improvement in the provision of basic services to the population and urban equipment, which in turn would generate more attractive for locating new investments, of all types and sizes, in the same area.

Finally, it can be mentioned that the project could generate an interest in installing ventures or investments - related or not with the project - in the vicinity of this and/or beyond the AID, since the location of the Project could constitute an indicator that the site is conducive and/or favorable for investments. These interests may materialize in the medium and long term, attracting greater investments in the area, synergistically promoting local and regional economic development.

Increase of Visitors to the Area

Activities or aspects that generate the impact: hiring of personnel for the operation of the industrial mill and related services; operation of the industrial mill and related services; transportation of raw materials, inputs and products; production and management of emissions (gases, vapors, odors); effluent production and management; production and management of solid waste.

The presence of employees of the mill operation in the ADA/AID may attract family members and/or close friends to visit them. Considering the expected number of employees, the visitors could be numerous, although in a smaller number than in the construction phase, but with an extension in the medium and long term.

In the same way, the operation of the mill may attract the visit of the press, academic groups, tourists, and people with curiosity in general, since it will constitute the first mill of its kind in the area.

On the other hand, it is estimated that non-local people such as those related to the logistics of materials, supplies, machinery and equipment for the operation and final products will arrive in the area temporarily; supplier and/or customer representatives; staff of international certifiers; specialists in repairs and/or maintenance; etc.

All these people may mean a greater promotion and dynamism of the area, particularly the ADA/AID, being able to contribute not only to the consumption of basic goods and services but also to the development of tourism and recreational activities that generate profit and economic benefits for the ADA/AID and even beyond this area, since visitors could take advantage of their passage through the ADA/AID to visit other nearby areas as well.

It is worth mentioning that the area has sites that could be promoted at a tourist level, such as watering places and/or beaches, historical sites and monuments, museums, among others, as well as tourist and recreational/sports activities, such as rides in boat on the Paraguay river and sport fishing.

These positive situations have been observed in other cities and towns in the country. For example, in the case of the city of Pilar, the development of industries, port terminals and/or public works have increased its economic development, due to the greater number of people who come to the area and the demands they have for food and lodging, mainly, but also for recreation and other basic services (telecommunications, health, etc.).

Impact on the Local and Regional Economy with the Use of Water

Activities or aspects that generate the impact: transportation of raw materials, supplies and products; production and management of effluents.

This impact would be produced in the event of contingencies. One case could be that of contingencies within the mill and the release of effluents into the Paraguay River without proper treatment. Another case may be that of contingencies in the river transport vessels of the loads of the Project operation, and spillage of fuels or other substances in the river.

These contingencies could generate water pollution, with a negative effect on commercial and recreational/sport fishing activities for profit. This impact could extend beyond the ADA to and/or beyond AID as well, depending on the extent of the pollution effects along the river.

The aforementioned contingencies, in addition to the effects on the environment, could affect both the aforementioned economic activities, as well as potential claims from the population.

REAL-ESTATE MARKET

Increase in the Price of Properties and Rentals

Activities or aspects that generate the impact: hiring of personnel for the operation of the industrial mill and related services; operation of the industrial mill and related services; transportation of raw materials, inputs and products; transportation of workers from the Industrial Mill; production and management of solid waste; maintenance of access roads to/from the Industrial Mill; accommodation of the workers of the Industrial Mill.

It is estimated that the increase in the definitive population due to the hiring of employees for the mill, and consequent increase in the workers influx compared to the current situation, and due to the arrival of other people to the ADA/AID induced by the project will generate an increase in the demand for rentals and the purchase of properties, essentially for housing, since they would remain in the ADA/AID during the medium and long term, for more years than those of the construction phase, where it was estimated that due to the nature of temporary jobs the greatest demand for housing would be through rent. Likewise, it is possible that for the operation phase of the Mill some basic services have been improved in the ADA/AID communities. These two factors, the demand and the improvement of services, may produce an increase in the value of properties and rents, although the impact could be less than that of the construction phase where the demand will be greater. The effect will be positive for the owners, who would see their real estate valued, but negative for the people who require a home.

On the other hand, there could be an effect of increasing the price of the properties closest to the land where the Mill is located and the port that the Project will build, due to the expectations that its location will generate economic development in the area in the medium and long-term and/or infrastructure improvements that the Project could introduce in the area during its operation.

Likewise, the properties located in direct proximity to the roads used by the Project vehicles may experience an increase in their value, due to their proximity and exposure to the greater social and economic dynamism that the traffic is expected to generate.

In the scenario where specific accommodation areas are established for the workers of the Mill operation, the properties in its vicinity may increase their value, due to the greater endowment in the area of services and/or basic urban facilities that may occur in time and due to its exposure to the greater social and economic dynamism that is estimated to occur due to the presence of a large number of people (assimilable to a new neighborhood/s).

Finally, considering that in the construction stage the location of the site for the final disposal (SDF) of solid waste within the industrial property (ZC) has already been foreseen, this will be managed properly, in order to minimize impacts related to the closest properties.

OCCUPATIONAL HEALTH AND SAFETY

Occupational Health Impairment

Activities or aspects that generate the impact: Operation of the industrial mill and related services; production and management of emissions (gases, vapors, odors); effluent production and management; production and management of solid waste; maintenance of access roads to/from the industrial mill.

It could affect the health of the employees of the operation of the mill and its related services due to exposure to dust, noise and vibrations, to raw materials or toxic inputs, to heat, etc. during your daily work activities.

Special attention should be given to the potential impact on occupational health during production and management activities of emissions, effluents and solid waste from the operation of the Mill, due to potential exposure to contact with emissions, effluents and/or hazardous solid waste, with chemical or organic content that could be toxic. Likewise, exposure to disease vectors (dengue, chincungunya, chagas disease, among others) could occur at this stage.

Similarly, employees exposed to noise, dust and combustion gases generated by the movement and use of vehicles and machinery in the periodic maintenance activities of the roads used by the Project may also suffer an effect on their health, although these activities will be of much shorter duration than the activities of the operation of the Mill itself, and would not involve exposure to potentially toxic substances.

Likewise, taking into account the pandemic declared by the World Health Organization, this situation or others that may occur over time and that spread zoonotic diseases, such as COVID-19, must be addressed, and specific measures must be established to prevent or minimize contagion between workers.

Paracel plans to implement the best operational practices in order to minimize risks in OHS, as well as to have the necessary number of technicians specialized in the subject.

Impairment of Occupational Safety

Activities or aspects that generate the impact: operation of the industrial mill and related services; transportation of raw materials, inputs and products; transportation of workers from the Industrial Mill; production and management of emissions (gases, vapors, odors); effluent production and management; production and management of solid waste; maintenance of access roads to/from the industrial mill.

In general, it is considered that the physical safety of the employees of the operation of the Mill and their related services could be affected during each and every activity of the operation, since every work environment presents certain types of security risks.

The most common occupational accidents that may take place are: traffic accidents within the Project site; accidents such as falls at the same level and/or from high places; blows by fallen objects and/or by the use of tools, equipment and/or machinery; cuts by equipment and/or machinery; electrocution during the manipulation of electrical installations; burn in the boiler area; hazards associated with manual handling of loads; eye damage; fires; among others.

Another environment with risk of affecting safety is during the transport of the loads and the Project personnel, due to traffic accidents that could occur on the roads and / or other types of accidents in case the means of transport are unsuitable (bodies, etc.).

In general, the project will have a strong occupational health and safety component, which can be considered inseparable from daily activities. With the implementation of the measures of this component, it is estimated that the risk is reduced to a minimum, but not completely eliminated.

The severity of the effects on occupational safety may range from mild to very serious, and may involve, in the most extreme case, the death of the worker. However, as mentioned above, this risk is not exclusive to the Project. Paracel plans to implement the best operational practices in order to minimize risks in OHS, as well as to have the necessary number of technicians specialized in the subject.

THIRD PARTY HEALTH AND SAFETY

Impact on Road Safety

Activities or aspects that generate the impact: transportation of raw materials, supplies and products; transportation of workers from the Industrial Mill; production and management of solid waste; maintenance of access roads to/from the Industrial Mill.

The current levels of road safety may be affected by the increase in vehicular traffic by vehicles of different types of the project, as well as by the increase in the workers influx compared to the current situation. It is estimated that those that can cause the most risks are large vehicles (heavy loads), which will circulate at the rate of one truck for every four minutes during the working day. However, small and medium-sized vehicles may also increase the probability of road accidents due to the increase in their number and because, in general, these can circulate at a higher speed than heavy vehicles. The main impacted would be the users of the roads, both pedestrians and vehicle drivers (bicycle, motorcycle, car), and also people who are in the immediate proximity of the roads (special attention to children and domestic animals and/or farm), who would be exposed to a higher level of risk of accidents due to collisions and/or run over.

The deterioration that the roads may suffer due to the increase in vehicular traffic associated with the project is also another source of potential impact on road safety, since the poor condition of the roads could lead to a greater number of traffic accidents.

On the other hand, road safety may be affected during the improvement works and/or periodic maintenance of the existing roads used by the Project, which are also used daily by pedestrians and/or vehicular users (bicycle, motorcycle, car) or they have people living or working in their immediate proximity. This impact could be due to accidents of the type of collision and/or run over that involve the Project's vehicles and/or machinery carrying out the road works, on the one hand, and the population on the other.

Regarding the signaling, it is expected that the projects undertaken by the MOPC in the area, will make the provisions related to the signaling, but these could be reinforced by the project, giving express indications of reduction in the area of entry and exit of trucks to the Industrial Mill as well as in areas where vulnerable groups or groups of children and people in general settle (schools, health centers, churches, others located on the roads of nearby communities). Along these lines, IFC PS 4 on “Community Health and Safety” will be observed by the project.

Impact on the Health of Third Parties

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the industrial mill and related services; transportation of raw materials, inputs and products; transportation of workers from the industrial mill; production and management of emissions (gases, vapors, odors); effluent production and management; production and management of solid waste; maintenance of access roads to/from the Industrial Mill.

It could have negative impacts on the health of third parties due to the operation of the mill and its related services, derived from the different activities and/or induced by the Project. The increased workers influx will lead to contact between the current AID communities and the temporary and definitive local and/or foreign population, which could increase the transmission of contagious diseases (examples: HIV, hepatitis, other sexually transmitted diseases, etc.).

Likewise, taking into account the pandemic declared by the World Health Organization, zoonotic diseases, such as COVID-19, could spread, and specific measures must be established to avoid or minimize the contagion of communities and populated areas.

The population increase will also mean an increase in the demand for health services, which could affect the capacity for health care in the ADA/AID, given the current conditions that were described for the construction phase. In general, it is considered that the decrease in care capacity may mean lower levels of health not only for the local population but also for the additional population.

During the same activities of the operation of the mill, noise and particle emissions will be produced that would not be incorporated into the emission treatment processes, such as those derived from cutting wood into chips (chipping). These emissions may impact on the resident population in the immediate vicinity of the Mill, in a minimum radius of around 100 meters. It should be noted that there is currently no population living or working in what would be the affected area, however, it is not ruled out that once construction begins and then the operation of the Mill, people could be located in its proximity, particularly to offer goods and/or services to workers of the Mill, but even to inhabit. This will depend exclusively on the land use planning done in the ADA and its immediate proximity (for example, not allowing businesses and/or homes to settle within a radius defined from the boundaries of the Mill's land).

Regarding the land vehicle traffic associated with the project, both for loads (at the rate of a truck every four minutes) and for the operation personnel, this traffic will constitute another Source of impact as it contributes to the increase in current levels of noise, dust and gases combustion from engines. These levels may be detrimental to the health of the population in the immediate vicinity of the roads used. On a smaller scale, taking into account the low population that lives in riparian areas near the industrial mill property, there could be a risk in people who are engaged in fishing, or who use small boats in the area, due to related activities to be developed, as well as the river traffic that would transport machinery and supplies by said route.

Related to the roads used by the project, it is expected that during the periodic maintenance of the same there would also be the emission of noise, dust and combustion gases from construction vehicles, with a negative impact on the health of the people who are in the immediate proximity of the tracks. However, these maintenance activities will be very specific in time and space, so it is assumed that their impact is less than that of the daily vehicular traffic associated with the Project.

During the production and management of emissions, effluents and solid waste from the operation of the Mill, sources of impacts for the health of third parties may also emerge in case of contingencies in the operation of the treatment lines of the mill’s emissions and effluents and/or in solid waste management. A similar situation in relation to effluents and solid waste, although on a smaller scale, could occur in the staff quarters, which would continue to operate to house people at this stage.

Regarding emissions, the release of untreated gases could occur, which could be dangerous or toxic for the population located in a geographic area that will depend on the characteristics of the emission and the atmospheric conditions in situ.

Regarding effluents, they could also be released without proper treatment, discharging substances harmful to human health into the Paraguay River and with variable extent of affectation depending on the characteristics of the substances, the behavior of the river and the weather conditions (winds, rains, etc.). The impact on human health could occur both by direct contact with river waters (for example, on beaches) and by consumption of contaminated products from subsistence fishing and commercial fishing (affecting consumers at the local and regional level), as well as the consumption of drinking water from the supply systems that are downstream of the Mill and that use river waters as a source of supply (for example, ESSAP in the city of Concepción).

Finally, regarding solid waste, considering that the project provides for a final disposal site within the industrial premises, the probability of affecting the population by contact with solid waste from the operation would be minimal.

Impact on the Levels of Local Citizen Security

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the industrial mill and related services.

An increase in the probability of crime and violence events in the ADA/AID could occur due to the increase in population and workers influx, and the circulation of money and material goods among them, since this population will be important in relation to size of the current local population, although much less than in the construction phase.

On the other hand, it is expected that the project will also indirectly contribute to a greater economic and cultural dynamism in the ADA/AID, with the development of shops and/or services and the consequent circulation of money and assets. This could be attractive to people with the intent to commit crimes such as robberies, robberies, kidnappings, etc.

Finally, it is not ruled out that among the additional definitive population that will settle in the ADA/AID there could be people who come into conflict with members of the current local population, especially in the first years of the Project's operation, and events of violence between people may occur. Due to the increase in the workers influx, many times it also leads to an increase in gender violence, attending to local sexist cultures, or due to the influx of a large number of male personnel.

As described for the construction phase, this impact may be significant considering that currently there are levels of "security" highly valued by the ADA and AID population and levels of "violence" that do not constitute a major problem for local people., indicating that, in general, security is good and violence is low. Although it is estimated that there may be an alteration of these levels in the operation, this will be preceded by the construction phase where the movement of people and assets will be greater and, therefore, the magnitude of the potential impact will also be greater.

Finally, as mentioned in the construction stage, the industrial development property will have its own security personnel, which is common in private enterprises. However, as it is a sensitive aspect that could involve the violation of human rights, the project will observe, as a minimum, IFC PS 4 on “Community Health and Safety”, regarding the safeguarding of personnel and properties; on the one hand, and the minimization of security risks for the surrounding communities, ensuring that these personnel do not exercise “abuse of power” as an extortion measure or pressure on workers and/or the community.

QUALITY OF LIFE, USES AND CUSTOMS

Increased Discomfort and/or Tranquility

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the Industrial Mill and related services; transportation of raw materials, inputs and products; transportation of workers from the industrial mill; production and management of emissions (gases, vapors, odors); effluent production and management; production and management of solid waste; maintenance of access roads to/from the industrial mill.

The increased workers influx and the presence of an unusual number of people directly and indirectly associated with the Project's works in the ADA/AID communities may promote the appearance (or increase) of activities such as sale and consumption of alcohol and drugs, sex work or prostitution, gender violence, crime, disrespect for the vulnerable population, disturbance of public peace due to a greater number of recreational and/or night-time activities (parties, leisure groups, etc.) on public roads and/or in homes within the communities, disrespecting the current levels of tranquility of the ADA/AID. In addition, among the vulnerable groups that may be exposed to the aforementioned situations, there are women, children and the elderly.

The project could also cause discomfort in the ADA/AID due to the competition that is estimated to arise from the use of resources, sites, equipment and/or recreation/leisure infrastructures, since their capacity may be congested by the additional population.

Likewise, the emergency or the increase in union activities (demonstrations, marches, others) among the employees of the Mill may create discomfort or uneasiness in the ADA/AID population, because they are not used to this type of situation.

Regarding the operation of the mill itself, the increase in noise and dust levels in the immediate surroundings of the mill due to noise from machinery and chimneys, due to the loading and unloading of raw materials, supplies, machinery and products within the mill, and dust from some stages of the operating flow, may have a negative impact on the comfort of the population in this environment. This impact will depend on the territorial organization that exists in the surroundings of the mill, which could prohibit the installation of shops, services and/or homes within a defined radius to avoid or reduce their impact.

For its part, the production and management of emissions and effluents at the Mill could produce the release of bad odors in case of contingencies in the operation and/or out-of-regime operations (stops and starts) of the emission treatment lines. –Especially– and effluents. These episodes will cause discomfort to the population of the ADA and probably the AID, depending on the atmospheric conditions at the time of the release of the odors.

On a lesser scale, there could be discomforts in the population near the staff quarters, in case of inadequate waste and effluent management, as well as due to changes in the dynamics of the areas where they will be operating at this stage.

Another important source of discomfort and/or restlessness of the population in the ADA/AID will be the increase in vehicular traffic by vehicles of all types associated with the project, although it is estimated that those that may cause more discomfort are those with heavy loads and the buses. It should be noted again that the circulation of heavy vehicles is expected at the rate of one truck for every four minutes during the working day. The main impacted would be the users of the roads, both pedestrians and vehicle drivers (bicycle, motorcycle, car), and also the people who are - live or work - in the immediate proximity of the roads, who would be exposed to a greater noise level, vibrations and air pollution by dust and combustion gases.

Finally, an additional source of inconvenience to the population will be the production of dust, vehicle fumes, noise, vibrations during the works that will be carried out periodically for the maintenance of the roads used by the project. The affected population will be the people who are - living or working - in the immediate vicinity of the roads.

As mentioned for the construction phase, “tranquility” is the aspect of the communities most valued by those interviewed in the ADA and AID and the “little existing traffic” is one of the aspects considered positive of living in the communities. In this context, it is estimated that the operation of the Mill will significantly and permanently affect the current levels of tranquility, given all the potential negative impacts mentioned. It should be noted, however, that this impact will be the continuation of the effects already introduced in the construction phase.

Changes in Customs and Uses

Activities or aspects that generate the impact: hiring of personnel for the operation of the Industrial Mill and related services; operation of the industrial mill and related services; transportation of raw materials, inputs and products; transportation of workers from the Industrial Mill; effluent production and management;

production and management of solid waste.

The increase in the workers influx compared to the current situation, and the consequent increase in the temporary and definitive population in the ADA/AID, associated directly and indirectly with the project, could generate definitive cultural changes in the communities of these areas, since it will remain in them in the long term, being able to affect both the social environment and the people who currently live in the area. As an important part of the employees and other people who will come to the ADA/AID may be foreigners and even foreigners, it is estimated that they may have customs, uses and values different from those of the ADA and AID currently. The impact would be adverse if the practice of traditions, customs, uses and values beneficial to the communities were eliminated, or if they implied a deterioration of existing freedoms and/or the normalization of acts contrary to the tranquility and harmony of the communities (for example, annoying noises, lack of respect for vulnerable members of local communities, lack of respect for the property of third parties, etc.). Although this impact would be had already in the construction stage of the Project, it is considered that in the mill's operation stage it could be consolidated and imply permanent changes.

Greater economic development in the ADA/AID could encourage the establishment of new recreational options, such as shopping centers, which, although they will contribute to the economic development of the area, could end up relegating the traditional recreational activities of the communities/districts, which make up their current identity. Some of these activities that have been reported in the ADA and AID are the patron saint festivities and the rope festivals.

On the other hand, the increase in vehicular traffic in the ADA/AID by vehicles of all types associated with the Project could generate an impact of alteration of daily customs and practices, since there is a greater vehicular movement, people could stop driving attending certain places in order to avoid using the streets, or interrupting certain practices that make use of the streets beyond mobility, such as spending part of their time on the sidewalks and/or using certain streets as gambling sites/entertainment. It is estimated that, mainly, large vehicles (heavy cargo) are those that may generate this impact.

Another impact on customs and uses in the ADA/AID may be the impact on subsistence fishing practices or self-consumption and/or recreation and the recreational use of beaches due to accidental contamination of the river or the simple suspicion of contamination, in case of contingencies at the Mill that imply the discharge of improperly treated effluents, or in eventual failures derived from port activity and/or river traffic. These impacts are related to the ecosystem services linked to the use of water, but it is considered that they would be avoidable and minimizable, taking into account the good operational practices provided by Paracel.

Finally, as mentioned before, the project could induce the emergency and/or a greater frequency of certain illegal/criminal activities in the ADA/AID, due to the presence of a greater number of people and due to the increase in economic dynamism. The occurrence of these criminal/illegal acts could mean changes in the habits and customs of the population in order to avoid them, such as stopping attending certain places, leaving the house at certain times of the day, letting the children go out alone from the houses, among others.

Impact on the Social Network

Activities or aspects that generate the impact: Hiring of personnel for the operation of the Industrial Mill and related services; operation of the industrial mill and related services; transportation of raw materials, supplies and products.

As described for the construction phase, in the operation phase of the industrial mill, the existing social network in the communities and districts of the ADA/AID could also be affected.

In general, the impact of the social network may occur in relation to the changes in uses and customs that were identified. For example, by stopping visiting certain recreational sites due to fears or the additional population or traffic associated with the Project, people could lose direct and/or frequent contact with each other, weakening existing social relationships. This could occur both in the communities near the project site, or those located in the vicinity of the roads where the vehicles associated with the Project would travel, as well as in the areas near the staff's accommodation

Another case may be the abandonment of the practice of traditional recreational activities, due to new options for leisure and/or recreation. Changes like this could suppress the regular meeting of people and affect their degree of relationship, especially of older people who have already become accustomed to attending traditional activities for much of their lives.

EXPECTATIONS

Generation of Positive Expectations in the Local Population

Activities or aspects that generate the impact: Hiring of personnel for the operation of the industrial Mill and related services; operation of the industrial mill and related services.

As in the construction phase, in the operation phase the project will also generate expectations among the population, especially the local population, of getting a job at the Mill, although the number of jobs offered will be reduced to around 15% of jobs in the construction phase.

Other positive expectations regarding the project are those described for the construction phase: the generation of indirect jobs, the revitalization of the economy at the local and departmental level, the enhancement of industrial development and, in general, the progress and development of the AID communities and districts. These expectations would already be given before the construction phase, but they would be maintained and it is expected that they will materialize in the operation since it is expected to be extended to the long term.

Generation of Negative Perception and/or Fears in the Local Population

Activities or aspects that generate the impact: Hiring of personnel for the operation of the Industrial Mill and related services; operation of the industrial mill and related services; transportation of raw materials, inputs and products; transportation of workers from the industrial mill; production and management of emissions (gases, vapors, odors); effluent production and management; production and management of solid waste; accommodation of the workers of the industrial mill.

As in the operation phase the job offer will be less and as most of the labor to be hired would be of a qualified or specialist type, there is the possibility that a negative perception of the Project will be generated due to the "insufficient" hiring of local labor, since in the ADA/AID there is mainly unskilled labor.

Additionally, the AID has mentioned expectations regarding the improvement of existing infrastructure and services. It has been observed in the field survey that the people and local authorities approached pointed out the possibility that the project will contribute to the "improvement of community infrastructure" as a positive aspect or benefit that the Project can offer to the community, "support for the growth of the communities in the area" was one of the most mentioned expectations in relation to the project. This may indicate the potential occurrence of a situation in which the Project will implement certain improvements in the ADA/AID communities as part of a Corporate Social Responsibility (CSR) scheme, but that these practices are seen by the population and/or the authorities' premises as a resource to meet their basic needs in terms of, for example, basic infrastructure, humanitarian aid, etc., which are not intrinsic responsibilities of the Project. Thus, the communities could become overly dependent on the Project's performance instead of improving their own capacities for self-organization and management for the legitimate claim of their rights before the local and national governments, as well as to press for the development of the communities. institutions necessary to develop their communities.

As most of the necessary labor force will be qualified and/or specialist, it is expected that fewer fears will be generated in the population and/or local ADA/AID authorities about the potential formation of working-class neighborhoods that deteriorate the current urban environment (due to unsanitary conditions, overcrowding, the occurrence of activities that disturb the current tranquility) and/or that become centers of proliferation of crime and other illegal activities (prostitution, drug trafficking, etc.), whose probability of occurrence could be higher in the construction phase.

On the other hand, the operation of the Mill itself and its cargo and personnel transportation vehicles may also generate other negative perceptions and fears in the ADA/AID population. Sources of fears may be: the safety of the operation and the transparency in the socio-environmental management of the mill (for example, that it really operates according to its standards, that it does not take undue actions outside of contingency events, etc.); the increase in vehicular traffic, especially cargo traffic, and the potential negative impacts on infrastructure, road safety, comfort, tranquility, customs and uses, and people's health; contingency events that could occur in the mill and that imply the release of nauseating odors, dangerous emissions and/or effluents without proper treatment, with potential impact on human health, commercial, recreational and subsistence fishing, to recreational activities with the use of water from the Paraguay River, to the environment, to tourist and recreational activities, among other aspects. In the same way, the management of solid waste from the operation of the Mill may also be a source of negative perception, generating fears regarding their inappropriate disposal, especially those of a dangerous nature, with potential impact on the human health and the environment; fears regarding the potential overloading of current landfills by the Project; and/or fears in the event that the Project opens its own sanitary landfill outside the Mill's premises, related to the choice of disposal sites.

Regarding several of the potential Sources of negative perception mentioned, what has already been mentioned for the construction phase should be highlighted, regarding the aspects that have been relieved in the AID as concerns regarding the Project: the "possible damage to the environment and/or human health", "low absorption of local labor", "non-compliance with national and international regulations", the possibility of "generation of conflicts if there is no good communication" or "lack of information" .

The ultimate consequence of negative perceptions, fears and unrealistic expectations could be the generation of an environment of latent tension and distrust on the part of the population and/or local authorities towards the Project and, in extreme cases, generating conflicts, which could be recurring over time, with their corresponding transaction costs.

Generation of Positive Expectations at the Regional and Extra-regional Level

Activities or aspects that generate the impact: Hiring of personnel for the operation of the Industrial Mill and related services; operation of the industrial mill and related services; transportation of raw materials, supplies and products.

Positive expectations may be generated at a regional and extra-regional level of getting a job in the mill's operation phase since, although the number of people to be employed is less than in the construction phase, the type of skilled labor and/or specialist can attract people from beyond AID.

The operation of the mill itself and its related services may generate positive expectations from potential suppliers of raw materials (wood), inputs (chemical products), specialized services, other services for the operation of the Mill, cargo transportation services heavy, land and/or river routes, as they could establish commercial relationships with the Project and broaden its spectrum of clients.

Likewise, the operation of the project may produce expectations of developing other ventures/investments in the same area of influence, given the importance that the Mill could confer as an indicator of a suitable site for locating ventures of different magnitude and/or by economies scale that could be identified when undertaking in the vicinity of the Mill, with the improvements in public and private infrastructure already introduced by it.

Along the same lines, there could also be expectations of people from outside the AID who could see the area as conducive to migrating and developing commercial and/or service activities, given the dynamism of people, monetary assets and goods that the Project would generate. Other expectations could arise in the population located in the vicinity of the roads to be used by the Project, even beyond the AID, since the frequency of vehicle circulation could provide greater dynamism and opportunities for economic development along these roads.

Generation of Negative Perception and/or Fears at Regional and Extra-regional Level

Activities or aspects that generate the impact: Transportation of raw materials, supplies and products; production and management of emissions (gases, vapors, odors); effluent production and management; production and management of solid waste.

In the operation phase of the project, negative perceptions and/or fears may also arise at a regional and extra-regional level in relation to the operation of the Mill.

Among these, there could be uncertainties of other users of the land and/or river routes that will be used for the transport of raw materials and inputs and the final products of the operation, due to the potential increase in traffic congestion - land and/or fluvial - and the deterioration of the condition and useful life of the road network. Other important fears may occur between people, groups of these, investors from other sectors (for example, tourism, accommodation, etc.), environmental defense groups (NGOs or others) and/or human rights, institutions and others for the potential environmental contamination that emissions, effluents and solid waste from the mill may generate, potentially affecting human health, deteriorating the tourist attraction of the area and opposition to the project.

6.5. Synthesis of Impacts Due to Significant Conditions Created by the Cctivities of the Industrial Component

Due to the logic of presentation of impacts of this study, developed previously, these were grouped by “factors of the social environment” and not by activities/causative aspects. Given the need to respond to a specific question to better make visible the impacts caused by activities that generate significant conditions such as the workers influx –and other population induced by the Project–, the impacts related to this people influx condition are grouped in this section.

However, it should be noted that these impacts have already been presented throughout the description of impacts for each factor of the social environment, and in each of the stages, mainly in all cases in which the “hiring of personnel” activity (involving workers influx) is indicated as a shocking activity. Both the construction and operational stages would have similar impacts, but it is considered that this will decrease in the second stage, since it would go from hiring 6,000-8,000 people to 600-1,000 people, respectively.

The increase in the workers influx, as well as the population induced by the project (temporary and/or definitive), could generate the following impacts:

- Significant increase in the employment rate, in a formalized manner, attending to the workers influx derived from the hiring of the enterprise, thus contributing to reduce the gap linked to the unemployment of the AID/ADA of the enterprise, which in turn leads to development of the local economy.

- Dynamization of the economy, due to the greater purchasing power that they will have for the consumption of goods and services, and even investment in their own businesses. This, indirectly, in both stages of the industrial component of the project, will generate a demand for local goods and services that will necessarily be higher than the current one, which will generate greater income and investment stimuli for the establishment and/or expansion of suppliers of goods and services. services of different types (food, communication, vehicles, transportation, recreation, education, health, etc.), formal and informal. Possible examples include the opening of shops and/or services with products due to the workers influx linked to the project (dining rooms, supermarkets/pantries, telecommunications, mechanical workshops, etc.), both in the area of the undertaking and in the vicinity of staff accommodation; the opening of new commercial and/or service premises along the communication routes used, with the expectation of selling products to carriers; the expansion and/or habilitation of currently insufficient or non-existent public services; the creation of jobs by the aforementioned enterprises, which will be able to employ more local people. The greater dynamism of the local economy has as positive effects the increase in household income associated with the provision of goods and services, the possibility of accessing goods and services that are currently non-existent, limited, insufficient or inaccessible.

- The temporary and definitive increase in the population in the AID communities, generated by the hiring of personnel and consequent increase in the workers influx in the area, and by the potential arrival of other people attracted by the indirect effects of the project, or by people who visit the area will produce a certain increase in the demand for public and non-public services, both those already existing and those currently non-existent. It could generate stress in some services, as well as an increase in the demand for housing, and to minimize these impacts, Paracel plans to develop its own infrastructure linked to drinking water, effluent management, and waste management, both on the property of the Industrial Mill, as in the staff accommodation sites. Likewise, it provides for the adaptation of the access road to the Industrial Mill, and in other areas through coordination already initiated with the MOPC, as well as the negotiations with ANDE in relation to the construction of a transmission line for the undertaking.

- Occupational health and safety, taking into account the number of workers linked to the undertaking, could have risks related to vector diseases, such as those transmitted by rodents, due to the solid organic waste generated by the staff, as well as the proliferation of other diseases vectors such as dengue, chincungunya, rapidly transmitted through the mosquito "aedes aegipty", and currently COVID-19.

- In relation to the health and safety of the communities, the increased workers influx will lead to the contact of the current AID communities with the transitory and definitive local and/or foreign population, associated with both stages of the industrial component, which that could increase the transmission of contagious diseases (examples: HIV, hepatitis, other sexually transmitted, etc.). Likewise, taking care of the pandemic declared by the World Health Organization, zoonotic diseases, such as COVID-19, could spread to individuals and families residing in communities.

- In addition to the risks related to the health of the communities, there are citizen security risks, and the probability of crime and/or violence events in the AID may increase due to the increase in population and the workers influx. In the interrelationships with the communities, the increase in the workers influx often leads to an increase in gender violence, attending to local sexist cultures, or due to the influx of a large number of male personnel.

- Perception could also be negatively impacted, considering that "security" and "tranquility" are the aspects most valued by the interviewees regarding the positive aspects of living in their communities. Likewise, according to those surveyed in the AID, “violence” appears as one of the least mentioned aspects in terms of the problems identified in the territory. This indicates that people currently feel that there is an important level of citizen security and low levels of violence; therefore, their alteration, induced by the project, could be abrupt.

- In both stages of the industrial component of the Project, the quality of life of the AID population could be affected. The quality-of-life aspects affected would be, mainly, the tranquility and comfort of the current inhabitants, attending to the manifestations of high valuation of these characteristics of the area by the people interviewed in the information survey in the field.

- The increased workers influx and the presence of an unusual number of people directly and indirectly associated with the project in the AID communities may promote the appearance (or increase) of activities such as sale and consumption of alcohol and drugs, prostitution, crime , gender violence, disrespect for the vulnerable population, disturbance of public peace due to a greater number of recreational and/or nighttime activities (parties, leisure groups, etc.) on public roads and/or in homes within the communities, disrespecting the current levels of tranquility of the AID. The presence of foreign personnel could impact on the current tranquility of the AID people, since they have referred that “getting to know each other” is a highly valued aspect in the communities, thus contributing to greater tranquility. This situation could occur both in the area of the Industrial Mill and in the accommodation of the staff.

- The increase in the workers influx, and the consequent increase in the transitory and definitive population associated with both stages of the industrial component, as well as the induced population, will force the interaction of the customs, uses and current values of the local AID communities with those of the additional population in the area. This could result in a negative impact; if these customs, uses, values and habits are changed by the predominant ones that emerge from said interaction, thus losing the sense of identity, belonging, community and mutual respect.

- Also, the possible alterations in the tranquility, comfort and even the civil security of the current AID population (as described before) may lead to the need to change their daily habits, customs and ways of life to adapt to the new conditions that would generate the presence of additional population, due in large part to the increased workers influx linked to the enterprise. The impact would be adverse if it implied a deterioration of the freedoms enjoyed by the current communities and/or the normalization of acts contrary to the tranquility and harmony of the communities (for example, annoying noise, lack of respect towards vulnerable members of the local communities, with an emphasis on women and children, lack of respect for the property of third parties, etc.).

- Another aspect related to the uses and customs of the community is related to the "use of water", both because of the "competition" that could be had over ecosystem services, although compared to the forestry component, this would be punctual and low probability of occurrence, considering that there are fishermen in the Paraguay River who engage in such activity for self-consumption or small-scale sale; likewise, there are customs linked to sport fishing, boating or recreational activities on beaches. This would be minimized by the undertaking, taking into account the good operational practices to be implemented by Paracel, both in the operation of the Industrial Mill and in river transport, activities that are related to this impact.

- Finally, it could have consequences on the networks/interconnections of the communities, as well as on family networks. For example, in the event that there are marked differences between the current population and the installed population, or in the event that people decrease their visits to places of recreation or the houses of relatives/neighbors due to fears caused by the increase in the workers influx, and the additional population directly and indirectly associated with the project, it is possible that there is a gradual erosion of relationships (beyond daily customs) between people or even within families or family networks, and may even promote the breakdown of these.

All the aforementioned impacts are addressed in one way or another by the various Programs detailed in the Social Management Plan (PGS) of this study, as well as in specific protocols to be developed by Paracel, in order to meet internal measures and procedures. that prevent or minimize, or failing that, mitigate them.

6.6. Cumulative Impact Analysis

The analysis of cumulative impacts is presented as an Annex, and for its evaluation, for which the "*Manual of Good Practice for the Evaluation and Management of Cumulative Impacts: Guide for the Private Sector in Emerging Markets*" (IFC, 2015)[150], was considered, guides the steps to follow for an assessment and management of cumulative impacts (CIA), bearing in mind that this is evolving, and there is no single globally accepted practice. Thus, the identification of environmental and social impacts and risks is sought, where promoters/operators: (a) recognize that their actions, activities and projects - their undertakings - can contribute to producing cumulative impacts on valued environmental and social components (VEC by its acronym in English - Valued Environmental and Social Components) on which other existing or future ventures could also have negative effects, and (b) to the extent possible, avoid and/or minimize their contribution to these cumulative impacts.

In accordance with the aforementioned manual, the steps of a rapid CIA were adopted, with the aim of:

- Identify the VECs (valued environmental and social components) of the project's area of influence. Only those from the socio-economic and cultural environment will be considered.
- Determine the existence of other enterprises, natural and social factors that occur in the area of influence studied, and how these will impact on the socio-environmental factors that would be generated as a result of the execution of the enterprise.
- Geospatially assess the risks and potential impacts of the project in the short and long term, in the context of the potential effects that other projects and/or external socio-environmental factors could have on the

150 http://documentos.bancomundial.org/curated/es/606171490866905590/pdf/113849-WP-SPANISH-IFCPerformanceStandards-PUBLIC.pdf

same VEC.

- Verify that the cumulative environmental and social risks and impacts of the project do not exceed a threshold in the condition of the selected VECs, so that their sustainability or viability is not compromised.

The Valued Socio-Environmental Components (VECs), recipients of the impacts, were taken into account, similar to the social factors considered in the impact analysis, that is: i) Jobs; ii) Demography; iii) Public/private services, infrastructure and/or property; iv) Archaeological, historical and/or cultural heritage; v) Landscape; vi) Local, regional and extra-regional economy; vii) Real estate market; viii) Occupational health and safety; ix) Health and safety of third parties; x) Quality of life, uses and customs (including ecosystem services); xi) Expectations.

From the information collected in the LBS, the projects developed or planned in the AID were briefly detailed, a total of twelve, these being linked to the water and sanitation sector, road projects, electrical system, dredging of the Paraguay River, industrial (cold storage).

From the relationship between social VECs and entrepreneurship, a total of 98 interactions were obtained. The VECs most affected by AID ventures are employment (100%), services, infrastructure and public/non-public property (100%), local, regional and extra-regional economy (100%), occupational health and safety (100%) and quality of life, uses and customs (100%), followed by real estate market (83%), health and safety of third parties (83%) and expectations (75%). Although expectations are considered as a result of perception studies carried out in stages prior to projects, these can be monitored throughout their life cycle, in order to see if they are maintained or changed, and if the change occurs in a positive way or if "negative perceptions" are generated about the undertaking/s.

Regarding the interaction of the project with other enterprises, there was greater interaction with industrial enterprises and with projects related to sanitation, a priori, due to the issues of water use, the influence on the quality of life of the population and the impact on jobs, public services and infrastructures and the local, regional and extra-regional economy. There was also a strong interaction with road and sanitation projects, interacting with each other on issues related to the pressure that could be exerted on road infrastructure and the safety of third parties.

The cumulative impact analysis showed a positive synergy in the generation of employment and in the development of the local, regional and extra-regional economy, as well as in other social factors. Likewise, the potential cumulative negative impacts due to pressure on public/non-public services and infrastructures have been detailed, associated with the people employed and induced by the projects in the AID and the increase in truck traffic in the area of influence. Thus, the Valued Socio-Environmental Components (VECs) mainly impacted are: i) Local, regional and extra-regional economy; ii) Public/non-public services and infrastructure and/or property; iii) Health and safety to third parties; iv) Quality of life, uses and customs.

The minimization of cumulative impacts, from Paracel, would be to strictly comply with all the measures indicated in the Social Management Plan; likewise, monitoring measures in the conditions of the water resources, attending the activities of the Industrial Mill, since the use that is given to the water in the area is directly linked to customs in the area (recreation, fishing, others); as well as in the supply for human consumption.

6.7. Identification and Analysis of Social Risks

Following the social evaluation of the undertaking of the Paracel pulp manufacturing industrial mill, located in the Zapatero Cué locality of the Concepción district of the Concepción department of Paraguay, the analysis of social risks is developed, with a focus on the operational stage of the entrepreneurship.

It is considered that for the pre-construction or design stage, the main risk of the project is misinformation, and to a lesser extent the possible economic displacement of families settled in the ADA, for which, in the first case, Paracel has started from early stages a Communication and participation Plan with local governments, potential suppliers, as well as with the general population. In the second case, although it is a low risk, in case of economically affecting ADA families, due to the high dependence of some of them on the ranches that could stop operating in the area, Paracel will define specific programs in the PGS that serve this situation, as well as compliance with IFC PS 5.

Environmental and social standards and safeguards policies adopted by financial institutions, including IFC, the World Bank, among others, focus both on promoting sustainable and positive development and managing the risk of impacts. adverse of the project. Although the terms risk and impact are sometimes used interchangeably, as defined by the Social Impact Assessment document (Kvam, Reidar, 2018), impacts can be both positive and negative, while risks refer to potential negative impacts that the project may cause or contribute to, or issues that may adversely affect the project.

The analysis of social risks is carried out for those impacts considered MEDIUM and HIGH social significance, and negative, described in section 6.4 that could lead to stoppage of the Mill or adverse risks to the health or safety of the population. In addition, as was already presented in the previous section, the impact of the impact on occupational health and safety gave a LOW significance, considering that compared to the construction stage, the number of personnel that could be hired is lower, and having assumed good management of occupational health and safety (OHS), however, it is recommended that before the start-up of the enterprise, depending on the technologies to be used in the enterprise, an analysis of specific risks in OHS be carried out.

Although, most of the risks in the industrial mill could be avoided with efficient and automated operating systems, permanent maintenance of the equipment, constant training in occupational health and safety issues, norms of conduct for the personnel and related suppliers; the need to have permanent communication between Paracel and the community is still relevant, before it is put into operation and throughout the project cycle, especially in order to minimize the risks to which third parties are exposed, with an emphasis on women and children (either due to issues related to road safety, customs and customs, annoyances due to possible odors or noise).

Although the risk analysis in this section focuses on the impacts identified in this study, it is recommended that they be deepened before the industrial mill is put into operation, adapting and specifying more specific measures related to specialized topics in industries with similar characteristics, and according to the social monitoring that is given to the communities in the immediate environment in question.

6.7.1. Definition of Risks and Methodology

As defined in the Social Impact Assessment document (Kvam, Reidar, 2018), risk is the combination of the expected intensity of (i) a potential adverse impact that a project can cause or to which it can contribute, or (ii) of issues that may negatively affect the project and the likelihood of one or both of them occurring.

The risk is calculated with the following formula:

R = P * C RISK = PROBABILITY x CONSEQUENCE	R = risk P = probability of occurrence of an event C = consequence or magnitude of the event

As there are five levels of probability and five levels of vulnerability, a five-by-five matrix is formed in whose cells are the risk rating values. This rating is obtained by multiplying the value of the probability by the value of the severity of the consequence. The result of the possible values can be seen in chart 119.

Chart 119. Assessment of probability and consequence of the risks' matrix – Semi-quantitative method (de Deere et al., 2001)

		Severity of the Consequence				
		Insignificant 1	Mild Effect 2	Moderated Effect 3	Serious Effect 4	Catastrophic Effect 5
Probability or frequency	Almost always / Once a day **Punctuation: 5**	5	10	15	20	25
	Probable / Once a week **Punctuation: 4**	4	8	12	16	20
	Moderated / Once a month **Punctuation: 3**	3	6	9	12	15
	Improbable / Once a year **Punctuation: 2**	2	4	6	8	10
	Exceptional / Once every 5 years / **Punctuation: 1**	1	2	3	4	5

The probability or frequency of the occurrence of a risk has been taken on a smaller scale than is usually considered from the environmental point of view, considering that social issues require less response time in order to minimize social contingencies. Regarding the severity of the consequence, the following chart describes each criterion adopted:

Chart 120. Description of the Magnitud of a consequence

MAGNITUDE OF A CONSEQUENCE	DESCRIPTION
Insignificant	Has an impact on the point of emission or causes an internal limit to be exceeded, without affecting personnel or third parties
Mild Effect	Causes an impact on the mill area or increases the load on the treatment mill, or the chimney, slightly affecting mill personnel or a resident of the area
Moderated Effect	Causes a slight negative impact on the environment and/or annoyance on ADA populations
Serious Effect	It causes a notorious problem to the environment, treatment mill, and affects the health of the AID population or accidents in the personnel
Catastrophic Effect	It interrupts the operation of the mill, and generates some fatality either to the personnel or to third parties

Source: Adaptated from OPS (2009)

It is important to be clear about how the different levels of risk are defined. To a large extent, social risks are a function of the expected "footprint" of a project. Its scale, complexity and inherent sectoral risks have to be seen in the context of local conditions, such as people's vulnerability, poverty levels, lack of resilience or social exclusion (IDB, 2018). Chart 105 summarizes some of these aspects:

Chart 121. Description of the risk class and its assessment

CLASS	PUNCTUATION OF THE RISK	DESCRIPTION
IV	<5	LOW Risk: Project activities with minimal or no adverse social risks and impacts. No specific mitigation measures are required, only preventive and communication.
III	5-8	MEDIUM Risk: Although not significant, operational risks and challenges still deserve attention. Adverse impacts can be limited and few in number and easily addressed through mitigation measures.
II	9-16	HIGH Risk: The nature and magnitude of potential or actual social risks and impacts are significant and problematic. While the likelihood of such a risk occurring may be low, the high intensity of the impact indicates a substantial risk overall.

CLASS	PUNCTUATION OF THE RISK	DESCRIPTION
I	>20	Risk VERY HIGH: The nature and magnitude of the potential or actual risks and social impacts of a project can cause serious adverse impacts on the people affected by the project. Unless properly managed, the impacts can be irreversible

Source: Social Impact Assessment (Kvam, Reidar, 2018)

6.7.2. Social Risks of the project

Chart 122 shows the main social risks identified, and a proposal for general measures to be addressed.

The values represented in said chart are the result of crossing the magnitude scores (from 1 to 5), according to the criteria mentioned in Chart 120, and considering the probability of occurrence (from 1 to 5) of the risks, as they may exceptionally or almost always occur, as indicated in the matrix in chart 119.

Risks related to road safety, or increased discomfort and uneasiness, could lead to "VERY HIGH RISK", in the event of a fatality, and specific protocols must be established for said situation. Paracel foresees high safety standards, and these will be extrapolated to all activities that generate HIGH risk to the surrounding community.

Chart 122. Main social risks of the project

Social Factor	Impact	Probability	Severity	Value	Risk rating	Measurement guidelines
Public/private services, infrastructure and/or property	Increase in demand for public and non-public services	2	3	6	MEDIUM	It is minimized from the design stages, anticipating meeting the necessary demand
Public/private services, infrastructure and/or property	Increase in demand of houses	2	3	6	MEDIUM	It is minimized from the design stages, anticipating meeting the necessary demand
Landscape	Landscape impact	2	3	6	MEDIUM	It is minimized from the design stages, foreseeing to cover the necessary demand and with communication programs and permanent community accompaniment
Health and Safety of third parties	Impact on third parties health	2	4	8	MEDIUM	It is minimized with permanent community support and with protocols to suppliers for the transfer of goods and products
Public/private services, infrastructure and/or property	Increase of vehicular traffic	4	4	16	HIGH	Require permanent community support, awareness campaigns on road safety and with protocols for suppliers of goods and products transfer
Public/private services, infrastructure and/or property	Impact on the road infrastructure	3	4	12	HIGH	It is minimized from design stages. The maintenance of the roads must be agreed with the authorities or covered with the project
Public/private services, infrastructure and/or property	Impact of land properties	2	2	4	LOW	It is minimized from design stages. Address agreements with third parties from the early stages of the project
Health and Safety of third parties	Impact on road safety	3	5	15	HIGH	Require permanent community support, awareness campaigns on road safety and with protocols for suppliers of goods and products transfer
Quality of life, uses and customs	Increased discomfort or restlessness	4	4	16	HIGH	Requier acompañamiento comunitario permanente y con protocolos a proveedores de translado de mercaderías y productos. En caso de manifestaciones deberá preverse protocolos específicos y voceros de PARACEL que medien con la comunidad
Quality of life, uses and customs	Changes in customs and uses	3	4	12	HIGH	Require permanent community accompaniment. In case of demonstrations, specific protocols and PARACEL spokespersons should be provided to mediate with the community
Quality of life, uses and customs	Affection of the social network	2	3	6	MEDIUM	It is minimized with permanent community support and with protocols for suppliers and workers who live in the built accommodation
Expectations	Generation of negative perception and/or fears in the local population	2	3	6	MEDIUM	It is minimized with permanent community support and communication strategies
Expectations	Generation of negative perception and/or fears at regional and extra-regional level	2	3	6	MEDIUM	It is minimized with permanent community support and communication strategies

7. Measures and Programs

7.1. Identification and Justification of the Programs/Measures

Based on the social baseline (LBS) and the impact assessment developed, the Social Management Plan is structured in this chapter, which guides and defines the scope of the programs and measures proposed to mitigate and manage the identified social impacts.

The measures and programs will seek, in addition to mitigating and preventing negative impacts, optimizing and/or enhancing those positive impacts, contributing to local development and improving people's quality of life.

In order to achieve this objective, mitigation and/or compensation measures, communication and monitoring measures, in addition to the implementation of programs, should be foreseen, according to the associated impact and the stage of the project.

7.2. Social Management Plan (PGS)

Considering the impacts of medium and high significance identified through the evaluation presented in chapter 6. Evaluation of social impacts of this document, the programs and measures were formulated taking into consideration the national and international legislation cited at the beginning of the document, and that seek to guarantee the sustainability of actions within the framework of social management.

Through the measures and programs, the following will be sought:

- To establish the bases of relationship with the community, enabling their participation.
- To establish a healthy bond between the community and the company.
- To promote local development.
- To raise awareness and keep the population in the area of influence informed about the activities and processes planned in the framework of the project and its stages.
- To encourage the participation of the population in the identification and solution of problems.

Paracel will implement the PGS through the Communication and Social Sustainability Management, working in a coordinated manner with the Environmental Sustainability Management; and in coordination with the other departments of the company. This PGS is also integrated with the Environmental Management Plan (PGA), thus developing an Environmental and Social Management System (ESMS) at the business level. This ESMS, as well as the PGS, apply to both the industrial and forestry components of the enterprise.

Certain programs in the social field are configured considering the close relationship with impacts that will be addressed from the environmental, engineering or technical areas, and that will be coordinated and managed in an articulated manner with the different areas to achieve a comprehensive approach. This is the case of impacts such as: impact on road safety, impact on road infrastructure, impact on the landscape, impact on river traffic and ports, temporary increase in population, impact on ecosystem services with emphasis on the forestry component, among others.

To monitor socio-environmental performance; and for the coordination and socialization of information, a Socio-Environmental Committee will be created and formed by the supervisors or teams involved in the social and environmental field of Paracel who will coordinate, depending on the particular issues for follow-up, the participation of local referents and/or institutions. The Committee will establish by common agreement, the dates and frequency of meetings, work spaces and joint tours.

In addition, the company has created a Communication and Monitoring Committee; composed, among others, by referents of the districts of the areas of influence and whose objective is to involve the population in each stage of the project and establish a direct communication channel between Paracel and its different interest groups.

Various measures and programs will be planned and implemented by interdisciplinary teams from Paracel; and will require coordination with national level institutions, local governments or other organizations (such as, for example: Signaling and traffic management, training of local labor[151], among others). For this, the Environmental Sustainability Management and the Communication and Social Sustainability Management will coordinate the alliances and necessary steps for said articulations.

Some of the programs and measures are transversal to all stages of the project; that is, they will be implemented from the pre-construction stage (in the case of the industrial component) or design, to the operation phase (in both components). Monitoring at all stages will be key, in order to guarantee the follow-up of the proposed measures; and, eventually, propose the necessary adjustments that guarantee the sustainability of the undertaking.

In addition to the Human Talent policies related to occupational health and safety (OHS), specific strategic guidelines related to COVID-19 are added, addressing the pandemic declared by the World Health Organization in the period of development of social studies.

Next, the programs and measures are presented in chart 123, linked to the stages and the impact associated with each of them. The main guidelines, objectives and scope of each program are described below. The programs will be elaborated in detail, in a timely manner, when the development of the project so demands.

It is important to mention that this PGS integrates the measures that are applicable for both components (industrial and forestry), with the exception of the “Social management program for ADA communities”, applicable only for this component.

Chart 123. Programs and measures

PROGRAMS/MEASURES	STAGES OF THE PROJECT	ASSOCIATED IMPACT
ADA Social Management Program for Communities	Pre construction	- Impairment of properties - Economic displacement - Affection of the social network - Economic displacement and impact on land (ranches) - Migration of workers from one sector to another - Generation of favorable expectations - Generation of fear and uncertainty
Community and Stakeholder Relations Program	Pre construction, construction and operation	- Impact of the social and community networks (family, social, productive) - Impact on units in the immediate surroundings due to access or proximity to the mill - Changes in customs and uses - Increased discomfort or tranquility

151 To be worked from the Human Talent area of Paracel.

PROGRAMS/MEASURES	STAGES OF THE PROJECT	ASSOCIATED IMPACT
Programa de desarrollo y vinculación de mano obra local	Pre construction, construction and operation	- Generation of local employment - Formalization of labor ties - Skills development
Local workforce development and linkage program	Pre construction, construction and operation	- Development of the local economy - Generation of local employment - Temporary population increase
Dissemination and communication program	Pre construction, construction and operation	- Increase in vehicular traffic - Temporary population increase - Impact on road safety - Generation of local employment - Generation of expectations and fears in the local population - Generation of expectations at a regional and extra-regional level - Changes in customs and uses - Increased discomfort or restlessness
Complaints, claims and concerns management program	Pre construction, construction and operation	- Generation of expectations and fears in the local population - Generation of expectations at a regional and extra-regional level - Affecting the social and community networks
Road safety program for institutions and communities of the ADA and AID	Construction and operation	- Increase in vehicular traffic - Temporary population increase - Impact on road safety - Changes in customs and uses - Impact on the health and safety of third parties
Awareness and monitoring program for contractors and workers on compliance with regulations	Construction and operation	- Impact of the social network - Impact on road safety - Impairment of occupational health - Impairment of occupational safety
Community Health and Safety Program	Construction and operation	- Impact on health and safety of third parties
ADA cultural heritage protection and enhancement program	Construction and operation	- Impact of materials of archaeological, historical and/or cultural interest - Management and enhancement of local and national heritage
Social contingency prevention and management program	Construction and operation	- Impact on health and safety of third parties - Impairment of occupational health - Changes in customs and uses - Affecting the security of third parties - Impact on river traffic and ports
Internal management program for land affectation (easement)[152]	Construction and operation	- Impact of land properties
Social monitoring program	Construction and operation	- Generation of expectations and fears in the local population

152 In the forestry component, this program is complemented by measures linked to risks from external agents.

PROGRAMS/MEASURES	STAGES OF THE PROJECT	ASSOCIATED IMPACT
		- Generation of expectations at a regional and extra-regional level - Changes in customs and uses

7.2.1. ADA Social Management Program for Communities

Stage: Pre construction

Objectives: To identify the effects generated from the definition of the design of the work and accesses, seeking to minimize the effects of the ADA population, with emphasis on vulnerable groups.

Measures/Guidelines

The determination of the access path to the mill, as mentioned in item 6.3.1.2. The immediate surroundings of the development site, sought to minimize the impact and avoid the possibility of resettlement to the Piquete Cue community. Although resettlement has been avoided, the effects that could occur on the economic activities and way of life of these families and the communities near the defined main access should be evaluated and monitored.

Measures to be established according to the impact on the Piquete Cue community and other units in the immediate vicinity of the mill

Taking into account the particular characteristics of the Piquete Cue community (presented in chapter 4) and the evaluation of possible impacts evaluated in chapter 6, the measures described here seek to minimize the impact on said community. The measures may include, among others: construction of an alternative road for the community in case the current road is affected by the Project. Likewise, specific communication measures with said community, in order to inform the progress of the Project, and monitor possible impacts that may occur as a result of the undertaking. In the same way, within the framework of other Programs of this PGS, awareness related to road safety, health and other issues will be promoted, verifying that the scope of the measures defined therein has coverage in families in this community.

These measures will be designed in consultation with the community, taking into account the expectations and concerns of the inhabitants in relation to the new dynamics that will take place in the area and the possible impacts evaluated.

For the units near the main access (Pyrenda), it will be sought to minimize the impact on the current dynamics of the way of life, uses and customs. These should provide signaling and communication measures, within the framework of a consultation process with the community.

Follow-up and monitoring measures in the ADA

The impacts on the current dynamics of the population adjacent to the mill are also determined by the proximity to the site where the installation is planned. In this sense, follow-up, accompaniment and monitoring measures will be envisaged to ensure that people maintain or improve their way of life that they had prior to the undertaking.

In the case of dwellings located along 3 km (mostly belonging to the community of Piquete Cue), given the proximity to the prospective property, measures should also be evaluated once the definitive data of the design and location of the mill, to mitigate and monitor the impacts that may occur due to being adjacent to the north of the mill.

Complementary programs/measures

The following complementary measures apply for this Program:

- Relationship program with the community and Stakeholders
- Dissemination and communication program
- Program for the reception and management of complaints, claims and concerns
- Road safety program for institutions and communities of the ADA and AID
- Social monitoring program

7.2.2. Community and Stakeholder Relation Program

Stage: Design, Construction and operation

Objectives: Encourage local development and promote close ties between the community and the company.

Measures/Guidelines

The program of relations with the community and local development refers, firstly, to the generation of mechanisms for the participation of the population of the areas involved in the project for both components (ADA/AID for the industrial component and AID for the forestry component). In actions that are oriented to the identification and formulation of alternatives to the changes that could occur with the implementation of this. Likewise, it seeks to contribute to the strengthening and development of the communities, both in the social, economic, cultural, and other aspects; and the active involvement of the inhabitants in matters that affect the transformation of the current conditions of their environment.

With the field work carried out for the preparation of the LBS studies; both in the first stage and in the second, survey and information exchange activities were developed with the population of the areas that make up the AID in each of the components, enabling a first communication channel with them, being able in turn know the situation of these territories regarding access to basic services, health, education, participation, others. This process and the international regulations involved constitute the basis for the generation of community development proposals in these areas, before which the following points should be considered:

- The importance of sustaining the communication, already initiated, in the territory by returning the results of the information survey; carried out for the baseline studies and the involvement of the various stakeholders and interest groups; already identified in the different spaces.
- All actions that involve the community must contemplate the prior elaboration of participatory diagnoses in consultation spaces, promoting equitable participation between women and men in the community, and permanent monitoring of the activities planned for this purpose.

The implementation of the activities with the aforementioned considerations ensure compliance with the principle of Ecuador No. 5; that highlights the importance of the “effective participation of Stakeholders in a continuous, structured and culturally appropriate manner for the Affected Communities; and, where appropriate, for Other Stakeholders ”, the importance of carrying out consultation processes according to the degree of adverse impacts that may occur in each area, adapted to their linguistic preferences; their decision-making processes, and the needs of disadvantaged and vulnerable groups.

The communities located on the access roads to the area surveyed for the installation of the mill; They have the particularity of becoming an area with an identity of cohesion between communities that are linked to each other and that are interdependent on each other; Saladillo, Mongelos and Roberto L. Petit are communities with greater capacity, in which educational institutions, health services, etc. are concentrated. which are attended daily by inhabitants of neighboring communities with less capacity.

For their part, the AID communities of the forestry component also constitute territories in which educational, health, recreational and religious institutions, among others, are present. Those with the largest number of institutions and centers are the district capitals such as Puentesiño, Paso Barreto and large towns such as Paso Mbutú and Colonia Jorge Sebastián Miranda (Hugua Ñandu).

In the areas involved in the project (both components), community organizations, producer committees, neighborhood commissions, water and sanitation boards, among others, were also identified; as well as, private initiatives for recreation such as watering places, and also small businesses and places with some type of service.

Taking into account this information and other characteristics surveyed, the following measures are proposed for the strengthening of local capacities by the project to be implemented within the framework of this program for both components:

- **Support to the strengthening of community identity:** Measure by which it is intended to generate activities that promote the strengthening of the existing community nexus between communities; accompanying the process of change that could be generated with the implementation of the project. The activities may include the participatory development of joint projects; including vulnerable groups (women, children, people with disabilities and the elderly), the establishment of community centers, the preparation of training plans in coordination with the regional offices of the MIC, SNPP, USF (training in preventive measures against COVID-19, HIV, and other public health issues), the organization of cultural events, etc.

- **Support to the strengthening of community organizations in the area:** In connection with the previous measure; It will seek to offer the organizations in the areas activities that promote their strengthening, placing special emphasis on productive committees (for example, in the forestry component, artisans dedicated to the production of karanday products), technical assistance with a gender approach the provision of marketing spaces in coordination with different relevant actors in the district. In addition, actions related to the rational use of water, the importance of the prior purification of the water provided by the sanitation boards or commissions, water quality monitoring, among others, will be promoted.

- **Promotion and development of local initiatives:** Aiming to provide technical support for the improvement and sustainability of local initiatives such as MSMEs, small businesses, workshops and others. In addition to support and advice for legal issues; such as the provision of tourist and recreation spaces (watering places) in the area.

- **Improvement of existing infrastructure:** In coordination with departmental and municipal governments, support the generation or improvement of spaces for recreation and outdoor recreation (squares, parks, courts, etc.), road safety signs in areas with concurrence of people and especially children (squares, schools, churches); as well as the improvement of the local landscape and all kinds of infrastructure of community relevance.

Complementary programs/measures

The following complementary measures apply for this program:

- Dissemination and communication program.
- Program for the reception and management of complaints, claims and concerns.
- Program for the development and linking of local labor.

7.2.3. Local Workforce Development and Linkage Program

Stage: *Design, construction and operation*

Objective: To promote the generation of local employment through the linking of qualified and unskilled labor from the project's area of influence and the development of capacities.

Measures/Guidelines

Partnerships for capacity development

One of the measures that the company is working on, in order to promote the employment of local labor, is the development of links with educational institutions present in the department in coordination and in alliance with the Ministry of Labor, Employment and Social Security (MTESS). Currently Paracel has two agreements signed with this ministry. These alliances aim to join forces between the company and the education sector, for the planning of training courses and training within the framework of capacity development.

In addition, in the forestry component, Paracel will promote the inclusion of female labor in the nurseries to be installed, thus developing actions for the inclusion of women in the forestry sector.

The characteristics surveyed in each social base line, related to the employment issue; the expectations of the population; the educational institutions present in the department of Concepción and the profiles of qualified and unskilled labor required by the company will be taken into account for the planning of actions and the design of the courses.

This measure is currently being implemented, as it was planned for the stage prior to construction, in order to have the necessary local labor. In addition, with a view to the following stages, new training courses may be designed in accordance with the personnel requirements necessary for the project's operation stage in each of its components. Currently the company is making the first calls for hiring and training of required personnel.

The capacities developed will remain at the end of the mill construction stage (as with the forestry component process), as installed capacity, thus enhancing the local qualified workforce that could be reintegrated into other ventures.

Promotion of the linkage of local labor

Paracel's human resources policy prioritizes the hiring of local labor, in the first place; and of national labor, in second place; over the hiring of foreign labor.

The diffusion and promotion for the hiring of local labor is carried out by different means. The planning of promotional activities takes into account the information channels most cited by the population in each of the components.

The MTESS created an exclusive job bank to respond to the needs of Paracel and its suppliers; in order to attract the largest number of local workforces. In accordance with the signed agreement, the MTESS will finance the training of the first 350 operators of the industrial mill.

Currently, courses are being developed through the SNPP in Concepción, to respond to the hiring needs of Paracel and project contractors. The areas covered are construction and forestry through training in the handling of large machines.

The promotion of this program is carried out through informational meetings, job fairs, and other identified spaces, in coordination with the MTESS, the focal points of the local governments, and references from the different localities in the areas of influence.

Applications are made through the website, to the email: talentohumano@paracel.com.py or from the company's customer service offices and from other points that are coordinated with local institutions.

Paracel will generate periodic reports on the hiring and the process carried out, with information about:

a) Number of vacancies and required profiles
b) Media used
c) Number of applicants presented
d) Number of applicants hired
e) % national, local and international skilled and unskilled labor

In addition, the labor hiring process will guarantee equal opportunities for men and women, with special emphasis on equal criteria for selection, remuneration and promotion and on the equal application of such criteria (Performance Standard 2, on Work and Conditions IFC Standards on Environmental and Social Sustainability). Likewise, it is estimated that both components (industrial and forestry), in the different stages of the project, can generate around 40,000 jobs (4,000 direct, 16,000 indirect and 20,000 indirect-direct). Considering the specific hiring profiles, it is foreseen that 90% of the people who work in the nurseries will be women, in the case of the forestry component; attending to international standards that ensure, among others, employment opportunities and the promotion of gender equity in undertakings of this nature.

Promotion of the hiring of local workforce from subcontractors

Considering that for the constructive stage, PARACEL will subcontract to other companies, in the tenders or contracts to be signed with each one, the same promotion and equity requirements mentioned in the previous measure will be established.

Complementary programs/measures

The following complementary measures apply for this Program:

- Relationship program with the community and Stakeholders
- Dissemination and communication program
- Program for the reception and management of complaints, claims and concerns
- Awareness program to monitor contractors and workers on compliance with regulations

7.2.4. Promotion and Development Programa for Local Suppliers

Stage *Design, construction, operation*

Objective: To promote the development and growth of the local economy through the promotion of local and national companies as possible suppliers.

Measures/Guidelines

In the areas of influence of the project there are important companies and people who are dedicated to providing goods and services of different areas, whether they are large or small companies. The largest proportion of people who work do so in MSMEs.

Taking into account the positive impact that the company will generate in terms of the demand for products and services to attend the different activities related to each component of the project; under this program, it will be sought to encourage the development of local suppliers.

Paracel has promoted and initiated an open channel of communication with the different local suppliers and merchant associations in the area; in coordination with local governments, organizations related to MSMEs and references from certain sectors; some identified in the process of consultation and preparation of the baseline.

In the case of the forestry component, the inclusion of 20% of local producers (large, medium and small) is foreseen; and in coordination with INFONA, a pilot project is currently being developed through which the socioeconomic and technical conditions of potential producers are evaluated, for the definition of lines of action such as: Investment funds for small producers, technical assistance and training, among others.

Paracel will provide, in a transparent and clear manner, information related to the demand for goods and services that it will have in each stage, estimated times, processes of contests and tenders, quality standards and required management.

Through this program, other activities and processes that help to:

- Achieve more competitive compliance standards
- Improve business and operational management processes
- Optimize production and delivery times
- Improve the quality of products and services, and the response capacity of suppliers
- Develop new products, services and position itself in other markets

- Contribute to sustainable local development in communities through the strengthening and development of SMEs
- Promote integration and coordination between supplier companies
- Contribute to economic decentralization

Complementary programs/measures

The following complementary measures apply for this Program:

- Relationship program with the community and Stakeholders
- Dissemination and communication program
- Program for the reception and management of complaints, claims and concerns
- Awareness and monitoring program for contractors and workers on the code of conduct and compliance with regulations

7.2.5. ADA Cultural Heritage Protection and Enhancement Program

Stage: *Construction and Operation*

Objective: To ensure a sustainable management of heritage, promoting the enhancement of Concepción's heritage value.

Measures/Guidelines

Although the social significance of impacts on heritage is low in both components, it is also expected to promote actions that help achieve a visible presence of tangible heritage; and, eventually, minimize its impact, as well as respect the intangible heritage, present in the way of life and culture of the population settled in the study areas.

In order to ensure a sustainable management of the project, and to take into consideration eventual findings –which, although they were not confirmed in the LBS field work–, construction contractors will be required to implement management protocols in case of eventual findings. Said protocols must foresee the participation of the National Secretariat of Culture, as well as that of local governments, as the case may be.

In order for the project to promote the revaluation and enhancement of the tangible and intangible heritage of Concepción -Villa Real de Concepción-; as well as its cultural identity, Paracel will promote actions with local and national cultural authorities, thus helping to ensure their safeguarding.

As already mentioned in the first version of this PGS; this is achieved through simple measures, such as, for example; support cultural centers or museums with graphic and printed material; as well as, in the event that during the works (industrial component) or in the installation of forest fields, the participation of archaeological specialists is required, they can document the findings, and the results be made available to local actors and institutions linked.

In the case of the forestry component, the largest number of planned activities will be of small-scale facilities that would not affect materials of archaeological value that could be found in the subsoil; also foreseeing the request of specific protocols to subcontractors linked to the adaptation of internal roads (roads, drains, others) and soil preparation. Likewise, the project expects to comply with the principles of IFC Performance Standard 8 on Cultural Heritage and current national regulations.

7.2.6. Road Safety Program for Institutions and Communities of the ADA and AID

Stage: *Construction and Operation*

Objective: To reduce the probability of occurrence of road accidents; and the impact on the way of life of the communities surrounding the mill and the properties for forest plantations, originated in the increase in traffic.

Measures/Guidelines

The measures mentioned here are complementary and must be coordinated with the guidelines or road safety program set out in the Environmental Management Plan; and that are related to the fulfillment of traffic and signage requirements and regulations (permitted traffic hours, speed regulations, avoid circulating in the vicinity of sensitive areas, installation of signage and signage, etc.). According to the field trips, a deficient signaling of the existing roads has been visualized, proposing that these be reinforced with the support of the enterprise, but through inter-institutional coordination with local governments and/or with the MOPC; this in the case of roads linked to both components.

To address these impacts from the social sphere, awareness-raising and information dissemination actions should be planned, in coordination with the other related programs.

Awareness and dissemination of information to neighboring communities and public institutions

In addition to the community relations and communication program, specific information should be shared with the communities and public institutions in the area about:

- Stages of the project and changes in the dynamics of vehicular traffic
- Traffic management plan
- Installation of regulatory and preventive signs (clear and easy-to-interpret signs)
- Details of the service offices installed by the company and the mechanism for inquiries and complaints

This socialization may be accompanied by training articulated with the competent regulatory institutions, or by distributing materials (posters, brochures, others) to educational centers, health centers and USF in the area.

Training and awareness-raising for drivers and workers related to transportation

In the framework of the development of training or induction processes for contracted personnel linked to the transport area, and suppliers in general, information will be provided related to the characteristics of the communities and their dynamics of use of access roads, location of the sensitive areas as school or health centers, among others. These trainings will be complementary to the trainings that the company will give on basic traffic rules, signage, schedules, etc.

The following complementary measures apply for this Program:

- Relationship program with the community and Stakeholders
- Dissemination and communication program
- Program for the reception and management of complaints, claims and concerns
- Awareness program to monitor contractors and workers on compliance with regulations

7.2.7. Awareness and Monitoring Program for Contractors and Workers on Compliance with Regulations

Stage: *Construction and Operation*

Objective: Accompany and monitor contractors and workers to ensure compliance with international regulations and national legislation.

Measures/Guidelines

Contractors and workers in the framework of subcontracts with Paracel are not considered third parties for the purposes of international regulations. They act on behalf of Paracel, and must be under the direct control of the company.

The trainings, workshops or meetings that the company dictates to its own workers or operators must also be extended to subcontractors and their workers; in order to optimize the programmed spaces and to promote a greater sense of belonging to the project by everyone.

It is important, therefore, that all related workers are aware of the scope of the project in general, of the code of conduct, of the environmental and social management programs that will be implemented in all stages, and that they handle clear information; so that it can be relayed to the community, when it requires it. In addition, there will be specific norms of "conduct" linked to the communities.

Paracel will ensure compliance by all contractors with the Human Resources Policy; and the principles and regulations that they must comply with such as: Principle of equal opportunities and fair treatment, priority of hiring local labor, working conditions, health and safety at work, principles of non-discrimination, preventive measures against COVID-19, among others. These requirements will be explicit in the bids and contracts to be signed. In addition, compliance with IFC Performance Standard 2, on Labor and working conditions, as well as the World Bank Group guidelines on the environment, health and safety, social management and coexistence in temporary accommodation.

In the framework of the construction of the mill (industrial component) and use of the accommodation to be built by Paracel; part of the personnel linked to the undertaking will temporarily live in the area. In this regard, standards of conduct will be established especially linked to minimizing the effects on the ADA communities, as well as reducing the effects on the uses and customs of the communities.

In addition, in both components, there will be specific personnel for the security area. Paracel will ensure that they do not exercise "abuses of power" as an extortion measure or pressure on workers and/or the community, conducting specific training.

Induction in SSO and follow-up

Although this will be addressed by specific programs, it is important to note that to minimize the impact on health and occupational safety, inductions will be made to workers in the current safety regulations (Decree 14,390; General Technical Regulation of Safety, Hygiene and Medicine at Work); as well as the IFC performance standard and the World Bank's general guidelines on environment, health and safety. In addition, considering that Paracel will require contractors to have occupational health and safety technicians as established by local labor legislation. The inductions will make the provisions on informing specific protocols in cases of accidents, incidents, emergencies, informing about the specific areas of the company that address these issues (SSO Technician, Emergency Brigades and Risk Management, others).

In addition, in response to the pandemic declared by the WHO, specific protocols will be established to prevent the spread of the virus both in Paracel personnel and in the communities surrounding the industrial mill and forest fields. Other diseases of hydric origin, transmitted by water, as well as diseases by vectors will also be addressed in the inductions, mentioning specific measures for their prevention and eventually, reducing the risk of their spread.

The proper management of solid waste is also related to OHS (many times a generator of vector diseases), as well as the handling and special disposal of hazardous waste, so inductions to staff will include these topics.

The monitoring of the implementation of the standards in OHS will be attended by specialists in OHS from Paracel, registered and authorized in the Ministry of Labor for this purpose.

Complementary programs/measures

The following complementary measures apply for this Program:

- Local workforce recruitment and development program
- Dissemination and communication program
- Program for the reception and management of complaints, claims and concerns

7.2.8. Community Health and Safety Program

Stage: *Construction and Operation*

Objective: To implement an efficient program of hygiene, safety and health care for the population, with emphasis on the prevention of diseases of hydric origin, transmitted by water and others that could be related to the increase in the workers influx.

Measures/Guidelines

In addition to the specific measures of preventive signs mentioned in the road safety program for institutions and communities of the ADA and AID, as well as the planned training, Paracel will establish specific alliances with local health institutions (USF, health centers) identified in the AID/ADA, in order to contribute to the management and monitoring of information related to water-borne diseases, vector diseases, respiratory diseases, sexually transmitted diseases, pregnancies, drug use, alcohol, among others.

In response to the pandemic declared by the WHO, special attention will be paid to supporting and disseminating the MSPyBS campaigns, both in measures against COVID-19, and other vector diseases that may occur.

Disease awareness campaigns

Paracel will support health campaigns in the AID communities, promoted by the MSPyBS, as well as in the distribution of awareness materials on sexually transmitted diseases, protocols against COVID-19, preventive measures against dengue and other vector diseases. Likewise, specific campaigns will be carried out to prevent water-borne diseases (with emphasis on children and women), considering the low quality of the water and the lack of treatment systems in certain areas; as well as dissemination of water quality results in the AID water courses (Paraguay River, Aquidabán River, others).

Other diseases can occur due to the inappropriate use of solid waste (many times generators of vectors) or due to poor disposal of packages of chemical products used as could be evidenced in previous chapters; especially in the forestry component, for which specific campaigns will also be carried out on the proper management and disposal of solid waste, as well as on the management of hazardous waste.

The information related to the attended campaigns, the number of people who receive the materials, the talks given by Paracel staff will be recorded; as well as possible claims related to illnesses that may be attributable to project personnel and/or activities, among others.

Disease baseline studies

Paracel will support specific studies to systematize information from the USF; and then deliver them to the MSPyBS, as well as to the Municipalities, in order to contribute in establishing the bases to have reliable statistical data in the area; moreover, taking into account the recent disintegration of some districts, of which there is no baseline data for subsequent monitoring.

In addition, a record will be kept of the illnesses related to the personnel of the work; and related to these issues, in order to prevent the spread of disease to communities. According to the results, specific awareness campaigns will be carried out with Paracel personnel, always promoting the norms of conduct with the communities.

Health impact monitoring

Specific studies will be carried out in order to monitor the health data of the community; and those that may be attributable to the project (accidents, sexually transmitted diseases, by vectors).

In addition, third party health and safety impacts will be monitored, as mentioned in the impact assessment chapter; in order to document possible cases of water-related diseases (water-borne or water-borne).

Complementary programs/measures

The following complementary measures apply for this program:

- Community and stakeholder relations program.
- Awareness program to monitor contractors and workers on compliance with regulations.
- Road safety program for institutions and communities of the ADA and AID.

- Social monitoring program.
- PGA environmental education program.

7.2.9. Dissemination and Communication Program

Stage*: Design, construction and operation*

Objective: Delivery of information about the project to the general population and to the resident communities in the project's areas of influence, in each of its components, in order to maintain and guarantee constant and timely communication.

This program is transversal to all the programs and measures of the PGS and PGA**.**

Measures/Guidelines

Information dissemination/disclosure

Communication represents a fundamental pillar of the PGS, through the design of alternatives for the use of different spaces and media; that allow the dissemination of clear and precise information about the project, among the different interest groups linked to it and the population in general.

Actions will be envisaged to ensure the arrival of information to the population of the areas linked to the project, in each of its components (AII, AIDs and ADA) periodically; containing deadlines, advances and setbacks (if any) of the project. The strategy will also involve planned communication for other levels such as regional and national. This means that communication, in addition to focusing on business and institutional matters, must have a social communication strategy focused on the communities surrounding both the mill and the properties for forest plantations and accesses, with emphasis on the most vulnerable groups, such as It is presented below in specific guidelines for these social actors.

Currently, the company has various communication channels such as: Social networks, website, exclusive service numbers for this purpose, institutional email: info@paracel.com.py, a YouTube channel.

Likewise, Paracel has promoted the creation of a Communication and Monitoring Committee of the company, a committee created with the purpose of involving the population in each Stage of the project, achieving a collaborative development of socio-environmental programs; and above all, establish a direct communication channel between Paracel and its different stakeholders.

All channels and spaces ensure that the content to be transmitted on the stages of the project is sufficiently clear and adapted to the cultural and linguistic particularities of the areas, in order not to generate confusion/doubts at the moment of reception. In connection with the Program of Attention to Queries and Claims; it will seek to generate materials in various formats (printed and digital), based on the registered concerns, in order to respond to the specific information needs; especially of the resident population in the area of direct influence of the project, in a timely manner.

Taking into account what was revealed in the perception studies; and considering that some people expressed concern in relation to the project, stating, among other issues; “That is sustainable”, the “possible contamination/affectation of natural resources and the environment”, that has “social responsibility”, as well as issues related to the use of chemical products. The dissemination of information to the populations near the forest fields must contain data on the afforestation process and related activities, such as the use of chemical products and fertilizers, “controlled burning” activities, among others.

All these actions meet and will comply with the provisions of IFC Performance Standard 1, in its item 29-Disclosure of information; in which it is highlighted that all relevant information about the project; the risks, impacts and opportunities must be issued, ensuring that the affected communities and other social actors dimension these aspects; for which *“The client will provide affected communities with access to pertinent information on: (i) the purpose, nature and scale of the project; (ii) the duration of the proposed project activities; (iii) the possible risks and impacts on these communities and the pertinent mitigation measures; (iv) the planned stakeholder participation process; and (v) the complaints mechanism ”*[153].

To date, as part of this program, there have been (6) virtual and (7) face-to-face meetings called: “Let's talk”; in order to deliver information about the project to the general population and to the resident communities in the project's areas of influence, seeking to maintain and guarantee constant and timely communication.

The content presented in all the talks was taken from the Environmental Impact Report (RIMA); trigger tool for queries, comments and suggestions to come up.

Paracel's communication channels were presented in all the talks and the participants were invited to form part of the company's Communication and Monitoring Committee. Committee created in order to involve the population in each stage of the project, achieve a collaborative development of socio-environmental programs and, above all, establish a direct communication channel between Paracel and its different stakeholders.

Communication to the population at the construction stage

The communication to the population in stage of works must foresee communication actions both in the previous phase and during the works. This will involve the dissemination of specific and relevant information; such as the planned schedule of works, activities related to the industrial mill and forest fields, seeking to prevent temporary annoyances, risks of accidents, in addition to noise, dust, etc., including recommendations and safety measures to be taken into account by the population affected, ensuring their well-being.

Recommendations and measures will be disseminated through mass communication media, social networks, printed materials such as newsletters, leaflets, pamphlets, among others; so that the population takes the necessary precautions based on this information. Likewise, informational spaces will be generated with the community, especially with the families residing in the ADA and AID, attending to their expectations, doubts, queries, etc. regarding said stage.

Another aspect to consider, in order to provide timely information to the population of the project's areas of influence, is the preparation and placement of all kinds of posters and signs necessary in the works area and/or in other areas with information related to these.

Delivery of timely information to the community and relevant stakeholders

Through this measure, it is proposed to generate a relationship of trust with the population (social actors, interest groups) in the project's areas of influence. By providing accurate and timely information on issues concerning the

153 IFC- Performance standards on environmental and social sustainability. Page 14.

impacts and the compensation and/or mitigation measures associated with them; as well as with the delivery of answers in time and form to the concerns that arise from the community.

For this, direct communication spaces will be generated with the population involved; participatory meetings by sectors, house-to-house visits, among others. So that people can take ownership of the process by expressing their needs, points of view, and through this an adequate management of project/community relations is given. In addition, there will be specific spaces for communication with local actors (Municipalities); as well as key messages to be communicated, according to a business communication strategy, with NGOs and other organizations (association of small producers, among others).

It will be ensured that the teams (social, communication, etc.) that are formed for the different jobs and Stages, handle the same information related to each program.

Based on the social work carried out in the territory, coordination with key local actors will be important; with whom permanent communication was initiated and maintained (referents from the public and private sectors, civil society, merchants, community leaders, among others). Within this framework, the company began the process of contact with said actors for the socialization of RIMA in each of the municipalities involved.

Finally, in addition to communicating specific issues to the project, Paracel will promote the communication of awareness of the surrounding populations, in order to disseminate specific measures and protocols in the face of the pandemic declared in the initial stage of the project (COVID-19); as well as promoting actions related to the rational use of water, the importance of the prior purification of the water provided by the sanitation boards or commissions, water quality monitoring, among others.

Complementary programs/measures

The following complementary measures apply for this Program:

- Community relations and local development program
- Local workforce recruitment and development program
- Program for the reception and management of complaints, claims and concerns
- Road safety program for institutions and communities of the ADA and AID
- Social monitoring program

7.2.10. Complaints, Claims and Concerns Management Program

Stage: *Design, construction and operation*

Objective: To guarantee attention to the complaints, claims and concerns of the population of the project's areas of influence, workers and the general population, establishing permanent communication channels.

Measures/Guidelines

Timely attention to queries, concerns or claims related to the undertaking will be key. From the fieldwork process, as a result of the perception study, potential impacts were identified linked to the generation of fears of the local population, in relation to the care of the environment and the possible impact on the way of life; this in the areas covered by both components of the project.

This program considers the principle No. 6 of Ecuador, Complaints Mechanism, as well as the guidelines of the standards proposed by the World Bank, and the IFC Performance Standard 2, on Work and working conditions. In these it is proposed:

Preparation and definition of the mechanism for receiving and managing complaints, claims and concerns - implementation manual

For the implementation of the program, it is necessary to formalize an action mechanism that "must be adapted to the risks and impacts of the project, and the affected communities must be its main users". For this, it must contain lines of action that guide the resolution of queries, doubts and concerns promptly, using an understandable and transparent consultation process that is culturally appropriate and easily accessible, without costs, and without any retaliation for those who raised the matter or worry[154]. For them, the following steps are proposed:

- Preparation of a procedures' manual, considering the different actors who will be served (general population, affected population and workers), as well as a scale of the type of claims and response time to these.
- Socialization and validation of the tool with all the teams involved.
- Training for its use.
- Activation and dissemination of the mechanism in spaces for participation generated, within the framework of this or other PGS programs, will inform the affected communities about the mechanism during the process of stakeholder participation.
- Monitoring the resolution and closure of claims.

Currently, the company has an elaborate procedure that describes the system for the effective attention, treatment and closure of complaints, suggestions and queries; and the channels enabled (website, email, specific number for attention, mailbox for complaints, suggestions and queries) located in the Paracel establishment.

Enabling spaces to offer the affected population and workers answers to their doubts and concerns

Generate a direct and continuous channel of communication between the project and the population; in order to receive and facilitate the resolution of the concerns and complaints received, also detecting their expectations and discomfort regarding the execution of the works; and the expected benefits. Guidance posts/offices will be installed for citizens and/or workers[155] who come to express concerns/claims. The installation should be planned in the areas of influence of the work, with the presence of qualified professionals for this purpose, they will treat the demands from the request to their resolution, response and registration within a period stipulated in advance by the company and the responsible team.

154 Ecuador Principle No. 6, Complaints Mechanism.
155 The company must establish a complaint handling mechanism so that "workers (and their organizations, where they exist) can raise their concerns regarding the workplace". The client will inform the workers about the complaint handling mechanism at the time of being hired and will give them easy access to it. IFC. Performance standards on environmental and social sustainability, Performance Standard 2 Work and working conditions. Item 20. Complaints handling mechanism.

Complementary programs/measures

The following complementary measures apply for this Program:

- Community relations and local development program
- Dissemination and communication program
- Local workforce recruitment and development program
- Social monitoring programs

7.2.11. Internal Management Protocols for Land Affectation (easement)

Stage: *Design, construction and operation*

Objective: To prevent conflicts with third parties (owners of properties used as easements) and outline internal protocols to guarantee the safety of Paracel personnel.

Measures/Guidelines

The LBS has confirmed the use of private property, such as easement for access/exit to the industrial mill, as well as from the forest fields. Paracel will make specific agreements with the owners of said properties; in order to guarantee the permanent use of these roads at all times, explicitly agreeing on their maintenance responsibilities and/or possible compensation. Likewise, the non-involvement of roads in the area of indigenous communities or on lands under their control will be guaranteed, in order to safeguard the principles established in section 2.1. Project synthesis and related regulatory framework.

In addition, in relation to the security strip linked to the construction of the transmission line (LT), the possible compensations that should be given to the properties will be addressed, in coordination with ANDE. The provisions of IFC Performance Standard 5 will be taken into account.

Likewise, in relation to the security of the lands, both for easement and for the security in general of the enterprise, there will be permanent security professionals both in the industrial mill and in the forest fields. Paracel will ensure that they do not exercise "abuse of power" as an extortion measure or pressure on operators and/or the community, conducting specific training, similar to those provided for in the Program of awareness and monitoring of contractors and workers on compliance with regulations.

Complementary programs/measures

The following complementary measures apply for this Program:

- Awareness program to monitor contractors and workers on compliance with regulations.
- Social contingency program.

7.2.12. Social Monitoring Program

Stage: *Design, construction and operation*

Objective: To monitor the implementation of the measures and programs established in the PGS through the definition and follow-up of performance indicators, so that inconveniences in the fulfillment of the established Objectives can be identified in time, and allow corrective actions to be taken timely. This program also contains a sub-component for monitoring social perception through which it will be possible to have updated information regarding opinions and expectations of the local population on aspects related to the project in its different stages.

Measures/Guidelines

Taking into account both the baseline drawn up for each component, as well as the possible impacts identified, the programs and measures were generated with a range of activities to be developed during the different stages of the project, these will have compliance indicators that will be defined taking into account each one of them counts. For the definition of the indicators, lines established in the Equator Principles, IFC and FSC Standards will be taken into account.

The company has developed verifiable measurement instruments for the implementation of constant socio-environmental monitoring and control activities of the process. Minutes of meetings, report of specific activities of each program, field visit reports, among others.

Spaces will be established for the review of the indicators by Paracel (Social Team/Management of Communication and Social Sustainability) to ensure the correct execution and implementation of corrective actions as necessary. Each of these spaces will be formally registered, which may be in meetings and/or visits to the territory on a regular basis, keeping a systematic record of the actions. Likewise, interviews, focus groups, workshops, etc. may be carried out with the affected persons to obtain complementary information based on each mentioned indicator.

The monitoring tools may contain the following lines:

- Detailed information on the progress in the implementation of the programmed activities.
- Quantitative data on the results obtained.
- Qualitative information at the results level.
- If any, information on challenges/problems encountered during implementation, which delayed or could delay implementation.
- Proposals to solve problems/challenges.
- Sources of verification.

The information will be processed based on the following aspects:

- Detailed information on the progress in the implementation of the programmed activities
- Quantitative data on the results obtained
- Qualitative information at the results level
- If any, information on challenges/problems encountered during implementation, which delayed or could delay implementation
- Proposals to solve problems/challenges

- Sources of verification

Information will be processed according to the following aspects:

Mitigation measure /Indicator	Goal	Means of Verification	Made in the period	Accumulated

Example of indicators to be defined by each program (Period: semester)

- Construction of a database with identification of interest groups and the number of biannual updates.
- Number of people in the community who have received some type of information about the project and the total population in the community.
- Number of people summoned to the activities compared to the number of people attending the activities.
- Number of concerns, complaints and/or claims received (define period) given the number of responses granted and number of cases resolved.
- Number of activities programmed in the communication project for participation/number of activities actually carried out.

Sub component

Monitoring the social perception

- For the development of the monitoring, the baseline studies carried out will be taken into account, both with regard to the socioeconomic characteristics of the project's areas of influence (secondary and primary sources); as well as the results of the work to survey the social perception in the territory, districts and communities, and the changes perceived by the population with the implementation of the project; for which the same techniques of the first approach to the population may be used.

- Regarding methodological aspects, participatory spaces can be generated with key institutional actors (government, municipal, business associations, NGOs); as community members who share their perception already in a stage of progress of the project, this both individually and in groups. The results of these studies may anticipate possible negative perceptions, and thus promote mitigation and/or contingency measures.

- All the resulting information will also serve as input for dissemination and communication programs, prevention and management of social contingencies, consequently; as well as eventual updates to these, in order to adapt them as the project progresses.

- All the resulting information will also serve as input for the dissemination and communication programs, for the prevention and management of social contingencies accordingly.

Complementary programs/measures

The following complementary measures apply for this Program:

- Community relations and local development program
- Dissemination and communication program
- Program for the reception and management of complaints, claims and concerns

- Awareness program to monitor contractors and workers on compliance with regulations

7.2.13. Social Contingency Prevention and Management Program

Stage: *Construction and Operation*

Objective: To prevent and give a prompt response to social contingencies in the constructive and operational stage of the undertaking.

Measures/Guidelines

In the face of an environmental or social contingency, the communication route to be used by Paracel personnel, contractors or a person outside the company, must follow the procedures described in the environmental contingency program in order to unify the procedure and the communication.

As the guidelines were presented in item 6.5 of risk analysis, the relevant ones are listed below, to be considered:

- Effects on communication programs and permanent community support are minimized.
- In the event of demonstrations by the community and/or third parties, Paracel spokespersons authorized to mediate must also be established.
- Risks related to road safety or increased discomfort and uneasiness could lead to “VERY HIGH RISK”. In the event of a fatality, specific protocols must be provided for that situation. Paracel foresees high safety standards, and these will be extrapolated to all activities that generate HIGH risk to the surrounding community.
- Through specific protocols with suppliers and/or carriers, which, in the event of accidents, must be communicated immediately to Paracel; and through the company, direct contacts with the families of those affected.

Paracel must establish specific spokespersons in the event that prompt communication with those affected is required, in the event of any social contingencies that may arise. These must be registered in the Complaints and Claims Attention Program, and monitored until their resolution.

Complementary programs/measures

The following complementary measures apply for this Program:

- Community relations and local development program
- Dissemination and communication program
- Program for the reception and management of complaints, claims and concerns
- Awareness program to monitor contractors and workers on compliance with regulations

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PÖYRY

Pöyry Tecnologia Ltda.
Av. Alfredo Egídio de Souza Aranha, 100
Bloco B - 7° andar
04726-170 São Paulo - SP
BRASIL
Tel. +55 11 3472 6955
Fax +55 11 3472 6980
E-mail: contato.br@poyry.com

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PARACEL

Pulp Mill, River Port, Transmission Line and Electrical Substation in Concepción – Paraguay

VOLUME III - ENVIRONMENTAL IMPACT ASSESSMENT, MITIGATION MEASURES AND CONCLUSION

Content	10	IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS
	11	INTEGRATED ANALYSIS OF ENVIRONMENTAL IMPACTS (CUMMULATIVE IMPACT ANALYSIS)
	12	CONCLUSION
Annex	I	Record of Public Consultations and Stakeholder Engagements

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CONTENT

10 IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS 6
10.1 Methodological procedures for environmental impact assessment..... 6
10.1.1 Identification of impact-generating activities 7
10.1.2 Methodology for environmental impacts assessment 8
10.1.3 Identification of environmental impacts 13
10.1.4 Environmental Impact Assessment 22
Qualitative Assessment..... 22
Quantitative Assessment..... 156
10.1.5 Evaluation Summary Tables..... 160
10.2 Mitigation, Compensation and Enhancement 208
11 INTEGRATED ANALYSIS OF ENVIRONMENTAL IMPACTS (CUMMULATIVE IMPACT ANALYSIS) 218
12 CONCLUSION..... 222

FIGURE LIST

Figure 1 – Map of accommodation/village areas (CAMP 1, 3, 6, 7, 9 Y 11) 32
Figure 2 – Natural and Modified Habitat at Mill site. 56
Figure 3 – Natural and Modified Habitat at Transmission line easement lane 58
Figure 4 – Example of a 3-dimensional dispersion plume simulation 101
Figure 5 – Risk matrix with hypothesis quantification 129
Figure 6 – Access to PARACEL pulp mill. Source: Google Earth, 2020. 133
Figure 7 – Location for the port 141
Figure 8 – Pulp waterway route 142
Figure 9 – River Port 143

TABLE LIST

Table 1 – Criteria for environment impact assessment 10
Table 2 – Basic procedure for the assessment of potential environmental impacts and their mitigation measures 11
Table 3 – Values for each attribute of impact characterization 12
Table 4 – Environmental components subject to impact 13
Table 5 – Interaction Matrix between the project activities that generate impacts and the environmental components (physical, biotic and socioeconomic aspects). 16
Table 6 – Check list of identified impacts 17
Table 7 – Intervention in protective forests for the implementation of raw water and discharge of treated effluents. 56
Table 8 – Current vegetation cover and PS 6 Type in pulp mill property 57
Table 9 – Future vegetation cover and PS 6 Type in pulp mill property 57
Table 10 – Vegetation cover and PS 6 Type in TL DIA 58
Table 11 – Treatment and/or final disposal of solid waste 92
Table 12 – Main places of noise generation 118
Table 13 – Noise limits established by World Bank Group General EHS Guidelines 120
Table 14 – Major products and UN class/subclass 127
Table 15 – Quantitative analysis of the impact assessment 156
Table 16 – Design Phase Impacts 162
Table 17 – Design Phase Impacts. (*cont.*) 163
Table 18 – Design Phase Impacts. (*cont.*) 164
Table 19 – Construction Phase Impacts. 165
Table 20 – Construction Phase Impacts. (*cont.*) 166
Table 21 – Construction Phase Impacts. (*cont.*) 167
Table 22 – Construction Phase Impacts. (*cont.*) 168
Table 23 – Construction Phase Impacts. (*cont.*) 169
Table 24 – Construction Phase Impacts. (*cont.*) 170
Table 25 – Construction Phase Impacts. (*cont.*) 171
Table 26 – Construction Phase Impacts. (*cont.*) 172
Table 27 – Construction Phase Impacts. (*cont.*) 173
Table 28 – Construction Phase Impacts. (*cont.*) 174
Table 29 – Construction Phase Impacts. (*cont.*) 175
Table 30 – Construction Phase Impacts. (*cont.*) 176
Table 31 – Construction Phase Impacts. (*cont.*) 177
Table 32 – Construction Phase Impacts. (*cont.*) 178
Table 33 – Construction Phase Impacts. (*cont.*) 179
Table 34 – Construction Phase Impacts. (*cont.*) 180
Table 35 – Construction Phase Impacts. (*cont.*) 181
Table 36 – Construction Phase Impacts. (*cont.*) 182
Table 37 – Construction Phase Impacts. (*cont.*) 183
Table 38 – Construction Phase Impacts. (*cont.*) 184
Table 39 – Construction Phase Impacts. (*cont.*) 185
Table 40 – Impacts of the Deactivation Phase. 186

Table 41 – Operation Phase Impacts. 187
Table 42 – Operation Phase Impacts. (*cont.*) 188
Table 43 – Operation Phase Impacts. (*cont.*) 189
Table 44 – Operation Phase Impacts. (*cont.*) 190
Table 45 – Operation Phase Impacts. (*cont.*) 191
Table 46 – Operation Phase Impacts. (*cont.*) 192
Table 47 – Operation Phase Impacts. (*cont.*) 193
Table 48 – Operation Phase Impacts. (*cont.*) 194
Table 49 – Operation Phase Impacts. (*cont.*) 195
Table 50 – Operation Phase Impacts. (*cont.*) 196
Table 51 – Operation Phase Impacts. (*cont.*) 197
Table 52 – Operation Phase Impacts. (*cont.*) 198
Table 53 – Operation Phase Impacts. (*cont.*) 199
Table 54 – Operation Phase Impacts. (*cont.*) 200
Table 55 – Operation Phase Impacts. (*cont.*) 201
Table 56 – Operation Phase Impacts. (*cont.*) 202
Table 57 – Operation Phase Impacts. (*cont.*) 203
Table 58 – Operation Phase Impacts. (*cont.*) 204
Table 59 – Operation Phase Impacts. (*cont.*) 205
Table 60 – Operation Phase Impacts. (*cont.*) 206
Table 61 – Operation Phase Impacts. (*cont.*) 207

10 IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS

10.1 Methodological procedures for environmental impact assessment

This document consists of the Environmental and Social Impact Assessment for the implementation of a PARACEL pulp mill, with a production capacity of 1.5 million tons per year of bleached paper pulp, in Concepción, Department of Concepción, Paraguay.

It should be noted that PARACEL's pulp mill, despite being designed to produce 1,500,000 tons per year, it will be able to produce up to 1,800,000 tons per year of bleached pulp as a result of greater overall efficiency of the plant, as well as higher equipment performance without the need to increase the constructed area or include new additional equipment. In addition, no modifications will be required to the main environmental control equipment, nor will there be any loss in performance, which can guarantee the same liquid effluent and atmospheric emissions considered in this ESIA. Therefore, it can be said that in the event of an increase in pulp production to 1,800,000 tons per year, there will be no changes in the environmental impacts identified and evaluated in this ESIA.

According to Article 1 of Law # 294/93:

> “Environmental impact, for legal purposes, shall be understood as any modification of the environment caused by human works or activities that have as a positive or negative consequence, directly or indirectly, to affect life in general, biodiversity, the quality or a significant quantity of natural or environmental resources and their use, welfare, health, personal safety, habits and customs, cultural heritage, legitimate livelihoods.”

The methods and criteria used for the evaluation of impacts consist of the analysis of the impacts derived from the company's actions in each environmental component (physical, biological and anthropic), being detailed according to the minimum content established in article 3 from Law nº 294/93.

Other than that, this document is in line with what established by the Performance Standards (PS) of the IFC:

- IFC PS 1 on "Evaluation and management of environmental and social risks and impacts";
- IFC PS 2 on “Labor and working conditions”;
- IFC PS 3, on “Resource Efficiency and Pollution Prevention”;
- IFC PS 4 on “Community Health and Safety”;
- IFC PS 5 on “Land Acquisition and Involuntary Resettlement”;
- IFC PS 6 on “Biodiversity Conservation and Sustainable Management of Living Natural resources”;
- IFC PS 7 regarding the Indigenous People;
- IFC PS 8 on Cultural Heritage.

Therefore, the diagnosis of the area of influence provided greater knowledge of the region, allowing a prognosis related to its future development. Having said this, the knowledge of the characteristics of the project and the environmental aspects of its area of influence made it possible to identify and evaluate the possible consequences for the natural or anthropic environment based on an appropriate methodology. For the analysis of these consequences, the structure of the document was based on the following procedures:

- Identification of impact generating activities;
- Methodology for environmental impacts assessment;
- Identification of environmental impacts;
- Environmental impact assessment;
- Evaluation summary tables.

The conclusions obtained in the impact assessment phase allowed us to propose mitigation measures, when negative impacts are involved, as well as ways to maximize impacts, when positive impacts are involved, thus optimizing the benefits generated by PARACEL's company.

10.1.1 Identification of impact-generating activities

In order to identify the activities that generate environmental impact, a survey was carried out of the actions to be carried out in the different stages of the project: design, construction, deactivation of works and operation. At each of these stages, due to the actions taken, there may be changes in the environment, which must be recorded and evaluated.

The main impact generating activities (generating factor) identified for each phase of the company's implementation were

Design phase

- Dissemination of the company;
- Elaborate environmental studies;
- Non-implementation of the project.

Construction phase

- Hiring of labor;
- Hiring of outsourced services;
- Construction of the workshop;
- Construction of accommodation and housing rentals;
- Cleaning of the land;
- Embankment services;
- Vegetation removal;
- Water consumption;
- Generation of sanitary sewage;
- Generation of solid waste;
- Vehicle traffic;

- Vehicle maintenance;
- Acquisition of materials, equipment and services;
- Soil waterproofing;
- Opening of accesses and roads;
- Construction and assembly of buildings and equipment;
- Implementation of water and effluent pipes and river port.

Phase of works deactivation

- Demobilization of the construction site;
- Demobilization of labor.

Operation phase

- Land occupation;
- Hiring of labor;
- Hiring of outsourced services;
- Water consumption;
- Discharge of treated effluents;
- Generation of atmospheric emissions;
- Generation of solid waste;
- Vehicle traffic;
- Transport of chemical products;
- Vehicle maintenance;
- Marketing of the final product;
- Transmission line and substation;
- Port operation

10.1.2 Methodology for environmental impacts assessment

Currently, there are several methodological lines developed for environmental impact assessment: spontaneous methodologies (Ad hoc), checklists, interaction matrices, interaction networks, quantitative methodologies, simulation models, overlay maps, scenario projection, among others.

PÖYRY has a multidisciplinary team with extensive experience and has conducted numerous environmental studies in various segments, and especially in the paper and pulp sector. Thus, over the years, through the accumulation of experience and the increase in the repertoire of technical and scientific works, PÖYRY has developed its own methodology for the identification and evaluation of impacts.

This methodology is based on the development of a checklist (which in turn already includes interaction matrices), in which the factors generating impacts (activities) and the aspects leading to impacts on the environmental components are listed in the various project phases.

The impact assessment methodology was also based on legal provisions such as Law no. 294/93 and therefore presupposes temporal and spatial scales of impacts. In this study, the design, construction, deactivation and operation phases were used as the temporal scales, and for the spatial scales the area directly affected, the area of direct influence and the area of indirect influence were used. The evaluation was consolidated through discussion among the members of the multidisciplinary technical team.

Thus, impacts were evaluated, qualifying them according to their specificities and indicating their spatial magnitude (qualitative measure) and degree of importance depending on how long they remain in the environment. According to these criteria, the main impacts were characterized by the following attributes:

- The **nature**: indicates whether the impact has beneficial/positive (P) or adverse/negative (N) effects;
- The **form of incidence**: indicates if the impact affects the environmental factor direct (D) or indirect (I);
- The **area of spatial coverage**: can be local (L), when the impact is spread in the directly affected area of the company and/or in the area of direct influence; regional (R), when the impact is spread in the municipality of Concepción and/or spreads to the Department of Concepción; or strategic (E), when the impact is interconnected with local and/or regional development strategies;
- The **probability of occurrence**: whether the impact is a certain event (C) to occur, or possible (P);
- The **moment of occurrence**: if the impact occurs after the start of the generating activities in an immediate way (I) / short term – one year (CP); medium term – 2-5 years (MP) and long term – 5+ years (LP);
- The **temporality or duration**: refers to the duration of the impact on the environment, which can be temporary (T), when it occurs in a determined period, permanent (P), when it occurs throughout the life of the company, and cyclical (C), when the effect is manifested in certain intervals of time;
- The **degree of reversibility**: reversible (R), when the affected environmental factor tends to return to the original conditions, or partially reversible (PR) and irreversible (I), when the factor does not return to the original conditions;
- With respect to **accumulation**: when the impact is established as simple (S), accumulation Type I (I), accumulation Type II (II), and accumulation Type III (III);
  - Simple (S): is not characterized by bioaccumulation or biomagnification processes; does not accumulate in time or space; does not induce or enhance any other impact; does not interact in any way with other impact(s); and does not increase in past and present actions (European Commission, 2001);
  - Type I (I) accumulation: accumulation by bioaccumulation;
  - Type II (II) accumulation: accumulation by repetition or overlap, accumulating in time and/or space;
  - Type III (III) accumulation: accumulation by interactivity or synergy.

– The **magnitude**: refers to the degree of impact on the studied element, which can be low (B), medium (M) or high (A), depending on the area of spatial coverage reached;

– In relation to the **possibilities of mitigation**: possible impact to be mitigated (M), partially mitigated (PM) and not mitigated (NM)

– Regarding **importance**: it establishes as small (P), medium (M) or large (G), taking into account the magnitude and possibilities of mitigation of the environmental factors affected by the impact. In order to establish a combined rule for the attributes of magnitude and mitigation for the definition of importance, the following Table was drawn up

Table 1 – Criteria for environment impact assessment

Importance	Criteria
Small	- Low and mitigated magnitude (or low degree of enhancement for positive impacts) - Low and partially mitigated magnitude (or medium degree of enhancement for positive impacts) - Medium magnitude and mitigated (or low degree of enhancement for positive impacts)
Medium	- Low and unmitigated magnitude (or a high degree of enhancement for positive impacts) - Medium and partially mitigated magnitude (or medium degree of enhancement for positive impacts) - High and mitigated magnitude (or low degree of enhancement for positive impacts)
Large	- Medium and unmitigated magnitude (or high degree of enhancement for positive impacts) - High and partially mitigated magnitude (or medium degree of enhancement for positive impacts) - High and unmitigated magnitude (or high degree of enhancement for positive impacts)

* Except when the impact, despite being small or medium and mitigable, is of extreme environmental and/or social importance.
Source: Pöyry, 2018.

Degree of resolution of the measures proposed to reduce or enhance a given impact: low (B), medium (M) or high (A).

In this methodology, the mitigation measures, in the case of negative impacts, or the strengthening of positive impacts are already predicted and related, and their degree of resolution (high, medium or low) is evaluated after implementation.

From the measurement of the impact and the resolution of the proposed measure it was possible to define the degree of importance of the impact, taking into account the environmental situation before the implementation of the company.

In the case of positive (beneficial) impacts, measures must be taken to make the most of the benefits generated; these are the so-called enhancing or compatible measures.

And in the case of impacts that are partially mitigated or not possible to mitigate, compensatory measures are proposed.

Having said that, the qualitative evaluation of each impact was carried out according to the Table below, which explains the attributes that were characterized during the analysis

Table 2 – Basic procedure for the assessment of potential environmental impacts and their mitigation measures

Potential environmental impact
Impacts that can cause changes in the environment.

Environmental aspect
Elements of a company's activities, products or services that can interact with the environment, causing or likely to cause environmental impacts, positive or negative.

Potential impact factor
Any form of matter or energy resulting from human activities that directly or indirectly affect the health, safety, well-being of populations, social, economic activities and infrastructure, and/or biota.

Technical justification
Impact analysis, with the technical-scientific basis for evaluation.

Characterization of the impact	
The characterization of environmental impacts is carried out in accordance with the environmental legislation in force and is indicated according to the following specificities and attributes:	
Nature:	**positive/beneficial or negative/adverse**
Form of incidence:	**direct or indirect**
Area of spatial coverage:	**local, regional, strategic**
Probability of occurrence:	**certain, possible**
Time of occurrence:	**short term, medium term or long term**
Timing or duration:	**temporary, permanent or cyclical**
Degree of reversibility:	**reversible, partially reversible or irreversible**
Accumulation:	**simple, type I accumulation, type II accumulation and type III accumulation**

Magnitude:	**high, medium or low**
Mitigation possibilities:	**mitigated, partially mitigated or unmitigated**
Importance:	**large, medium or small**
Potential for enhancement:	**high, medium or low**
Degree of resolution of measures:	**low, medium or high**

Mitigation or enhancement measures
Actions that will reduce or minimize negative impacts or enhance positive impacts.

Responsibility for the implementation of the measures
Indicates the person responsible for the implementation of the measures.

Forecast after implementation of measures
Impact analysis after the implementation of measures

The quantitative evaluation of the impacts was carried out through analyses of the magnitude associated with the area of spatial coverage, probability of occurrence and duration of the actions and the importance of the impacts on the environmental factors associated with the action, temporality/duration and degree of reversibility of the action. Therefore, the greater the impact, the higher the assessment. The assessment uses 1 to 3 following the methodology of Leopold et. (1971) so that even the least significant impact is considered in the assessment.

The following Table shows the values of each impact characterization attribute:

Table 3 – Values for each attribute of impact characterization

Spatial coverage area		
Local	**Regional**	**Strategic**
1	2	3
Occurrence probability		
Possible		**Certain**
1		2
Occurrence moment		
Short term	**Medium term**	**Long term**
1	2	3
Timing/Length		
Transitory	**Cyclical**	**Permanent**
1	2	3
Reversibility degree		
Reversible		**Irreversible**
1		2
Magnitude		
Small	**medium**	**Large**

1	2	3
	Importance	
Low	**Medium**	**High**
1	2	3

Individually, each impact will have a sum corresponding to the criteria presented above. For positive impacts the values are positive (+), for negative impacts the values are negative (-) and for positive and negative impacts the values are cancelled.

After this individual stage, the results obtained for all impacts are added up, obtaining the total sum of the impact assessment.

The total sum of the quantitative impact assessment is compared with the maximum achievable score (number of impacts x maximum impact score) corresponding to 100%.

The result of the comparison with the maximum score, in %, was assessed according to the following criteria:

- Up to 50%: company is viable;
- Between 50 and 80%: the company is viable with the implementation of new mitigation measures, which have not been contemplated in the evaluation;
- Between 80 and 100%: company is not viable

10.1.3 Identification of environmental impacts

Based on the characterization of the project and based on the environmental diagnosis in the area of influence, the identification of environmental impacts generated in the physical, biotic and socioeconomic environments for the different phases of the project was initiated: design, construction, deactivation of the works and operation.

For the identification of impacts, the environmental components studied in the environmental diagnosis were considered, listed in the following Table.

Table 4 – Environmental components subject to impact

PHYSICAL ENVIRONMENT	Soil
	Water
	Air
BIOTIC ENVIRONMENT	Flora
	Terrestrial Fauna
	Aquatic fauna
SOCIO-ECONOMIC ENVIRONMENT	Urban and rural structure
	Production and economic structure
	Social structure
	Road Infrastructure

	Public finance
	Cultural Heritage

As mentioned, the main mechanism used to identify the impacts was the use of the Interaction Matrix along with the checklist, which contains the list of the main actions associated with the phases of the project that can generate environmental impacts.

The analysis between the impacting actions and their interactions with the environmental components, for the different phases of the project, allowed through the Interaction Matrix the identification of environmental impacts, as described in the methodology.

With the use of this Matrix it was possible to identify 44 environmental impacts on the environmental components (physical, biotic and socioeconomic aspects) in the project's areas of influence, as follows

Design Phase

– A.1 - Generation of expectations in the population;
– A.2 - Generation of direct and indirect temporary jobs;
– A.3 - Hypothesis of non-realization of the project.

Construction Phase

– B.1 - Generation of erosive processes and sedimentation of the river;
– B.2 - Water use conflict;
– B.3 - Change in surface water quality;
– B.4 - Change in air quality;
– B.5 - Disturbances related to noise;
– B.6 - Change in soil and/or water quality due to improper waste disposal;
– B.7 - Impacts generated by the construction of the river port;
– B.8 - Vegetation and land habitat loss;
– B.9 - Higher risk of running over animals
– B.10 - Change in aquatic ecosystems;
– B.11 - Generation of direct and indirect temporary jobs;
– B.12 - Interference on infrastructure;
– B.13 - Higher risk of accidents;
– B.14 - Impact on morphology;
– B.15 - Interference with cultural heritage;
– B.16 - Increasing tax collection and Boosting the local economy;
– B.18 - Worker influx Increase;
– B.19 - Dust generation due suppression of local vegetation;
– B,20 - Risk of harassment to flora and fauna by workers.

Phase of works deactivation

– C.1 – Reduction in the number of jobs.

Operation Phase

- D.1 - Noise-related disturbances;
- D.2 - Change in soil and/or water quality due to improper waste disposal;
- D.3 - Change in soil and/or water quality due to leaks and chemical spills;
- D. 4 - Conflicting use of water;
- D.5 - Change in river quality;
- D.6 - Change in air quality;
- D.7 - Fugitive emissions increase;
- D.8 - Higher risk of running over animals
- D.9 - Change in aquatic ecosystems
- D.11 - Impact to Natural and modified habitat;
- D.12 - Generation of direct and indirect jobs;
- D.13 - Higher risk of accidents;
- D.15 - Increasing tax collection and Boosting the economy;
- D.16 - Road transportation increase;
- D.17 - Impacts from Transmission line and substation;
- D.18 - River transportation increase;
- D.19 - Visual impact;
- D.20 - Port operation;
- D.21 - Increase communication with local Stakeholders;
- D.22 - Injury or death to fauna and flora due to improper waste disposal, and spills;
- D.23 - Noise-related disturbances on fauna.

In the Interaction Matrix, the potential impacts identified are distributed by environmental component (physical, biotic and socioeconomic aspects). The Interaction Matrix and the list of identified impacts, due to project actions, are found in the following tables.

Table 5 – Interaction Matrix between the project activities that generate impacts and the environmental components (physical, biotic and socioeconomic aspects).

INTERACTION MATRIX	COMPONENTES AMBIENTALES														
	Physical Environment				**Biotic environment**				**Socio-economic environment**						
	Soil	Surface water resources	Groundwater resources	Air	Flora terrestrial	Flora aquatic	Fauna terrestrial	Fauna aquatic	Urban and rural structure	Production and economic structure	Social structure	Infrastructure	Quality life	Public finance	Cultural Heritage
ACTIONS GENERATING PROJECT IMPACTS															
Design															
Company diffusion									A.1	A.1, A.2	A.1	A.1	A.1, A.2	A.1	
To elaborate environmental studies										A.2		A.2	A.2	A.2	
Non-implementation of the project									A.3	A.3	A.3	A.3	A.3	A.3	
Construction															
Hiring of man power;									B.12, B.18	B.12, B.16, B.18	B.11	B.12	B.11, B.18	B.16	
Hiring of outsourced services									B.12, B.18	B.12, B.16, B.18	B.11	B.12	B.11, B.18	B.16	
Implantation of the construction site	B.1	B.3		B.4	B.8								B.5		B.15
Accommodation facilities and home rentals									B.14	B.12, B.17	B.14			B.17	
Cleaning the land	B.1				B.8		B.8		B.5						B.15
Embankment services	B.1			B.4	B.8		B.8		B.5						B.15
Water consumption		B.2	B.2							B.2					
Vegetation removal					B.8		B.8, B.9		B.5						
Generation of sanitary wastewater		B.3													
Generation of solid waste	B.6	B.6	B.6												
Vehicle Transit				B.4			B.9		B.5	B.13		B.13	B.5		
Vehicle maintenance				B.4									B.5		
Acquisition of materials, equipment and services										B.11, B.17	B.11		B.11	B.17	
Soil waterproofing									B.14			B.14			
Opening of access and roads				B.4					B.5, B.12, B.14	B.13		B.13, B.14			B.15
Construction and assembly of buildings and equipment									B.5, B.14			B.14			
Implementation of water and effluent pipes and river port	B.1, B.7, B.10	B.10		B.4		B.7, B.8, B.10		B.7, B.10	B.7	B.7	B.7				B.15
Deactivation of works															
Deactivation of work site													B.5		
Workforce Downsizing									C.1	C.1	C.1		C.1		
Operation															
Hiring of labor										D.14		D.12	D.14	D.15	
Hiring of outsourced services;										D.14		D.12	D.14	D.15	
Water consumption		D.4								D.4					
Discharge of treated effluents		D.5				D.9		D.9							
Generation of atmospheric emissions				D.6, D.7											
Generation of solid waste	D.2	D.2	D.2												
Vehicle Transit				D.6			D.8, D.13			D.13			D.16		
Transport of chemicals	D.3	D.3, D.5	D.3				D.8, D.13			D.13			D.16		
Vehicle maintenance	D.3	D.3	D.3												
Marketing of the final product							D.8			D.13			D.16	D.15	
Infrastructure operation	D.10	D.10	D.10	D.10	D.10, D.11		D.10, D.11		D.16, D.19	D.17, D.18		D.16, D.17, D.18, D.20	D.21, D.22	D.21, D.22	D.21, D.22

That said, the impacts identified from the project's actions are listed in the Table below.

Table 6 – Check list of identified impacts

Phases	Component	Activity (Generating factor)	Environmental Aspect	Impact
Design	**Socioeconomic**	Information about the implementation of the company	Generation of Jobs	Generation of expectations in the population
		Studies for the generation of scientific knowledge of the project region	Hiring of services for the preparation of environmental studies	Generation of direct and indirect temporary jobs
		Non-implementation of the project	Stopping or non-execution of the project	Hypothesis of non-realization of the project
Construction	**Physical**	Earthworks and water intake services, emissary	Earth movement and interventions in land areas near the river	Generation of erosion processes and river sedimentation
		Water consumption during the construction phase	Availability of groundwater	Water use conflict
		Construction of the pulp mill	Inadequate generation and disposal of effluents and sanitary wastewater	Change in surface water quality
		Movement of vehicles and machines	Dust generation	Change in air quality
		Movement of vehicles and machines	Noise generation	Disturbances related to noise
		Implementation of the pulp mill	Inappropriate generation and disposal of solid waste	Change in soil and/or surface water and groundwater quality

Phases	Component	Activity (Generating factor)	Environmental Aspect	Impact
Construction	Biotic	Earth moving activities	Suppression of vegetation	Vegetation and land habitat loss
		Dust generation due to earth movements	Removal of vegetation and alteration of associated habitats	Dust generation due suppression of local vegetation
		Implementation of water collection and effluent discharge	Interventions in the riverbed and land areas near the river	Change in aquatic ecosystems
		Movement of vehicles	Increased vehicle traffic	Higher risk of running over animals
		Opening accesses and roads, and workers pass increase	Hunting risk	Risk of harassment to flora and fauna by workers
		Pulp mill construction	Replacement of Habitat with pulp mill and its infrastructure	Impact to Natural and modified habitat
	Socioeconomic	Mobilization of workforce	Hiring of temporary man power	Generation of direct and indirect temporary jobs
		Mobilization of workforce	Pressure on infrastructure due to the increase in the population represented by the workforce in the construction phase	Interference on infrastructure
		Civil works for the construction of the port infrastructure	Impacts due to the port works	Impacts generated by the construction of the river port
		Movement of vehicles	Increase in vehicle traffic	Higher risk of accidents

Phases	Component	Activity (Generating factor)	Environmental Aspect	Impact
Construction	Socioeconomic	Implementation of the mill, which consists of buildings, towers, chimneys, etc.	Change of landscape and land use	Impact on morphology
		Earth moving activities	Possibility of affecting cultural heritage sites	Interference with cultural heritage
		Demand for products and services by the company and the workforce	Growth in the production of goods and services	Increasing tax collection and Boosting the local economy
		Mobilization of workforce	Demand for workforce	Worker influx increase
		Mobilization of workforce	Pressure on infrastructure due to the increase in the population	Impacts to community health and safety
		Mobilization of workforce	Pressure on infrastructure due to the increase in the population	Impacts to vulnerable groups
Works Deactivation	Socioeconomic	Demobilization of temporary man power	Termination of the construction works of the PARACEL pulp mill	Reduction in the number of jobs
Operation	Physical	Operational activities for the manufacture of pulp	Noise generation by the pulp mill	Noise related disturbances
		Pulp mill operation	Inadequate generation and disposal of solid waste	Change in soil and/or surface water and groundwater quality
		Use of chemicals	Improper storage and handling causing chemical leaks or spills	Change in air, soil and/or surface water and groundwater quality

Phases	Component	Activity (Generating factor)	Environmental Aspect	Impact
Operation	Physical	Water consumption	Paraguay River Water Availability	Conflicting water usage
		Pulp mill operation	Launching of liquid effluents generated without or with inadequate treatment	Change in river quality
		Operational activities for the pulp mill	Generation of atmospheric emissions	Change in air quality
		Operational activities for the pulp mill	Generation of atmospheric emissions	Fugitive emissions increase
	Biotic	Movement of vehicles	Increasing vehicle traffic	Higher risk of running over animals
		Operation of the pulp mill	Inappropriate generation and disposal of solid waste and spills	Injury or death to fauna and flora due to improper waste disposal, including spills
		Pulp mill operation	Liquid effluents disposal in Paraguay river	Change in aquatic ecosystems
		Pulp mill operation	Replacement of Habitats with pulp mill	Noise related disturbances on fauna
		Accidental oil leakage or spill	Change in the physical-chemical conditions of soil, water and/or air	Impact of oil spills in river due to river transportation

Phases	Component	Activity (Generating factor)	Environmental Aspect	Impact
Operation	Socioeconomic	Movement of vehicles	- Increasing vehicle traffic - Increasing running over animals	Road transportation increase
		Maneuver, loading and unloading	Risk of accidents	Port operation
		Pulp mill operation	Risk of accidents and electromagnetic field	Impacts from the Transmission line and substation
		Manpower demand for the operation of the pulp mill	Hiring of manpower for operation of the pulp mill	Generation of direct and indirect jobs
		Pulp mill operation	Risk of accidents in the pulp mill	Higher risk of accidents
		Product and service demand	Growth in the production of goods and services	Increasing tax collection and Boosting the economy
		Mill operation, which consists of buildings, towers, chimneys, etc.	Change of landscape and land use	Visual impacts
		Pulp mill operation	- Risk of accidents - Electromagnetic field	Impacts from Transmission line and substation
		Pulp mill operation	- Affected elements from the mill - Communities consultation due to impacts	Increase communication with local Stakeholders

10.1.4 Environmental Impact Assessment

Once the generating activities, the environmental impacts and the methodology of their evaluation had been identified, a qualitative and quantitative evaluation of the environmental impacts was carried out.

Qualitative Assessment

In the qualitative evaluation, the impacts were considered in the different phases of the project: design, construction, deactivation of the works and operation; and mitigation or enhancement measures were proposed according to the degree of alteration that occurred in the physical, biotic and anthropic environments, described in the technical base, as follows.

10.1.4.1 Design Phase

10.1.4.1.1 Socioeconomic Environment

10.1.4.1.1.1 Generation of expectations in the population

Environmental aspect

Generation of expectations of the population in relation to the opening of work fronts resulting from the implementation of the company.

Impact-Generating Factor

Dissemination of information about the company's implementation

Technical justification

As soon as the implementation of the pulp mill is publicized, it is expected that there will be a creation of expectation in the population of the region. Expectations can be positive or negative.

The results of the study of "Social Perception" allowed to have in pre-project stage the opinion/perception of the communities about the socioeconomic characteristics of the area and also about the construction of the industrial plant. This information was obtained from approximately 316 people from DAA and DIA by using various techniques such as a census of families located in the immediate surroundings of the project implementation area, interviews with key institutional and community actors, and as a complement, community focus groups and a participatory workshop were carried out in the city of Concepción, the capital of the department, as well as surveys at strategic points in the districts involved.

In order to understand the above, the people consulted have expressed as the main concern in relation to the problems of the area, both of the ADA and of the DIA, the lack of employment, which in turn leads to the migration/emigration of people (they migrate to the Chaco or other regions of the country and emigrate to Argentina and Spain). This is related to the response that the communities give to what they expect from the venture, where most have responded that they expect "Generation of sources of work", that the project would bring "Progress and development", as well as

"Promoting the development of the department and support the growth of the communities in the area".

Having made that point, the project is a significant source of new jobs for the population, since it will need both direct jobs for the implementation of the company and subcontracted labor.

According to what has happened in similar companies in Brazil, job creation will benefit the local and regional population.

For the population's expectations to remain positive, it is important to carry out presentations of the project through the Dissemination and Communication Program to the main community representatives in order to create a good image and transparency of the company with the population of the municipality from the planning phase.

<u>Characterization of impact</u>

	Qualitative	Quantitative
Nature:	Positive / Negative	+ -
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local, regional and strategic	3
Probability of occurrence:	Possible	1
Moment of occurrence:	Immediate	1
Temporality or duration:	Temporary	1
Reversibility:	Reversible	1
Accumulation:	Simple Accumulation	
Magnitude:	High	3
Importance:	Large	3
Mitigation possibilities:	Mitigated	
Possibilities of enhancement:	High	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Enhancing and mitigating measures

- Disseminate the project, informing the data of jobs that will be generated, as well as the strategy to prioritize the local workforce, in addition to the capacity data, the technology to be used, the environmental control systems, the information on the negative and positive impacts of the company, among others, through meetings with the community and also through other means, in the Dissemination and Communication Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be stated that the dissemination of the project with all interested parties (community, employees, suppliers, government, customers, etc.) and the clarification of doubts that may arise in the sector, will bring confidence and satisfaction to the population regarding the implementation of the project, contributing to the good image and transparency of the company.

10.1.4.1.1.2 Generation of direct and indirect temporary jobs

Environmental aspect

Hiring of services for the preparation of environmental studies.

Impact-Generating Factor

Environmental studies for the generation of technical and scientific knowledge of the project region

Technical justification

The preparation of the Preliminary Environmental Impact Assessment provided a survey of information about the project's area of influence, which resulted in an even greater contribution of knowledge about the region studied - Municipality and Department of Concepción.

In this sense, for the ESIA, campaigns were carried out for noise measurements, analysis of the water quality of the Paraguay River, analysis of air quality, study of information on the biotic environment, and socio-economic data were considered.

For all these works it was necessary to hire labor for the preparation of environmental studies. Several services were supported by the local population, in addition to outsiders moving the hotel chain and restaurants in Concepción and the region.

It is important and fundamental to deal with the social problems that a company of this size can generate, and they are essential for the success of its implementation and regional insertion. In this sense, PARACEL must take the necessary steps to make the region aware of the type and consequences of this project, including ensuring that the population is able to follow the environmental licensing process, in accordance with the law, and have access to the jobs to be generated.

Characterization of impact

	Qualitative	Quantitative
Nature:	Positive	+
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local, regional and strategic	3
Probability of occurrence:	Certain	2
Time of occurrence:	Short term	1
Temporality or length:	Temporary	1
Reversibility:	Reversible	1
Accumulation:	Simple	
Magnitude:	Medium	2
Importance:	High	3
Possibilities of potentiation:	High	
Degree of measurement resolution:	High	
Degree of potentiation:	High	
Area of influence:	DIA and IIA	

Potential measures

Disseminate the project, informing data such as: the company's impacts and future monitoring programs, which may require labor through the Dissemination and Communication Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

The dissemination of the environmental monitoring programs to be implemented at the time of construction and later in the operation phase of the project can be considered to generate new data and jobs, which will contribute to clear expectations of the jobs that will be generated.

10.1.4.1.1.3 Hypothesis of non-realization of the project

Environmental aspect

Stopping or non-execution of the project

Impact-Generating Factor

Non-implementation of the project.

Technical justification

The entire infrastructure needed to implement a pulp mill brings numerous socio-economic benefits to the region. Among these benefits are: direct and indirect job generation, service contracting, tax collection, among others.

With current high unemployment rates, the need for labor to build and assemble PARACEL's pulp mill sector will be a major factor in the generation of direct and indirect jobs. Thus, during the construction period, thousands of employees will work in the construction of the project.

It is worth adding the influence of the work on tax collection, taking into account that priority will be given to the municipality of Concepción, for the acquisition of construction materials and services demanded.

There will be a strong impact on the local economy, boosting the industry and services sector. This process is called the multiplier effect and is based on economic theories to estimate the economic impact of the main initiatives.

There will be a strong addition of hundreds of permanent homes in new hotels and lodges in the region.

The economic development of Concepción will also have an impact on the industrial GDP.

There will be a significant increase in the municipal per capita values of health and education.

Therefore, the implementation of a new pulp mill in Concepción should change the GDP of the municipality, possibly reflecting positively also in the region and the Department.

The suitability of this project with government policies, plans and programs (in the planning and execution phases) shows that the company is in harmony with the government's intentions, favoring growth and promoting growth, in an organized and sustainable way.

The hypothesis of not carrying out the project will have an impact on the economic aspects in the municipality of Concepción since its construction will include a new vector in the economic process of the region.

In addition, the non- installation of the project will create the frustration of the expectation of development that is being created in the municipalities and the region.

Under operating conditions, the PARACEL pulp mill will be self-sufficient in power generation, this factor is important for it to be able to attract other companies to the site due to the greater availability of energy in the region.

As for the environmental impacts on the physical and biotic environment, the non-installation of the project will be reflected in the absence of direct environmental impacts resulting from construction and operation. This can be considered a positive factor in these environments, as they would tend to maintain their current qualities. However, PARACEL will implement the Environmental Management Plan to mitigate all impacts on the physical, biotic and socioeconomic environments.

Impact characterization

	Qualitative	Quantitative
Nature:	Positive/Negative	+ -
Form of incidence:	Direct and Indirect	
Area of spatial coverage:	Local, Regional and Strategic	3
Probability of occurrence:	Possible	1
Moment of occurrence:	Long term	3
Timescale or length of time:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Simple	
Magnitude:	High	3
Importance:	Large	3
Mitigation possibilities:	Mitigated	
Degree of resolution of	High	
Area of influence	DIA and IIA	

Enhancing and mitigating measures

Implement the pulp mill in a sustainable manner, reinforcing the company's commitment to the preservation of natural resources and the reduction of environmental impacts through the Environmental Management Plan.

Responsibility for the implementation of the measures

Forecast after implementation of measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Responsibility for the implementation of the measures

Forecast after implementation of measures

Paracel intends to implement the company in a sustainable manner, committed to the preservation of natural resources and the reduction of environmental impacts, and in accordance with current legislation. The hypothesis of not carrying out the project will have an impact on the economic aspects in the municipality of Concepción and will create frustration in the expectations of the population of the municipality and the region.

10.1.4.2 Construction Phase

10.1.4.2.1 Physical Environment

10.1.4.2.1.1 Generation of erosion processes and river sedimentation

Environmental aspect

Earthworks and interventions in land areas near the river

Impact-Generating Factor

Services of earthwork and works of water intake and emissary.

Technical justification

Earth movement is predicted due to earth-moving services, with a balance between cutting and planned sanitary landfill, in order to minimize the areas needed for disposal and borrowing of material from outside the site.

The removed surface soil can be reused as a substrate for any area receiving landscaping treatment.

The areas of influence of the PARACEL pulp mill have basically two types of soil: sandy and clay.

Sandy soils are suitable for forestry. Normally, this type of soil has little capacity to retain water, although it can improve depending on the concentration of organic matter it possesses. Water erosion has devastating effects on sandy soil.

Clay soils are harder and heavier, dark red in color, and when wet they become extremely slippery precisely because of their ability to retain water. Clay soils are excellent for agricultural production, as they are less favorable to erosion, and clay loam soils - a mixture of sand and clay - are also suitable for agriculture. The most outstanding feature of this type of soil is the layering of sandy sediments and white and granular marl. The igneous rocks come from the depths of the earth and have melted to the surface. The sedimentary rocks were formed from clay thanks to the pressure of the earth's layers.

The equipment to be used during the execution of the embankment and cleaning of the land will correspond to blade tractors, loaders, excavators, trucks, dumpers and trailers, among others.

In addition to earthmoving in the project's industrial area, interventions in land areas near the Paraguay River bed for the construction of the raw water intake and effluent disposal system may increase turbidity and the concentration of suspended material in the river.

The layout of the intake pipeline and the land-based emissary of treated effluents, starting from the industrial site to the Paraguay River, prioritizes passage through existing access points and areas used for activities in the region.

With regard to the work to be carried out on the land side of the water intake and the emissary, the project provides for preventive soil protection measures to prevent the transport of sediments into the Paraguay River.

Earthworks are being planned, preferably in non-rainy periods, to reduce the possibility of erosion processes due to the susceptibility of the soil. Some of the measures to be adopted during construction of the project to prevent impacts include building temporary drainage structures to prevent sedimentation in the water body, structures to contain materials, minimizing the exposure time of areas without plant cover and with friable characteristics, and environmental monitoring and supervision of the works. In addition, rainwater will be conducted superficially, through an adequate modification and drainage of soil, being naturally drained in the area.

Land-use conflicts in Transmission Line path are not expected to occur because there will not be any displacement, the 33 km length of the transmission line will follow the existing roads paths, and there will be appropriate negotiations for the release of the corridor's road rights for the transmission line.

Impact characterization

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Immediate	1
timing or length of time:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	

Area of influence	ADA	

Mitigation measures

- To implement the Erosive Process Control and Monitoring, which aims to:
  - Plan the implementation of earth-moving and land-preparation works preferably outside the rainy season, in order to reduce the possibility of erosion phenomena due to the susceptibility of the land;
  - Minimize the exposure time of uncovered areas in the construction phase;
  - Store the top organic layer of the soil in a suitable place, for later reuse in a landscaping project, in gardening within the pulp mill;
  - Build temporary drains and sedimentation boxes around the embankment service works, to retain the solids, avoiding sedimentation in the water body.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be said that there will be no change in water quality since the execution of earthmoving works and land preparation will be planned preferably outside the rainy periods and minimizing the exposure time of the areas without vegetation cover. In addition, the project includes solids retention cells, as well as drainage channels provided around the earthmoving area in order to retain sediments and avoid sedimentation in the local water bodies.

10.1.4.2.1.2 Water use conflict

Environmental aspect

Groundwater availability.

Impact-Generating Factor

Water consumption during the construction phase.

Technical justification

As reported in Volume I, the water supply for the workshop will be provided by the Paraguay River or, eventually, by an artesian well. That said, the groundwater can be used for water supply for workers and concrete preparation only during the construction phase.

The expected period for the construction of the PARACEL pulp mill is 24 to 30 months. However, the period of time in which the groundwater would be used will be shorter than this, as it would only be used while the Paraguay River water intake works were in progress.

The raw water will be subjected to a conventional treatment consisting of coagulation and flocculation processes using aluminum sulphate, caustic soda and polyelectrolyte, followed by decantation, filtration and chlorination, which will be carried out in a compact station. The filtered water must be chlorinated, followed by storage in a tank, for subsequent distribution to users.

In principle, this system should provide a flow rate of the order of 150 m³/h, which should serve the maximum population of 8,000 workers (peak of the works) and also for the preparation of concrete.

The quality required for the water must comply with the parameters established in Annex III of Law 1,614/2000 - Law of the Regulatory Framework and Tariff of the Drinking Water and Sanitary Sewerage Service.

According to GODOY and PAREDES (1995), practically all of the potential aquifers in the Eastern region of Paraguay have water that is suitable for human consumption, irrigation, and industrial use. In the Western or Chaco region, the chemical quality of the waters of the Yrendá Aquifer System is a limiting factor for domestic, cattle, agricultural, and industrial use. The presence in most of the area of waters with high salt content is due to the fact that, among the sediments that fill the basin, there are evaporite salts (mainly gypsum), which due to their solubility, give rise to brackish or salty waters.

According to the hydrogeological map, the areas of direct influence (DIA) and directly affected (DAA) of the PARACEL pulp mill are located in the Aquidauana - Aquidaban Aquifer System.

According to PMCIC (2015), the Aquidauana-Aquidaban Transboundary Aquifer System is located in the Paraná River Basin, with an area of approximately 27,000 km2, of which 14,600 km2 are in Brazil and 12,300 km2 in Paraguay, extending in a NE-SW direction, and is used for human and animal supply both in Brazil and Paraguay.

The aquifer is of the semi-confined type, made up of glassy-marine sediments with intense variations in facies, presenting flows that are also quite dispersed, with average values oscillating between 10-20 m3/h-well.

From the chemical point of view, it also presents waters with quite variable characteristics. Its use in the short term has become essential for human supply and to allow the economic development of the region, with agricultural and livestock characteristics.

Although the majority of the population of the Department, according to the permanent survey of households, have had access to drinking water service between 2017 and 2018 via SENASA and/or the local Sanitation Board, the homes in the Piquete Cue community (located approximately 0.4 km to 1.5 km from the PARACEL industrial site) do not have a drinking water network and the main source of water for the members of the household is the well; practically no families carry out any treatment, with the exception of one (applies product - bleach - after the rains). The distance from where it is drawn is less than 10 blocks in all cases.

Therefore, if it is necessary to drill wells for water supply, PARACEL will previously send to MADES a schematic design of the place where it is intended to drill, in which possible points of interference will be presented, such as: other wells installed, existence of springs, water courses, possible sources of contamination, etc., all within a radius of 500 m from the point of interest, as well as their relative distances to the future well. It will also send the results of the groundwater quality monitoring, as well as a hydrogeological study before the implementation of the wells.

The well will be circular with a reduced diameter, drilled with specialized equipment, forming a well designed and constructed hydraulic structure, which will allow the economic extraction of water from deep underground layers in the aquifer. The well will be jacketed with pipes in order to prevent unwanted water from entering and not to allow the collapse of the layers of soil that have been crossed, interspersed with filters through which the water can flow.

At the end of the works, the wells will be duly closed to prevent any contamination of the aquifer.

Accommodation

In addition to the use on the construction site, workers coming from outside the region will be duly accommodated in 6 (six) temporary accommodations, in addition to hotels and private properties located mainly in Concepción and Loreto, during the construction phase of the PARACEL mill.

The temporary housing will consist of a fenced area with a guard, surveillance, first aid system, bedrooms, bathrooms, cafeterias, leisure area, internal roads, electricity and drinking water supply, trash collection system, treatment (type of modular station), and disposal of sanitary effluents and firefighting system.

These accommodations will have a total capacity of up to 7,280 workers.

The location of these accommodations is shown in the following Figure.

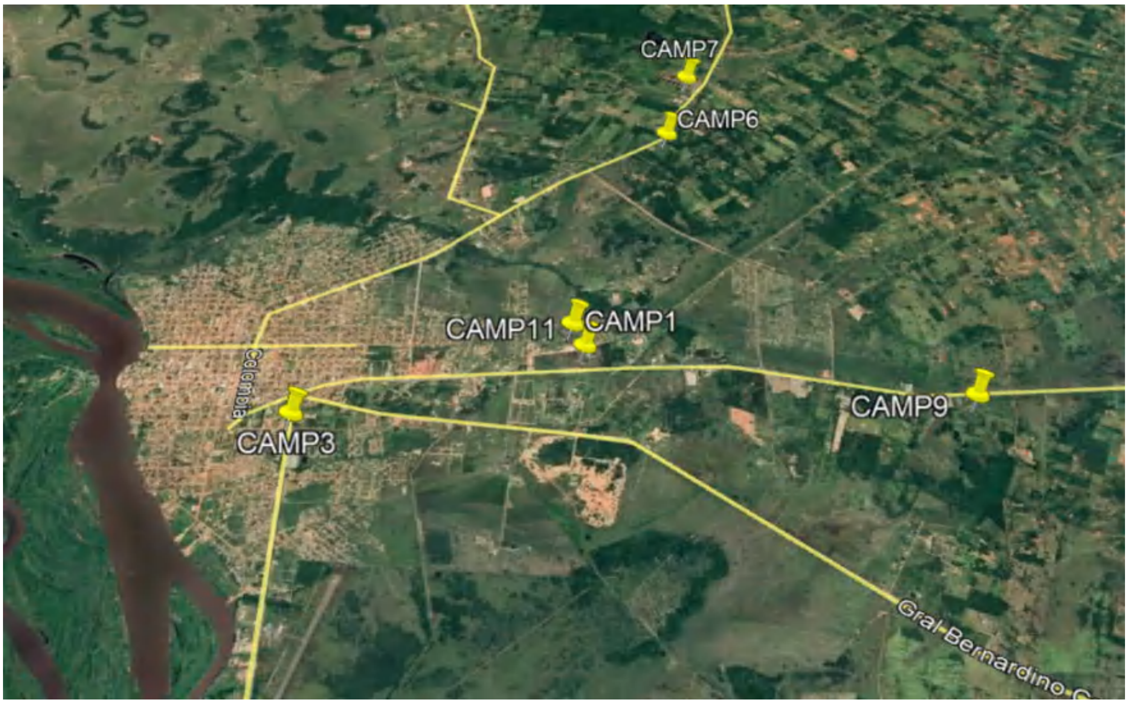


Figure 1 – Map of accommodation/village areas (CAMP 1, 3, 6, 7, 9 Y 11)

The clean water supply in the accommodations will come from the public network but may also come from artesian wells if the network is not available.

In both the Department of Concepción and San Pedro, in 2017, the largest percentage of water in homes came from SENASA or the local Sanitation Board, while in Amambay most homes obtained water from a community network.

Based on the field survey process of 18 micro territories in the project's DIA, most of the interviewees mentioned that all micro territories have a water system from the local Sanitation Board, as already mentioned in the socioeconomic characterization of the Department. Many times, communities are left without water due to permanent power cuts in the area, since without it, pumping cannot be started. To alleviate or prevent these shortages, cases were observed such as those of the USF in Callejón San Antonio, which has its own water reservoir (tank) that is used when there is a shortage; but it is supplied from the same community water source. There are only two residents who have a well. Others, like the communities of San Luis, must move to neighboring communities; or have water tanks; but it is not applicable to all cases.

Given that one CAMPs is located in the city of Concepción, the probability that there is a public water supply is great, so it will probably not be necessary to drill wells.

It should be noted that if it is necessary to drill wells for the accommodations, PARACEL will communicate beforehand with the MADES and the same precautions will be taken as for drilling the wells within the mill site.

Nevertheless, it is not expected that there will be a conflicting use of the groundwater as the information collected shows that there is availability of the aquifer. In addition, if it is necessary to drill wells, PARACEL will communicate in advance with MADES, conduct a hydrogeological study and care will be taken to avoid any contamination of the aquifer, since the drilling until final closure of the wells.

Transmission line

The trace of the electrical transmission line will not significantly affect surface water because they will not interrupt or modify the natural course of the waters through which they will travel.

During construction some drainage alterations and quality change can occur due to the construction of foundations, fillings, etc., and also by the assembly of structures and conductors, but the magnitude of the impact is considered not to be very significant.

Special attention should be paid to the potential impacts on existing wetlands in the three sections of the transmission line trace.

Impact Characterization

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1

Probability of occurrence:	Possible	1
Moment of occurrence:	Immediate	1
Time or duration:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

- Send to MADES a diagram of the place where the well is to be drilled, in which possible points of interference will be presented, such as: other wells installed, existence of springs, water courses, possible sources of contamination, etc., all within a radius of 500 m from the point of interest, as well as their relative distances to the future well;

- Carry out a hydrogeological study before the installation of the wells;

- Carry out Groundwater Quality Monitoring;

- Coat the well with pipes to prevent the entry of unwanted water and not allow the collapse of the soil layers;

- Properly close the wells to avoid any contamination of the aquifer, at the end of the works;

- If it is necessary to drill wells for housing, PARACEL will inform the MADES beforehand and take the same care to avoid any contamination of the aquifer, from drilling to closing the wells.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be affirmed that there will be no change in the quality or availability of the groundwater since the execution of the wells will be done in an environmentally correct way, according to a hydrogeological study before the drilling, and the captured flow will be little and temporary, in addition, at the end of the works the wells will be properly closed to avoid any contamination to the aquifer.

10.1.4.2.1.3 Change in Surface Water Quality

Environmental aspect

Inadequate generation and disposal of sanitary wastewater.

Impact-Generating Factor

Construction works of pulp mill.

Technical justification

At the beginning of the work, the liquid waste from the chemical toilets will be removed by clean trucks, transported and disposed of by accredited companies in authorized landfills. Once the construction site installation is completed, the chemical toilets will be deactivated and returned to the leasing company.

After the construction of the infrastructure, the sanitary wastewater generated during the construction of the PARACEL pulp mill will be collected and treated in a treatment system consisting of a flow meter, an aerated pond and a polishing pond, and then sent to the Paraguay River.

This system is a biological treatment, which works with microorganisms that will degrade the organic matter present in the wastewater (expressed in terms of BOD - Biochemical Oxygen Demand) through an aerobic process.

The choice of this system is due to the fact that this type of treatment has a good performance in terms of BOD removal, in addition to be a robust system, capable of withstanding the variations in load and flow to which the system will be subject (due to variations in the contingent peaks of employees who will work on the site).

The treated wastewater must comply with the emission standards for the parameters established by SEAM Resolution No. 222/2002 (Water Quality Standards for the Entire National Territory).

The flow of wastewater generated during the construction of the project will be approximately 70 m^3/h taking into account the maximum population of 8,000 workers (peak during construction work).

Impact Characterization

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local and Regional	2

	Qualitative	Quantitative
Probability of occurrence:	Possible	1
Time of occurrence:	Immediate	1
Duration or length of time:	Temporary	1
Reversibility:	Reversible	1
Accumulation:	Type II Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence	DIA	

Mitigation measures

- Certify that the company hired to collect the wastewater from the chemical baths is properly regulated, and that the wastewater is disposed of in an environmentally sound manner;
- Implement and operate a sanitary wastewater treatment plant to treat the wastewater generated during the construction phase after the chemical baths have been deactivated;
- Perform Water and Effluent Management Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be stated that there will be no change in the quality of surface waters, since the sanitary wastewater generated during the works will be duly treated and disposed of in an environmentally appropriate manner and in accordance with the legislation in force.

10.1.4.2.1.4 Change in air quality

Environmental aspect

Movement of vehicles and machines for the implementation of the project.

Impact-Generating Factor

Generation of dust due to the movement of machinery and vehicles

Technical justification

It is expected that during the construction of the project, heavy vehicle traffic, such as machinery and trucks, will increase significantly on the access routes to the site, as the work will require a quantity of material, equipment, machinery and various inputs.

Vehicle traffic can generate dust, related to traffic on unpaved roads, which can carry dust depending on the wind conditions in the region. An important point is that the new internal roads and the construction yard will be wetted during the execution of the works.

In addition, trucks transporting soil, rocks and all dusty material must have their cargo covered, preventing the release of particles and dust.

In the air quality assessment, as presented in the environmental assessment, two monitoring campaigns were carried out at three sampling points in the area near the project area.

In these campaigns it was possible to verify that, with regard to the particulate pollutants sampled: total suspended particles - TSP and inhalable particles - IP (PM10), they were presented in accordance with the current legislation on air quality standards. However, the parameter respirable particles - PR (PM2.5) presented concentrations above the standards, possibly due to the material associated with the suspension of particles originating from unpaved roads and the emission of diesel vehicles.

The parameters NO_2 - Nitrogen Dioxide, O_3 - Ozone, CO - Carbon Monoxide and SO_2 - Sulphur Dioxide were also below the limit set by the regulations.

It should be noted that the area surrounding the company's site is dominated by agricultural and livestock activities. The closest presence of population agglomeration is the Piquete Cue community, so near this area dust control will be more rigorous, with more humidification on the access routes to the community, and more frequently. It should be noteworthy to mention that no people or economic displacement will occur.

Impact Characterization

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Moment of occurrence:	Immediate	1
Time or duration:	Temporary	1

Reversibility:	Reversible	1
Accumulation:	Type II Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA, DIA	

Mitigation measures

- Follow the guidelines of the Vehicular Emissions and Dust Control Program, to minimize the generation of dust, such as:
  - Humidify the internal circulation routes and the work yard during the execution of services, when necessary;
  - Cover the trucks transporting earth, rocks and all powdery material with tarpaulins.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be stated that, through the implementation of mitigation measures, air quality will not be changed.

10.1.4.2.1.5 Disturbances related to noise

Environmental aspect

Movement of vehicles and machines for the establishment of the company.

Impact-Generating Factor

Noise generation due to the company's construction work.

Technical justification

It is expected that during the construction of the project, the traffic of light and heavy vehicles, such as machines, trucks and buses on the access roads will increase significantly, as the work will require an amount of material, equipment, machinery, various supplies and transportation of hired personnel.

One impact of the increased vehicle traffic on the roads relates to noise generation.

Regular maintenance of equipment and vehicles plays a key role in noise control and safety, as well as increasing the life span of machinery. The causes of increased noise emissions from machines in use are: wear and tear of gears, bearings, poor lubrication, imbalance of rotating elements, clogging of air pipes, unsharp cutting devices, clogged and damaged silencers, removal of the noise attenuation device, etc. (BISTAFA, 2011).

Therefore, PARACEL will require the maintenance of machinery engines, trucks and vehicles.

Noise is an important factor to be observed for the integration of the company with the neighboring communities.

Noise, both day and night, must be in accordance with Law 1,100/1997.

By prioritizing activities with heavy vehicles and crushers during the day, potential disturbances will be reduced.

It should be noted that the area surrounding the company's site is dominated by agricultural and farming activities. The closest population center is the Piquete Cue community, so priority should be given to daytime activities near this area.

Impact Characterization

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Moment of occurrence:	Immediate	1
Timing or duration:	Temporary	1
Reversibility:	Reversible	1
Accumulation:	Type II Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	

Area of influence:	ADA, DIA	

Mitigation measures

- Follow the guidelines of the Noise Monitoring Program, such as:

  – Carry out maintenance on machine, truck and vehicle engines;

  – Carry out activities in the area predominantly in the daytime period;

  – Carry out noise monitoring during the construction phase.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be said that, through the implementation of mitigation measures, there will be no noise disturbance.

10.1.4.2.1.6 Changes in Soil and/or Surface Water and Groundwater Quality

Environmental aspect

Inappropriate generation and disposal of solid waste.

Impact-Generating Factor

The pulp mill's construction work.

Technical justification

In the construction phase of the project, several types of solid waste will be generated such as: construction debris (block, concrete, brick, wood), scrap metal, paper/cardboard, plastics, rubber/tires, glass, fluorescent lamps, batteries, health services waste, maintenance equipment waste (lubricating oil) and organic waste (leftover food).

In earthmoving activities, earthmoving of approximately 8,000,000 m^3 is forecast, with a balance between cutting and the planned sanitary landfill, in order to minimize the areas needed for disposal and the borrowing of material from sites outside the company. It should be noted that, if necessary, delivery areas will be defined and licensed prior to project implementation, as most areas are owned by third parties.

Solid waste generated in the construction phase will have an environmentally appropriate final destination, i.e. it will be destined for reuse, recycling, incineration, co-processing, etc. There will be a system of selective collection that aims to pre-separate materials with similar characteristics at the source.

Adequate control of solid waste will be carried out through collection, packaging, transport and disposal in accordance with the nature of the waste, which will minimize possible environmental impacts. In addition, the process of reusing the material through selective collection can significantly reduce this impact.

In the construction phase, there will be a Temporary Solid Waste Storage Centre that will be managed by a company specialized in this service. This company will be responsible for receiving, temporarily storing and allocating all the solid waste generated in this phase.

All contractors for the construction of the different parts of the process, as well as all other companies contracted to perform any other service during the construction phase, will be responsible for the collection, segregation, storage and disposal of their solid waste in the Temporary Solid Waste Storage Center.

The solid waste generated in the common areas and in the accommodation will also be collected, segregated, conditioned and transported to the temporary storage plant. The collection of this waste will be carried out by a company specialized in this service.

Lack of control and inadequate solid waste disposal can compromise the environmental quality of the area.

The debris generated will be disposed of in a specific landfill for the final disposal of this debris. Therefore, a Debris Landfill will be implemented in the project area for the disposal of solid construction waste, with a capacity of 75,000 m^3. Lower drains will be built to collect rainwater, which will be installed in the longitudinal axis of the landfill, in order to prevent the dragging of solids. A filter will be installed in the last drainage pipe, before it is sent to the receiving water body. The slopes will have the ratio 1:2 (V:H) and will be properly compacted. The outer sides of the slopes will have grass, in order to avoid erosion. There will be ramps to provide access to the interior for landfill trucks.

The organic solid waste generated in the construction phase will basically come from the kitchen and cafeteria (food processing waste, leftover food, napkins and similar) and toilets. During the pulp mill's construction phase (24 months to 30 months), 6,800 m^3 of organic waste is expected to be generated. The construction of a sanitary landfill (organic) in the mill area is planned, which will have a useful life to comply with the construction phase of the implementation and the first two years of operation of the PARACEL mill. The capacity of this landfill will be 20,000 m^3.

The construction of the Debris and Sanitary Landfill (organic) will be carried out in an environmentally appropriate manner that minimizes possible impacts on the quality of soil and/or surface and ground water due to the disposal of solid waste generated in the construction phase of the project.

<u>Characterization of the impact</u>

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	

Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Possible	1
Time of occurrence:	Medium term	2
Timing or duration:	Temporary	1
Reversibility:	Reversible	1
Accumulation:	Type III Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA, DIA	

Mitigation measures

- Follow the guidelines of the Waste Management and Monitoring Program, among which:
  - Manage the solid waste generated in the construction of the PARACEL pulp mill with the best practices, in accordance with Law # 3,956/2009 and Decree # 7,391/ 2017 (Integral Management of Solid Waste in the Republic of Paraguay), among which are:
    - Minimize waste generation through the 3R principle (Reduce, Reuse, Recycle);
    - Segregation of solid waste according to color standard;
    - Collection, packaging, storage and transport of solid waste in accordance with current legislation;
  - Environmentally appropriate final destination (reuse, recycling, composting, energy use, etc.) and/or environmentally appropriate final disposal of solid waste generated in the company:
    - Arrange the materials (excavation soil), if necessary, in duly authorized external areas.
    - Implement a Temporary Solid Waste Storage Center that will be managed by a company specialized in this service.
    - Implement a Debris Landfill and a Sanitary Landfill (organic).

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

After the implementation of the measures, it can be said that there will be no changes in the quality of soil and/or water due to the generation and disposal of waste, without compromising the environmental quality of the area.

10.1.4.2.2 Biotic Environment

Terrestrial Habitat

10.1.4.2.2.1 Vegetation and land habitat loss

Environmental aspect

Removal of vegetation and alteration of associated habitats in the project area, including riverine habitat.

Impact-Generating Factor

Earth movements and works in the site and for water intake and effluent discharge pipelines, routes and transmission line construction.

Technical justification

In the earthmoving activities there will be suppression of vegetation in the project area. The suppression will occur in the area where the mill will be located, as well as, in the areas of the routes where the access, port, transmission line, the water intake and the effluents disposal pipelines will be built. The layout of the water intake pipes and the treated effluent emissary from the industrial park to the Paraguay River will give priority to passing through areas that have already been used by man.

Therefore, there will be loss of vegetation and associated terrestrial habitat, and it can drive away wildlife. However, it is known that, as occurred in similar companies in Brazil, the fauna tends to move away in the construction phase and return in the operation phase, not interfering significantly with the local fauna.

It should be noted that the company's areas of influence are already highly anthropized and with low connectivity between the remains of vegetation, intensive use for cattle farming is another of the main pressure factors in these environments.

Regarding vegetation coverage, it is partly affected by anthropogenic occupations and economic activities already well established in the region.

The implementation of the project will interfere in approximately 150 ha of savannah remains. Specifically, for the implementation of the raw water intake and the treated effluent terrestrial emissary, it will also be necessary to intervene in the Protector Forest of water channels of the Paraguay River, i.e., there will be the removal of approximately 0.31 ha of remaining savanna vegetation and the removal of approximately 3.99 ha of remaining vegetation of the Semideciduous Forest.

Taking into account the results obtained in the biotic environment diagnosis, it is concluded that the implantation of the industrial plant and the associated structures will have a local impact on the vegetation, however, there will be no impact on the connectivity of the remains of vegetation in the environment; the fragments and isolated tree specimens affected are within the Zapatero Cue.

Therefore, the project foresees the suppression and/or interference in the remaining fragments of vegetation that present the physiognomy of Savannah and Semideciduous Forest located within the DAA and the intervention in Protective Forests of water channels of the Paraguay River, in which the riparian vegetation plays an environmental role, protecting the riverbanks and other water bodies. It should be noted that, despite records of the effects of human activities on the remains of existing native vegetation, those that remain still support the maintenance of native fauna and flora species. Therefore, any removal must be duly authorized and will be compensated in accordance with current environmental legislation.

In order to mitigate this impact, Paracel has committed to compensate the suppression of riverine habitat by increasing the native area in relation to the current situation, specially enlarging the riparian areas, with approximately 250 ha, by converting Grassland/Pasture lands to native forest.

Transmission Line

The elimination of grasslands and tree vegetation can result in a decrease of food source, amide and rest areas for the fauna due to the fragmentation of their habitats and the modification of ecosystems suitable for the settlement of faunistic populations.

The elimination of plant cover, whether trees or grasslands, also involves the alteration of ecosystems suitable for the settlement of faunal populations, increased hunting pressure on threatened species, endangered species and/or species for commercial purposes and increases run-in of individuals of fauna by increasing vehicular traffic.

The barrier effect caused by the cutting of wildlife habitat to allow the placement and installations of electrical structures can have an initial disturbing effect on terrestrial and air species, although subsequently the species will be used to the facilities.

As had been described in the characterization of the three sections of the trace of the Electric Transmission Line, most of it will develop on soils of natural meadows and agriculture, usually subsistence and few places with species of tree vegetation, except for Section II trace where tree vegetation could be more relevant, in the still-selected trace of selection , which would produce some vegetation changes over the right of way to meet the technical requirements demanded by the electrical transmission line system.

If the affectation of plant cover is severe, the energy base of the affected ecosystem may be altered, which decreases the quality and supply of the flora resource. Likewise, in case of gallery forests, alteration and decrease of the protection of the associated body of water can be generated. These manifestations have a global impact on the quality of the landscape and ecosystems.

The loss of natural pastures will be minimal caused, mainly, by the excavation of the soil for the installation of the infrastructures and it is estimated that the magnitude of its impacts will be very low.

In tree felling, which could occur especially in Section II trace, it is not identified that endangered forest species will be affected according to vegetation studies carried out in the region.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Certain	2
Time of occurrence:	Short term	1
Timing or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Simple Accumulation	
Magnitude:	Medium	2
Importance:	Medium	2
Mitigation possibilities:	Partially Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

- - Follow the guidelines of the Environmental Management Program for Construction - CAP, regarding the criteria and operational controls that will be carried out in the suppression of vegetation, which are:
  - Picking to mark the area to be removed;
  - Use a team experienced in this suppression activity;
  - Properly dispose of organic waste and vegetation from the abatement activity;
  - Store the top organic layer of the soil in an appropriate place for later reuse in the landscape design of the industrial area;

- Promote, as compensation, the replanting with native species of areas within the property today impacted by livestock activity, in an area equal to or greater than that occupied by the vegetation to be suppressed;
- Implement the Biodiversity Monitoring Program on the Industrial Site;
- Carry out the supervision and environmental control of the suppression;
- Prohibit the use of fire for vegetation suppression.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be stated that by adopting mitigation measures, vegetation removal will be minimum, and any removal of natural vegetation will be adequately compensated with native trees, especially with the vegetation of the region, not interfering significantly with the local biota, since the area already suffers from a high degree of human intervention.

10.1.4.2.2.2 Dust generation due suppression of local vegetation

Environmental aspect

Removal of vegetation and alteration of associated habitats in the project area, including riverine habitat.

Impact-Generating Factor

Dust generation due to earth movements and works in the site and for water intake and effluent discharge pipelines, routes and transmission line construction.

Technical justification

An important factor in terms of machine movement is the increase in noise and dust at this time, and may impact the nearby population as the local fauna, driving it away.

As described in the characterization of the enterprise, the construction of pulp mill requires prior cleaning of the areas. Depending on the type and quality of vegetation, habitat loss for specialized or generalist fauna will occur, imposing its displacement to less disturbed areas.

In the phase of implementation and operation of the mill, there may be increased noise and dust from the movement of people, trucks and equipment, which can enhance the level of disturbance to the local fauna.

Thus, it is recommended to humidify the internal circulation routes and the work yard during the execution of services, when necessary and cover the trucks transporting soil, rocks and all powdery material with tarpaulins. Other than that, for suppression hire biodiversity specialists to rescue small animals in order to avoid or minimize the loss of populations occurrence such as arthropods and other animals with limited mobility in the area and regenerate degraded areas and implement corridors in order to favor the displacement of fauna species.

Impact Characterization

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Moment of occurrence:	Short term	1
Time or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Medium	2
Importance:	Medium	2
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DAA, DIA	

Mitigation measures

Humidify the internal circulation routes and the work yard during the execution of services, when necessary;

Cover the trucks transporting earth, rocks and all powdery material with tarpaulins;

Perform small animals rescue, before suppression, in order to avoid or minimize the loss of populations occurrence such as arthropods and other animals with limited mobility; and

Regenerate degraded areas and implement corridors in order to favor the displacement of fauna species.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

The actions adopted by PARACEL preserve the areas of native vegetation, riparian permanent persevered areas and legal reserve of its own lands, in addition to the legal requirement, minimizes the impact.

10.1.4.2.2.3 Higher risk of running over animals

Environmental aspect

Increasing vehicle traffic.

Impact-Generating Factor

Vehicle movements.

Technical justification

During the construction phase there will be a considerable increase in vehicle traffic, especially trucks and trailers on the main access roads to the company's area, which will increase the risk of animals being run over.

According to observations of the existing roads in ADA/DIA, the national routes and branches (such as those connecting Concepción to Belén and Loreto) are paved, have widths of up to 10 meters and two lanes of traffic; other secondary roads are dirt roads (in some cases corrugated) and widths that allow two lanes of traffic; these will be the roads shared by the Project with other users in ADA/DIA.

The determination of the access route to the area under study took the consideration that no people or economic displacement will occur.

Main access is through the area of the town of San Ramón (south-east), passing through the Pyrendá farm, or the San Miguel farm. The access road extends to a certain extent within the private property, so if this alternative is chosen, roads must be opened and the existing one adapted, with the advantage that these roads would not be used by other users except for the owners.

It can be affirmed that accesses are well anthropized, however, in order to avoid accidents, even with local fauna, PARACEL must implement the Road Safety Program so that its own employees and third parties receive information on defensive driving, traffic legislation and local laws.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and Indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Possible	1

Time of occurrence:	Immediate	1
Timing or duration:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Simple Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA	

Mitigation measures

- Inform and make drivers aware of defensive driving, traffic legislation and local legislation through the Road Safety Program, in order to minimize the risk of accidents, including those involving wildlife.
- Provide speed limit signs.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

There will be no risk of animals being run over due to the movement of vehicles for the construction of the company, as the company's own employees and third parties will receive training on preventive defensive driving, traffic legislation and local legislation through the Road Safety Program.

10.1.4.2.2.4 Risk of harassment to flora and fauna by workers

Environmental aspect

Hunting risk.

Impact-Generating Factor

Opening accesses and roads and workers pass increase.

Technical justification

Due to increased access to the roads openings in the region, to the areas, before preserved, by third parties and surrounding population, can induce the activities of hunting and capturing animals in this region.

The presence of people in the area may result in possible pressure to hunt and capture wild animals, both for the consumption and illegal trade of these animals.

Besides, environmental education work to make population aware of this fact, PARACEL should avoid fragmentation by roads in the cerrado areas because, in addition to facilitate the displacement and entry of hunters, it also increases the risk of animals run over, as well as may influence some small species that considers this road a barrier to displacement. In order to avoid animals hunting PARACEL should consider to carry out inspection on their native and regenerated areas mainly on weekends and holidays.

Impact Characterization

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and Indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Possible	1
Moment of occurrence:	Medium term	2
Time or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Medium	2
Importance:	Medium	2
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DAA, DIA	

Mitigation measures

Intensify surveillance activities in partnership with local authorities and neighbors to avoid animals hunt.

Perform environmental education program to give conscious to fauna and flora preservation.

Prohibit fire arms and hunting by workers, add signs prohibiting hunting, ensure workers sign code of conduct.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be stated that the risk on local fauna will be minimized by the implementation of the proposed mitigation measures.

Aquatic Habitat

10.1.4.2.2.5 Change in aquatic ecosystems

Environmental aspect

Interventions in the riverbed and land areas near the river

Impact-Generating Factor

Water intake and effluent emissary works.

Technical justification

Interventions in the riverbed for the construction of the intake and discharge can increase turbidity and concentration of suspended material in the Paraguay River, thereby disturbing habitats there, and can affect local aquatic communities during the period of construction of the intake and discharge structures.

In relation to the works to be carried out on the land side, the implementation project envisages preventive measures to protect the land to prevent the transport of sediments to the Paraguay River. The implementation of earth movements is being planned preferably in non-rainy periods in order to reduce the possibility of solids being carried away due to the susceptibility of the soil.

The construction of temporary structures for physical storage, minimizing the exposure time of areas without vegetation cover, and environmental monitoring of the works are some of the measures to be adopted during the project's implementation, especially in the areas of land near the river.

River Port

The construction of the river port may increase turbidity and concentration of suspended material in the Paraguay River, thereby disturbing habitats there, and may affect local aquatic communities during the period of construction of the river port structures.

Therefore, one measure aimed at reducing interference in the riverbed is the implementation of the river port pier with the fewer number of pillars possible.

Transmission Line

Aquatic fauna, along the trace of the transmission line, has not been identified as it is affected by not being modified as its direct habitats are not modified.

The impacts, estimated as not very relevant, will be associated with the assembly of the structures, the laying of conductors and cables, and during the operation and maintenance and cleaning of the bondage strip.

<u>Characterization of the impact</u>

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Immediate	1
Duration or length of time:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Type I	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA	

<u>Mitigation measures</u>

- Plan the execution of earthmoving works and land preparation preferably outside of the rainy periods;
- Build a temporary structure for the containment of sediments;
- Supervise the works during the project period;
- Implementation of the quay in the river port with the least number of pillars possible;

- Monitoring the quality of surface water in the construction phase.

Responsibility for the implementation of the measures

PARACEL.

Forecast after implementation of measures

Se it can be assumed that, through the implementation of mitigation measures, the water quality of the Paraguay River will not change significantly in relation to turbidity and suspended solids, therefore, that aquatic communities are not expected to be affected. In addition, it should be noted that this activity is temporary.

10.1.4.2.2.6 Spread of invasive species within transmission line Right of Way

Environmental aspect

Replacement of Habitat.

Impact-Generating Factor

Transmission Line construction.

Technical justification

The Transmission Line has the potential to impact sensitive ecosystems such as wetlands, impact high quality fishery resources when waterways are crossed, and create pathways for the spread of invasive species.

It should be noted that the Right of Way area total approximately 23,1 ha. About 84,3% of this area is already modified, specially by roads and 15,3% is natural forest and 0,4% is watercourse.

From the 23 km, the transmission line will pass through only one watercourse, according to the figure bellow:

There should be noted that there is already a road in this area, so it is no expected that the transmission line will interfere within this area.

<u>Characterization of the impact</u>

	Qualitative	Quantitative
Nature:	Negative/Positive	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Accumulation Type II and III	
Magnitude:	Medium	2

	Qualitative	Quantitative
Importance:	Medium	2
Possibilities of potentiation:	Medium	
Degree of potentiation:	Medium	
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Mitigation measures/enhancement

Minimize impacts on land use and landscape by tracing the transmission lines on the path of existing roads.

Responsibility for the implementation of the measures

PARACEL.

Forecast after implementation of measures

The Transmission line will not cause any significant impact to the physical and to the biotic environments, neither to the communities because they will be placed on anthropized areas along existing road rights sides.

10.1.4.2.2.7 Impact to Natural and modified habitat

Environmental aspect

Replacement of Habitat with pulp mill and its infrastructure.

Impact-Generating Factor

Pulp mill construction.

Technical justification

The figure below shows the satellite image of the mill site property, identifying modified and natural existing areas. These area total approximately 1,206 ha. About 83% of the area is modified and 17% is natural forest and watercourse.

Figure 2 – Natural and Modified Habitat at Mill site.

The implementation of the pulp mill will require the suppression of approximately 3.99 ha of remaining vegetation of the Semideciduous Forest and 0.31 ha of remaining vegetation of the Savannah (African grass) at riparian area for the implantation of the water intake system, the terrestrial emissary of treated effluents and the river port(presented on table below).

Table 7 – Intervention in protective forests for the implementation of raw water and discharge of treated effluents.

Structure	Area (ha) of intervention	Vegetation
Water intake system	0,62	Semideciduous Forest
	0,31	Savannah
Emissary of treated effluents	0,87	Semideciduous Forest
River port	2,50	Semideciduous Forest

Knowing that DAA has 150 ha, so the suppression will correspond only to 2,8% of the existing native forest. Paracel has committed to compensate the suppression by increasing the native area in relation to the current situation, specially enlarging the riparian areas, with approximately 250 ha, so that the net increase will represent approximately 400 ha. The implementation of the project will determine a native forest coverage in 30% of the mill site, compared to the 12% that it currently occupies. This compensation measure thus determines an increase in the native area of approximately 150% in relation to the current situation.

As summary the following table shows the percentage of the current vegetation cover at Paracel pulp mill property.

Table 8 – Current vegetation cover and PS 6 Type in pulp mill property

<table>
<tr><th>Class ID</th><th>Class type</th><th>Area (ha)</th><th>Percentage</th><th>Nat/ Mod</th><th>Area (ha)</th><th>Percentage</th></tr>
<tr><td>1</td><td>Native forest</td><td>192.96</td><td>16%</td><td rowspan="2">Natural</td><td rowspan="2">205.02</td><td rowspan="2">17%</td></tr>
<tr><td>2</td><td>Floodable/ Waterland</td><td>12.06</td><td>1%</td></tr>
<tr><td>3</td><td>Grassland/Pasture/Roads</td><td>1,000.98</td><td>83%</td><td>Modified</td><td>1,000.98</td><td>83%</td></tr>
<tr><td colspan="2">Total</td><td>1,206</td><td>100%</td><td></td><td>1,206</td><td></td></tr>
</table>

Most of the area in which the pulp mill will be built is considered savanna, although it is considered modified habitat because it was used for cattle gaze.

But Paracel has committed to compensate the suppression of 4.3 ha (converted natural to modified area) by increasing the native area in relation to the current situation, specially enlarging the riparian areas, with approximately 250 ha, by converting Grassland/Pasture lands to native forest. So the vegetation cover in the future will be as follows:

Table 9 – Future vegetation cover and PS 6 Type in pulp mill property

<table>
<tr><th>Class ID</th><th>Class type</th><th>Area (ha)</th><th>Percentage</th><th>Nat/ Mod</th><th>Area (ha)</th><th>Percentage</th></tr>
<tr><td>1</td><td>Native forest</td><td>438.66</td><td>36.4%</td><td rowspan="2">Natural</td><td rowspan="2">450.72</td><td rowspan="2">37.4%</td></tr>
<tr><td>2</td><td>Floodable/ Waterland</td><td>12.06</td><td>1%</td></tr>
<tr><td>3</td><td>Grassland/Pasture/Roads</td><td>755.28</td><td>62,6%</td><td>Modified</td><td>755.28</td><td>62,6%</td></tr>
<tr><td colspan="2">Total</td><td>1,206</td><td>100%</td><td></td><td>1,206</td><td></td></tr>
</table>

Transmission Line

Likewise the figure below shows the image of the transmission line easement lane, identifying modified and natural existing areas. These area total approximately 23,1 ha. About 84,3% of the area is modified and 15,3% is natural forest and 0,4% is watercourse.

Figure 3 – Natural and Modified Habitat at Transmission line easement lane

Vegetation cover and PS 6 Type in Transmission Line DIA is divided in 3 classes type: native forest, Floodable/Waterland area, Grassland/Pasture/Roads area. The percentage of vegetation cover in DIA is presented at the table and figure below:

Table 10 – Vegetation cover and PS 6 Type in TL DIA

Class ID	Class type	Area (ha)	Percentage	Nat/ Mod	Area (ha)	Percentage
1	Native forest	3,53	15.3%	Natural	3,63	15.7%
2	Floodable/ Waterland	0,10	0.40%			
3	Grassland/Pasture/Roads	19,47	84.3%	Modified	19,47	84.3%
Total		**23,10**	**100%**		**23,10**	

The vegetation cover within transmission line DIA is not expected to change significantly.

In order to mitigate this impact, PARACEL must Implement the Restoration, Compensation and Management Program of Biodiversity in the Industrial Site, including revegetation, reforestation and restoration of natural habitat.

Workers Accommodation Sites

The camps will be built in areas that have already been modified, 2 of them are located in the municipality of Concepcion.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative/Positive	+ -
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local	1
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Accumulation Type II and III	
Magnitude:	Medium	2
Importance:	Medium	2
Possibilities of potentiation:	Medium	
Degree of potentiation:	Medium	
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Mitigation measures/enhancement

Implementation of the Restoration, Compensation and Management Program of Biodiversity in the Industrial Site, including revegetation, reforestation and restoration of natural habitat.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

The industrial plant and associated civil structures of the PARACEL pulp mill will have a local impact on the vegetation, however, there will be no impact on the connectivity of the remaining environment because it is located in a strongly anthropized area, used for cattle rising and as a compensation measure there will be an increase in the native area of approximately 150% in relation to the current situation.

10.1.4.2.3 Socioeconomic Environment

10.1.4.2.3.1 Generation of direct and indirect temporary jobs

Environmental aspect

Hiring of temporary workforce.

Impact-Generating Factor

Mobilization of work.

Technical justification

Employment opportunities will be generated from the construction of the Industrial Plant and related services. The types of employment will be qualified and unqualified labor, professionals, specialists, etc. who will carry out the construction of civil works and roads, the assembly of equipment and machinery, as well as those related to the logistics of materials, inputs, machinery, equipment, human resources, waste, etc.

It is estimated that the Project will directly employ some 8,000 people at the peak of the construction phase, of which 10% will be professionals, 30% technicians and 60% suitable. Among these direct jobs are considered people hired directly by PARACEL and people from contractors and subcontractors hired for construction and assembly. The Project must comply with the principles of IFC Performance Standard 2, clearly defining the employment relationships, depending on whether the employees are direct workers, contract workers, or supply chain workers, depending on the case.

According to the socio-economic data, people in the department of Concepción will be able to cover the demand for unskilled employment, as there is a wide availability of people who could be suitable. In the department of Concepción, a large part of the population is young, 72 per cent of whom are under 35 years of age, with an average of 7.61 years of education. The project could also help to increase the employment of women, since 53 per cent of the population of the department is made up of women. It is also noted that most of the department's population, some 182,000 people, are concentrated in the four districts that make up the Project's DIA and have a young population following the trend in the department. For its part, the population of working age (WAP) is 186,627 people of which 58.33% are economically active. With these data, it is estimated that a large part of the unskilled labor that will be employed by the Project could be local, from the same department of Concepción.

The department of Concepción could also provide a certain amount of qualified labor, as the Social Baseline showed that different types of technical courses are offered in the department with a rapid return to work, especially in the urban areas of the department, and that there are several public and private training centers.

The departments of Amambay and San Pedro, considered within the Project's IIA, will also be able to provide labor, mainly unskilled, for the Project. In both departments, most of the population is young, under 35 years of age (68% Amambay, 70% San

Pedro), with averages of 8.48 and 7.21 years of study. Women make up approximately half of the population of the two departments.

The generation of jobs at the local level will contribute to the reduction of unemployment, which is 6.66% (about 7,247 people) in the department of Concepción, higher than the national average rate, and of income poverty and structural poverty, which in the department of Concepción are high, over 40% in terms of income poverty and over 50% in terms of at least one (1) Unsatisfied Basic Need (UBN), above the national average. In addition, the creation of a source of employment, albeit temporary, could help reduce the levels of migration observed in the department of Concepción, which would be motivated by work, study and, more recently, lack of security.

In addition, the labor required for the construction and assembly of the project will preferably be recruited in the region of Concepción through the Program for the Development for Hiring of Local Workforce.

Transmission line

The construction of the transmission line will also generate new local jobs that will be temporary of a positive and direct relationship nature, in addition to the pulp mill and the Substation that is intended to be installed. Some qualified labor will be needed that can be covered with workers in the project's area of influence, which although of a small magnitude, will nevertheless result in a temporary increase in the economic income levels of workers' families and thus the possibility of improving their standards of quality of life. The negative impact of the economic damage affected by the right of servitude should be adequately mitigated through negotiations for fair economic compensation to the owners of affected land.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Positive	+
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local, regional and strategic	3
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or duration:	Temporary	1
Reversibility:	Reversible	1
Accumulation:	Type III Accumulation	
Magnitude:	High	3

Importance:	Large	3
Possibilities of potentiation:	High	
Degree of resolution of measurements:	High	
Degree of potentiation	High	
Area of influence:	DIA and IIA	

Enhancement measures

- Promote an information dissemination campaign for the hiring workforce for the construction phase through the Dissemination and Communication Program, giving priority to the hiring of local people through the Local Labor Development and Linkage Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be stated that PARACEL will generate jobs for the construction of the project and this impact can be enhanced by the insertion of other companies that provide services in the region, mitigating the effects of displacement migration and generating direct and indirect jobs in the region of Concepción.

10.1.4.2.3.2 Interference on infrastructure

Environmental aspect

Pressure on local infrastructure due to the increase in the population represented by the workforce in the construction phase.

Impact-Generating Factor

Mobilization of work.

Technical justification

The increase of the population, represented by the labor force of the construction phase and people possibly attracted by the possibility of professional insertion in the activity, tends to increase the demand for public equipment such as: education, health, sanitation, transportation, etc., as well as tends to seek social interaction in the city of Concepción and the region. For the purposes of the study, we consider the increase of people in the region corresponding to approximately 8,000 workers in the phase of greater intensity of this activity.

With respect to education, it is expected that some workers in the construction phase will migrate with their families. Those who migrate with children tend to increase the demand in education, either for basic education for their dependents or for their own technical training to improve the knowledge of the activity to be developed in the operation of the company.

Having said that, PARACEL should disclose the existing options of the educational institutions of the municipality to the workers who decide to migrate with their families, as well as support, if necessary, the competent educational bodies in the technical training of the population.

Regarding health, according to the standards established by the WHO (World Health Organization), the classic indicator of health care and its infrastructure is formed by the number of beds per inhabitant. To meet the necessary demand, WHO recommends a minimum of 4 beds per 1,000 inhabitants.

In the micro territories closest to the location of the Industrial Plant, there is information about the short-term installation of a USF in the community of Roberto L. Petit, and about the management for the installation of a health post in the community of Laguna Plato. It is estimated that the existence of these by the time the construction phase of the Project begins could contribute to decompressing the demand for more basic health services in the ADA/DIA.

As mentioned by the ADA census personnel, the community does not have health services on site, so they must go to the nearest health posts or centers to receive medical attention. Based on the above information, the following data are obtained:

- 8,33 % (1 of 12) mentioned that they attend the Health Centre in the city of Loreto; located 25 km from the community.
- 8,33 % (1 in 12) mentioned that they attend the Health Centre of Concepción; located about 40 km from the community.
- On the other hand, 91.67% (11 of 12) of the population studied attends the Health Post of Colonia Roberto L. Petit which is located between 9 and 17 km; (approximately one hour by motorcycle).

It can be verified that the region has a health deficit and the project may aggravate this deficit. Therefore, PARACEL must provide ambulatory and hospital structures to its own employees and third parties, which minimizes this impact on the health service in the region.

In addition, PARACEL must develop and follow standards to ensure a safe and healthy working environment for all of its own employees and subcontractors, with a goal of zero accidents.

In relation to the basic sanitation system, the construction of the water supply system; sewage collection and treatment system; and solid waste collection and treatment system is planned.

The water supply for the construction site will be through the Paraguay River or artesian well. The raw water will undergo conventional treatment consisting of coagulation and flocculation processes using aluminum sulfate, caustic soda and polyelectrolyte, followed by decantation, filtration and chlorination, which will be carried out at a compact station. The filtered water must be chlorinated, followed by storage in a tank, for subsequent distribution to users. In principle, this system should provide a flow of the order of 150 m^3/h, which should serve the maximum population of 8,000 workers (peak during work) and also for the preparation of concrete.

The quality required for the water must comply with the parameters established in Annex III of Law 1,614/2000 - Law on the Regulatory Framework and Tariff for Drinking Water and Sewerage Services.

With respect to the wastewater treatment system, at the beginning of the work, liquid waste from the chemical bathrooms will be removed by clean trucks, transported, and disposed of by accredited companies at authorized landfills. Once the installation of the construction site is completed, the chemical toilets will be deactivated and returned to the leasing company.

The final wastewater treatment system will consist of a flow meter, aerated lagoon and polishing pond, and subsequent discharge into the Paraguay River. This system is a biological treatment, which works with microorganisms that will degrade the organic matter present in the wastewater (expressed in terms of BOD - Biochemical Oxygen Demand) through the aerobic process.

The increase in population will add to the already existing problem of solid waste, and may aggravate the situation of inappropriate solid waste management in ADA/DIA communities, promoting practices of burning, burying, proliferation of collection sites on streets and/or vacant lots, etc. with potential effects on the health and quality of life of the communities. To prevent this from happening, PARACEL will manage the solid waste generated during the construction of the pulp plant, considering best practices.

At the construction site, there will be a Temporary Solid Waste Storage Center that will be managed by a company specialized in this service. This company will be responsible for receiving, temporarily storing and assigning all solid waste generated during this stage. A Debris Landfill will also be implemented for the disposal of solid waste from the construction phase, with a capacity of 75,000 m^3. And for the organic waste, a Sanitary Landfill (Organic) will be implemented within the plant area that will have a useful life to comply with the construction phase plus the first two years of operation of the PARACEL pulp mill, so the capacity of this landfill will be 20,000 m^3.

The low coverage of the final sanitary sewerage service for the collection and final disposal of domestic water, and the increase in the transitory and definitive population related to the construction phase of the Project may generate an unhealthy environmental situation in the communities of the DIA where the population will settle, if the contingent of people associated with the Project is not accompanied by the development of the infrastructure of housing and essential basic services. This could lead to the settlement of people in a precarious state, and the deterioration of living conditions in general in DIA communities.

In addition, in view of the need for sanitation on the construction fronts of the plant and the lack of collection and final disposal services in the area where the plant is located, the Project provides for the proper disposal of effluents both in the construction/operational stage of the industrial plant and in the three temporary housing facilities planned for personnel.

Initially, existing accommodations, hotel networks and housing will be used, with minimal provision of toilets, cafeterias, electricity, garbage collection system, sewage and drinking water collection and disposal, and should not overload the existing municipal system.

As there are no public transportation services connecting the Plant's location area to the main population centers of DAA/DIA, one option will be for the Project to provide daily transportation for construction workers (from their homes to the construction site and back), and another alternative is for workers to have their own means of transportation, which is presumed to be preferably motorcycles.

Improvements in public services in education, health, sanitation, transportation and equipment to ensure the safety of the population due to social interaction, in the municipality of Concepción and region should be made from PARACEL associations in coordination with the departmental and municipal governments, support the generation or improvement of spaces for recreation and outdoor recreation, (squares, parks, courts, etc.) as well as improving the local landscape and all types of infrastructure of community relevance through the Community Relationship and Social Investment Program.

Another aspect to take into account is that the social interaction of workers may be reflected in the search for bars, restaurants, prostitution and eventually drugs, leading to an increase in violence. This will require some care in the context of security.

According to the data obtained, there are police stations, sub-commissariats and police posts in the DIA. There are five police stations in Concepción and one in each of the cities of Belén, Horqueta and Loreto. There are five sub-stations in Concepción, one in Belén, eight in Horqueta and five in Loreto.

The DAA population consulted has referred to the "poor police presence" as one of the areas of concern in the community. If this is the case, the effects induced by the construction phase of the Project may further increase the pressure on the existing police capacity.

In order to minimize the impact, PARACEL should carry out awareness raising work with workers and subcontracted companies, to guide workers on: child prostitution, sexually transmitted diseases, drugs, etc., as well as to ask public agencies for greater security supervision, to inhibit illegal acts.

In order to identify in time inconveniences in the fulfillment of the objectives established, and to allow taking corrective actions in a timely manner, the Social Monitoring Program must carry out the monitoring of the social perception through which it will be possible to have updated information regarding opinions and expectations of the local population on aspects related to the project in its different stages.

PARACEL should identify the effects generated by the definition of the design of the project and accesses, seeking to minimize the effects on the ADA population, with emphasis on vulnerable groups through the Social Management Program for ADA communities.

Characterization of the impact

	Qualitative	Quantitative

Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Time of occurrence:	Medium Term	2
Temporarily or duration:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Type III Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Mitigation measures

- Disseminate the existing options of educational institutions in the municipality to workers who decide to migrate with their families, as well as to support, if possible, the competent educational bodies in the technical training of the population;
- Provide an outpatient and inpatient structure for own and external employees;
- Promote a zero accident practice that minimizes dependence on the region's health infrastructure;
- Implement and operate on the construction site the basic sanitation system composed of: water supply service, wastewater collection and treatment, and solid waste collection and treatment service;
- Accommodate workers coming from outside the region in accommodation, hotel network and rental housing already existing in the region with basic sanitation
- Provide for improvements in the public service system, together with the responsible public agencies, to meet the additional demand of the population of the region through the Community Relationship and Social Investment Program;
- Implement the mechanisms for transporting workers between the municipalities involved and the construction site;

- Identify the effects generated by the definition of the design of the construction site and accesses, seeking to minimize the effects on the DAA population, with emphasis on vulnerable groups through the Social Management Program for DAA communities;
- Carry out a dissemination work with the subcontracted companies to orient the workers on: child prostitution, drugs, sexually transmitted diseases, etc., in the Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations with own employees and third parties;
- Address issues such as health, hygiene and safety in the Environmental Education Program with the community;
- Request public agencies to supervise safety, to inhibit illegal acts;
- Implement a Program for Social Monitoring.

<u>Responsibility for the implementation of the measures</u>

PARACEL together with responsible public bodies

<u>Forecast after implementation of measures</u>

There will be interference in the local infrastructure considering that there is already a deficit in public health, sanitation, transport and security services in the region. However, the implementation of PARACEL's mitigation measures and partnerships with the public authorities responsible under the Community and Stakeholder Relations Program and the Social Monitoring Program will make it possible to compensate for the additional demand generated by the increase in population in the region.

10.1.4.2.3.3 Impacts generated by the construction of the river port

<u>Environmental aspect</u>

Impacts due to the port construction.

<u>Impact-Generating Factor</u>

Civil works for the implementation of the port infrastructure.

<u>Technical justification</u>

The river port of the pulp mill will be a terminal-type construction on the left bank of the Paraguay River, built as an elevated platform on a structure composed of: an operating platform, an access bridge on pillars for vehicles and people, and a shed structure for the pulp transport and loading area. All the structures will be made of reinforced concrete and the loading roof will be made of a metal structure. It will be implemented from the shore through the sustainable methodology of the Cantitraveller type with prefabricated elements.

The port will operate with the following loads:

– The transport of pulp by river barges at an average rate of 1,500,000 t/year;

- Reception of timber in logs with volumes varying between 2 and 5 million m^3 s sc/year;
- Reception of inputs for the pulp mill (liquid or bulk) up to 450,000 t/year.

The boats that will operate in the port will be the current models in circulation in the fluvial section of the Paraguay River with the format of convoys according to the official conditions of navigation. The typical pulp convoy will consist of 12 barges (3 x 4) with a unit capacity of up to 2,500 tons each.

The boats for wood and inputs will be suitable for each of the operations/products and will be regulated by the established navigation conditions.

No dredging actions will be required for the approach channel, the evolution area and the anchorage area of the vessels (barges and pushers). For platform or access bridge construction services, bottom forming services may occasionally be required at the site of underwater structures.

Some impacts of the river port works were not separated from the impacts of the mill because the companies and workers for the construction of the port will be basically the same, in addition the services such as: water supply, energy, will be the same as the industrial area and the generation of effluents and residues of the port will receive the same treatment as the effluents and residues of the PARACEL pulp mill works. The impact of the change in the landscape due to the implementation of the port was also evaluated together with the PARACEL pulp mill since it has a greater scope.

Since the river port is within the pulp mill property, the main impacts will just cumulate with the ones already evaluated on physical environment, such as:

- Generation of erosive processes and sedimentation of the river
- Disturbances in relation to noise due to the movement of vehicles and machines
- Change in surface water quality.

The impacts on biotic environment:

- Change in aquatic ecosystems,
- Vegetation and land habitat loss.

Were also assessed and cumulated with the impacts by the pulp mill.

It was left socio-economic impacts associated with the implementation of the river port.

Interference due to the navigation of ships

The Paraguay River is navigable by vessels of greater draught, in the stretch from the confluence with the Paraná River to Asunción; in the stretch from Asunción to Corumbá (Brazil) and passing through all the ports of the Department of Concepción, medium sized vessels can navigate. It is used to a great extent by boats that transport grains, lime, cement and cattle.

The region has an infinite number of rivers and streams that offer the possibility of water sports, fishing, sailing and beaches. Numerous spas have been installed in the area. In the crystalline Tagatiya stream and in the Aquidabán River, ecotourism services are offered. Some boats offer river tourism services on the Paraguay River, especially for trips and fishing. There are establishments that offer tourism of stay (camping, cavalcades, camping etc.); in addition, of the use of beaches and lagoons in their properties. In Vallemí, tours are offered to visit the characteristic caves of the place, while it is possible to visit the hills of San Luis and Paso Bravo. It should be highlighted that Paracel's port will be far from those areas, about 130 km away. The impact study on aquatic biota and on the use of water resources concludes that there will be no impact on fish or fishing. For this reason, the only impact on fishermen is due to the potential fear caused by misinformation.

The port construction and operation will not interfere with the river traffic since it is located on the shore opposite the navigation channel.

During the construction phase of the port, there will not be any restriction for transport. The port area construction on the Paraguay River should be properly identified to avoid accidents of boats; in addition, it is recommended that meetings are held through the Program of dissemination and communication with local fishermen to inform the period and attention during the construction phase, to avoid accidents even if the area is not often used by fishermen.

<u>Characterization of the impact</u>

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Temporality or duration:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

- To inform local fishermen about the period and care during the works of the port through the Dissemination and Communication Program;
- Signal the port implementation area on the Paraguay River to avoid boat accidents.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be stated that, through the application of mitigation measures, the impacts generated by the construction of the river port will be minimal and temporary.

10.1.4.2.3.4 Higher risk of accidents

Environmental aspect

Increasing vehicle traffic

Impact-Generating Factor

Movement of vehicles.

Technical justification

It is expected that during the construction of the project, the traffic of light and heavy vehicles, such as machinery, trucks and buses on the access roads to the construction site will increase significantly. The work will require a number of materials, equipment, machinery, various supplies and hired personnel, which could cause an increased risk of accidents on the project access roads.

According to observations of the existing roads in DAA/DIA, the national routes and branches (such as those connecting Concepción and Belén to Loreto) are paved, have widths of up to 10 meters and two lanes of traffic; other secondary roads are dirt roads and their widths allow two lanes of traffic; these will be the roads shared by the Project with other users in DAA/DIA.

The determination of the access route to the area under study took the consideration that no people or economic displacement will occur.

Main access is through the area of the town of San Ramón (south-east), passing through the Pyrendá farm, or the San Miguel farm. The access road extends to a certain extent within the private property, so if this alternative is chosen, roads must be opened and the existing one adapted, with the advantage that these roads would not be used by other users except for the owners.

It should be noted that "infrastructure and road safety" is the aspect most often mentioned by representatives of DIA institutions and communities in relation to the aspects necessary for the further development of their communities/districts. In this sense, they have highlighted the need to improve the state of the roads and the neighborhood roads. The inadequate condition of some roads in the DAA/DIA plus the already existing perception of these roads in the DIA and the loading of the vehicles of the Project construction give a notion that the impact of the Project will be important on the road infrastructure from the social perspective.

Therefore, it is recommended that these routes undergo constant maintenance and are properly signposted, and it is necessary to inform and raise awareness among vehicle drivers about defensive driving to avoid accidents.

On the main access roads to the internal area of the pulp mill project, PARACEL must install road signs, warning of dangers and speeds. In addition, proper maintenance of the engines of the machines, trucks and vehicles used, together with a Road Safety Program will prevent accidents due to the increase in vehicle traffic.

Transmission line

During the construction phase of the transmission line, the risk of accidents especially of local people and project workers will increase, due to the handling of existing power grids, movement of poles, machinery and others.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and Regional	2
Probability of occurrence:	Possible	1
Time of occurrence:	Short term	1
Timing or duration:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Type II	
Magnitude:	Medium	2
Importance:	Medium	2
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Mitigation measures

- Install signage plates on the main internal access roads to the pulp mill's implementation area;
- Perform maintenance on the engines of machines, trucks and vehicles used by the company;
- Informing and raising awareness among vehicle drivers about defensive driving through the Road Safety Program;
- Install signage plates on the transmission line path.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be said that, with the implementation of these mitigation measures, the risk of accidents will be minimal. In order to provide improvements in the road system due to the additional traffic, PARACEL can establish partnerships with the responsible public agencies to mitigate and compensate the impacts generated.

10.1.4.2.3.5 Impact on morphology

Environmental aspect

Change of landscape and land use.

Impact-Generating Factor

Implementation of the pulp mill, consisting of buildings, towers and chimneys

Technical justification

The pulp mill will be located in the municipality of Concepción, about 15 km from the city center.

City people may not see the impact on the landscape, however, everyone who lives nearby, or uses the roads and/or waterway near the company may feel the impact on the morphology.

According to the environmental diagnosis, the existing agricultural routes and activities throughout the study area have historically already led to a modification of the landscape, favoring generalist species, rather than those more sensitive to changes in the environment.

The area planned for the implementation of PARACEL's industrial unit (object of this study) is located in a rural area of the cattle activity, however part of the water intake area, effluent emissary and river port are located in areas of natural vegetation.

Obviously, the industrial unit consisting of buildings, towers and chimneys will change the local landscape.

To mitigate the impact on the morphology (landscape) a landscape project must be implemented to favor the integration of the plant with the environment.

Transmission Line

In the design of the trace even when the greatest care of the vertex location of the transmission line will be taken in order to avoid, within what possible vegetation areas and populated areas will always occur some kind of impact on the site.

Indeed, electric transmission lines have impacts on the landscape by adding new visual elements that will modify or often interfere with existing visual resources and in this sense the greatest impacts on the landscape are considered to occur in wetland areas, river crossings and saw dries.

There will only be an impact on the visual aesthetics of the area during the construction period of working camps, warehouses, material couplings, etc., which will be transient.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type III Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Partially Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

Implement the landscape project that favors the integration of the plant with the environment, reducing the effect of the contrast of the buildings and structures with the natural landscape, such as the implementation of tree curtains and the reuse of the land in gardens within the plant in accordance with the Landscape Recompositing Program.

Responsibility for the implementation of the measures

PARACEL.

Forecast after implementation of measures

The implementation of the pulp mill will inevitably alter the landscape and local land use, which can be minimized by implementing the landscaping project.

10.1.4.2.3.6 Interference with cultural heritage

Environmental aspect

Earthmoving activities.

Impact-Generating Factor

Possibility of affecting cultural heritage sites.

Technical justification

According to Article 6 - Law # 5621, for the purposes of registration of cultural property, the regime of protection of cultural heritage and sanctions, cultural property must be considered in the following categories:

a) National Cultural Heritage properties:

1. The properties corresponding to the World Cultural Heritage declared by supranational entities, whose instruments were ratified and exchanged by Paraguay.

2. National monuments declared by the National Secretariat of Culture, by law or by decree, following an opinion by the General Directorate of Cultural Heritage.

3. Heritage properties of cultural value, exceptionally valuable, which are significant and outstanding exponents of the culture of Paraguay. They must have been declared as such by the National Secretariat of Culture; they may also be declared as such by the governorates or municipalities, subject to a ruling by the Directorate-General for Cultural Heritage. b) Assets of Heritage Value:

This category is made up of cultural goods, whether tangible or intangible, that are significant in local or sectorial terms or that have any of the values considered relevant under this Law. They may be declared of specific cultural heritage value by resolution of the National Secretariat of Culture, the governments or municipalities.

Based on a primary archaeological and historical assessment, based on the secondary information available (historical background and local testimonies), added to the field survey conducted in the area of direct and indirect impact of the project, the importance of a deeply rooted cultural territory can be affirmed, with local testimonies that are alive and present in its experiential imagination. For each of the documented testimonies, an assessment is made, and measures are proposed to generate cultural roots and protect the present collective memory.

With regard to the valuation and potential social impacts, both in the Area of Direct and Indirect Influence of the project, specifically with regard to intangible cultural heritage, we can mention that it could suffer a moderate to significant alteration, due to changes in habits and significance as social capital. The presence of external personnel, to complete in the very first part the spatial transformation of the project, is also considered a cultural impact on the uses and forms of appropriation (livelihoods).

Therefore, the information gathered in the diagnosis attests to the potential of the region for the occurrence of national cultural and heritage value Assets. It should be noted that the area where the pulp mill is to be implemented has already been transformed by human activity; however, PARACEL will take measures to ensure that the earthworks during the construction phase do not impact or destroy the cultural assets considered to be protected through the ADA's Program for the Protection and Valorization of Cultural Heritage.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Simple	
Magnitude:	Low	1
Importance:	Medium	1
Mitigation possibilities:	Partially Mitigated	
Degree of resolution of measures:	High	
Area of influence	ADA	

Mitigation measures

Take actions to ensure that the construction activities of the pulp mill do not affect or destroy the cultural property considered as protected heritage through the DAA's Program for The Protection and Valorization of Cultural Heritage.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It is possible to affirm that there will be no interference with the cultural heritage, taking into account that the area where the project will be implemented is significantly anthropized. Furthermore, all mitigation measures will be taken so that there is no possible interference with the cultural heritage in accordance with the law in force.

10.1.4.2.3.7 Increasing tax collection and Boosting the local economy

Environmental aspect

Growth of activities producing goods and services.

Impact-Generating Factor

Demand for products and services by the company and the workforce employed.

Technical justification

In the construction phase, there is a growth trend in the tertiary sector in the region, possibly generating the installation of new commercial units (workshops, service units, transport unit, food and other activities).

Thus, the local economy tends to benefit from the emergence of this demand, linked both directly to the activity of the company's execution and indirectly, through the consumption made by the labor linked to the implantation.

This dynamism of the local economy can be demonstrated through indicators, which can be the significant increase in public investment, or in tax collection.

The growth of the activities producing goods and services, resulting from the demands generated by the construction of the mill, tends to increase the collection of taxes both among the companies that will provide direct services to the company, and among those indirectly involved.

The acquisition of construction material and the demand for other services in Concepción represent the direct influence of the work in relation to tax collection.

The project will generate an increase in tax collection at the municipal, departmental and national levels, in accordance with current legislation. This increase can be reinvested in improving basic infrastructure to meet the social needs of the municipality and region.

The informal economy will also increase due to the implementation of the pulp mill. The low-skilled population, or those who cannot be included in the formal activity, tends to resort to emerging informal activities, due to the demand generated by the presence of the labor contingent in the construction phase of the project. The appearance of bars, food stands, cigarette and other consumer goods vendors may occur in the area near the company.

Informal commercial activities are generally not recorded. If there are no records, there is no way to evaluate the benefits that could be generated for the public coffers and to monitor the quality of services.

On the other hand, this informal trade can be analyzed in a positive way, taking into account the generation of income and economic activities that will favor the circulation of money in municipalities and regions.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Positive	+
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local, regional and strategic	3
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Time or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	High	3
Importance:	Large	3
Possibilities of potentiation:	High	
Degree of enhancement:	High	
Degree of measurement resolution:	High	
Area of influence:	DIA and IIA	

Measures of enhancement

Give preference to companies, service providers and trade in the region through the Promotion and Development of Local Suppliers Program.

Prioritize the acquisition of services and goods in the construction phase of the project, preferably in Concepción and the region.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

The implementation of the pulp mill will generate an increase in tax collection at the municipal, departmental and national levels, so that, there will be a boost to the local economy from the construction phase due to the demand for products and services by the company and the workforce employed, boosted by the Promotion and Development of Local Suppliers Program. However, it is up to the government to reverse the taxes collected in improvements to the municipality and region.

10.1.4.2.3.8 Worker influx increase

Environmental aspect

Demand for workforce.

Impact-Generating Factor

Mobilization of workforce.

Technical justification

It is anticipated that the industry component of the project may impact the migration of people in different ways, due to the increase in the flow of workers in the area.

The increase of the population, represented by the labor force of the construction phase and people possibly attracted by the possibility of professional insertion in the activity, tends to increase the demand for public equipment such as: education, health, sanitation, transportation, etc., as well as tends to seek social interaction in the city of Concepción and the region. For the purposes of the study, we consider the increase of people in the region corresponding to approximately 8,000 workers in the phase of greater intensity of this activity.

One type of migration may occur due to the change of workers from one productive sector to another, bearing in mind that today the predominant activity in the area is livestock and to a lesser extent agriculture. The employment opportunity generated in both stages of the industry component of the project may attract people who currently already have a job in another productive and/or service sector and promote migration to the project, due to various factors that could make the offer of Project employment more attractive than the existing job/income generation offer, such as: better wages/income, job formalization, related benefits, proximity to the home, desire for experience in a project with such characteristics, etc. The impact would be positive if migration means an increase in the level of income and quality of life of the people who have migrated to the project sector. The impact will be negative for the productive/service sectors that will lose employees and will have to hire new personnel and train them, or that will stop producing due to the lack of labor.

In the field data collection, most of the interviewed population declared to work in activities of the primary sector, including agriculture and small-scale livestock; mainly for self-consumption and, as needed, for sale. Part of the population referred to commerce and services (pantries, minor sales, motorcycle workshop, snack bars/dining rooms, sale of mini-phone charges) as their activities.

The ADA population consulted has referred to the "poor police presence" as one of the areas of concern in the community. If this is the case, the effects induced by the construction phase of the Project may further increase the pressure on the existing police capacity.

In order to minimize the impact, PARACEL should carry out awareness raising work with workers and subcontracted companies, to guide workers on: child prostitution, sexually transmitted diseases, drugs, etc., as well as to ask public agencies for greater security supervision, to inhibit illegal acts.

In order to identify in time inconveniences in the fulfillment of the objectives established, and to allow taking corrective actions in a timely manner, the Social Monitoring Program must carry out the monitoring of the social perception through which it will be possible to have updated information regarding opinions and expectations of the local population on aspects related to the project in its different stages.

In addition, after construction is completed, PARACEL may require some service providers to continue their work during the operation phase of the mill, without requiring their demobilization.

PARACEL must also provide training and qualification of people from the region for the pulp sector, or mechanical, electrical and instrumentation maintenance, to enable the retention of people for the operation of the pulp mill.

The program to raise awareness and follow up with contractors and workers regarding compliance with regulations will ensure that all contractors comply with the Human Resources Policy and the principles and regulations they must comply with, which will also minimize the impact.

According to the National Statistical Institute of Paraguay, the population of the Concepción department by 2020 is 254,976 inhabitants, representing 3.5% of the country's total population and in 2018 the municipality of Concepción had 76,378 inhabitants in total. So, although 8,000 workers in the phase of greater intensity of this activity is a high number, it represents about 10% of the total municipality. PARACEL will take efforts to minimize the influx impacts by using existing accommodations, hotel networks and housing will be used, with minimal provision of toilets, cafeterias, electricity, garbage collection system, sewage and drinking water collection and disposal, and should not overload the existing municipal system. Them, PARACEL has foreseen camps for workers accommodation.

It is estimated that the Project will directly employ some 8,000 people at the peak of the construction phase, of which 10% will be professionals, 30% technicians and 60% suitable. Among these direct jobs are considered people hired directly by PARACEL and people from contractors and subcontractors hired for construction and assembly. The Project must comply with the principles of IFC Performance Standard 2, clearly defining the employment relationships, depending on whether the employees are direct workers, contract workers, or supply chain workers, depending on the case.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative/Positive	+ -
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Possible	1
Time of occurrence:	Medium term	2
Timing or length:	Permanent	3
Reversibility:	Reversible	1
Accumulation:	Accumulation Type II and III	
Magnitude:	Medium	2
Importance:	Medium	2
Possibilities of potentiation:	Medium	
Degree of potentiation:	Medium	
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Mitigation measures/enhancement

- Give priority to hire local people through the Local Labor Development and Linkage Program;
- Accommodate workers coming from outside the region in accommodation, hotel network and rental housing already existing in the region with basic sanitation, the provide camps for the workers;
- Carry out a dissemination work with the subcontracted companies to orient the workers on: child prostitution, drugs, sexually transmitted diseases, etc., in the Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations with own employees and third parties;
- Carry out the social perception monitoring through the Social Monitoring Program in order to identify in time inconveniences in the fulfillment of the objectives established, and to allow taking corrective actions in a timely manner;

- Carry out the demobilization in accordance with the legal procedures of the contracting regime through the Contractor and Worker Awareness and Monitoring Program on compliance with regulations;
- Provide in the contract with service providers, a commitment that all hired employees will be encouraged and supported to return to their places of origin, once the contracted work is completed; in addition, monitor demobilizations of hotels, rental properties and lodging;
- Promote the training and qualification of people in the region for the pulp production, equipment maintenance, mechanical, electrical and instrumentation sectors, encouraging the possibility of contracting for the mill's operational phase, through the Local Labor Development and Partnership Program, signing partnerships with associations and educational institutions.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

By giving priority to hire local people through the Local Labor Development and Linkage Program, accommodate properly the workers from outside Concepción, carry out the demobilization in accordance with the legal procedures of the contracting regime and promote the training and qualification of people in the region for the pulp production, equipment maintenance, mechanical, electrical and instrumentation sectors, the negative impacts due to workers influx will decrease and by the end of the construction ate least the people will be better qualified.

10.1.4.2.3.9 Impacts to community health and safety

Environmental aspect

Pressure on local infrastructure due to the increase in the population.

Impact-Generating Factor

Mobilization of work.

Technical justification

According to the impact scoping and screening process, the main relevant impact on community health and safety Is due to the pressure on infrastructure at construction phase.

The main health services may be affected by the increase in the temporary and permanent population associated with the construction of the Project, which will settle in the DAA/DIA communities. This could translate into a lower average attention span per person.

The most relevant data are those of the department of Concepción, as it is expected that most of the population will settle in the communities near the Mill, within the department. Concepción had 214 hospital beds in 2017 and 76 public health facilities in

2018, throughout the department. In the AID districts, there are the following numbers of establishments of different types, dependent and not dependent on the Ministry of Public Health and Social Welfare (MSPBS): Concepción 21 dependents and 16 non-dependents, Belén 3 dependents, Horqueta 15 dependents and 1 non-dependent, Loreto 5 dependent and 3 non-dependent. The care centers with the highest demand are those located in the district of Concepción, due to the degree of complexity, where 5,295 cases were attended in 2019; in Belén 343 were treated, in Horqueta 1,985 and in Loreto 116 cases.

According to the surveys carried out in the AID districts, “health” is the aspect most mentioned as a priority for a greater development of the communities. They consider that it is necessary to improve: access to quality health care, the number of health units close to the communities, the provision of the necessary equipment, supplies and resources for adequate care. This constitutes an indicator that, despite the numbers currently available in terms of health care units in the AID, these are not sufficient for the current population and would not be, even more so, if the population were to increase in AID districts and/or communities. Added to this is the COVID-19 pandemic, which is a threat that increases the demand for hospital beds.

Information has been accessed on the expansion and/or new opening of Family Health Units (USF, dependent on the Ministry of Public Health) in the AID districts, with a care capacity of between 2,500 and 3,000 people each. In the micro-territories closest to the location of the Industrial Mill, there is information on the short-term installation of a USF in the community of Roberto L. Petit, and the management for the installation of a health post in the community of Plato Lagoon. It is estimated that the existence of these by the beginning of the construction phase of the Project may contribute to decompressing the demand for more basic health services in the ADA/AID.

On the other hand, the Project will be able to provide better preventive health conditions to direct employees in the construction phase and to their families, while the work lasts, since to date only up to 15% of the department's population has medical insurance, either private or IPS. This impact is associated with the formalization of labor ties, since, since the jobs are not formalized, people do not have compulsory social security.

Public services for the protection of the safety of the population may also be affected by the presence of a greater number of people in the ADA/AID communities associated with the construction of the Project.

According to the data obtained, there are police stations, sub-police stations and police posts in the AID. As for police stations, there are 5 in Concepción and one in each of the cities of Belén, Horqueta and Loreto. Sub police stations there are 5 in Concepción, 1 in Belén, 8 in Horqueta, 5 in Loreto.

The consulted ADA population has referred to the “little police presence” as one of the aspects of concern in the community. If this is the case, the effects induced by the construction phase of the Project may further increase the pressure on the currently existing police backup capacity.

The property of the industrial enterprise, as well as the forestry component, will have its own security personnel, which is common in private enterprises. In this sense, the need for the project to have the support of the public police/security service is reduced. However, as it is a sensitive aspect that could involve the violation of human rights, the project will observe, at a minimum, IFC PS 4 on “Community Health and Safety”, regarding the safeguarding of personnel and properties; on the one hand, and the minimization of security risks for the surrounding communities, ensuring that these personnel do not exercise "abuses of power" as an extortion measure or pressure on workers and/or the community; Paracel will have a specific area, under the human resources area, which will implement a "Security Policy" at the business level.

The corporate security mission consists in guaranteeing that all the people of Paracel and those that work for Paracel in its installations are taken care and protected in a safe environment. Likewise, it guarantees the security of all the installations and allows that all Paracel´s operations carry out freely. It provides effective operative support in the area of security to all the activities of the project.

Paracel´s security personnel will carry out its mission from the principle that the good security and the respect by the human rights are totally compatible, which will reflect, among other things, in the behavior of the security forces, the communications and the use of force.

The Corporate Security Management Manual of Paracel is part of the Environmental and Social Management System (SGAS – initials in Spanish). The number of security personnel is detailed on pages 67-70, as well as the training they will receive to do security with the appropriate and available equipment will be detailed later.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Time of occurrence:	Medium Term	2
Temporarily or duration:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Type III Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	

Area of influence:	DIA and IIA	

Mitigation measures

Perform Relationship Plan with the Community and other Social Actors Plan;

Perform Community Health and Safety Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

The implementation of PARACEL's mitigation measures and partnerships with the public authorities responsible under the Community and Stakeholder Relations Program and the Social Monitoring Program will make it possible to compensate for the additional demand generated for health and safety by the increase in population in the region.

10.1.4.2.3.10 Impacts to vulnerable groups

Environmental aspect

Pressure on vulnerable groups due to the increase in the population.

Impact-Generating Factor

Mobilization of work.

Technical justification

The increased workers influx and the presence of an unusual number of people associated directly and indirectly with the Project's works in the ADA/AID communities may promote the appearance (or increase) of activities such as sale and consumption of alcohol and drugs, sex work or prostitution, gender violence, crime, disrespect for the vulnerable population, disturbance of public peace due to a greater number of recreational and/or night-time activities (parties, leisure groups, etc.) on public roads and/or in homes within the communities, disrespecting the current levels of tranquility of the ADA/AID.

Also, the possible alterations in the tranquility, comfort and even the security of the current population of the AID may lead to the need to change their daily habits, customs and ways of life to adapt to the new conditions that the presence of additional population would generate, due in large part to the increase in the workers influx linked to entrepreneurship. The impact would be adverse if it implied a deterioration of the freedoms enjoyed by the current communities and/or the normalization of acts contrary to the tranquility and harmony of the communities (for example, annoying noise, lack of respect towards vulnerable members of the local communities, with an emphasis on women and children, lack of respect for the property of third parties, etc.).

The increased workers influx and the presence of an unusual number of people directly and indirectly associated with the Project's works in the ADA/AID communities may promote the appearance (or increase) of activities such as sale and consumption of alcohol and drugs, sex work or prostitution, gender violence, crime, disrespect for the vulnerable population, disturbance of public peace due to a greater number of recreational and/or night-time activities (parties, leisure groups, etc.) on public roads and/or in homes within the communities, disrespecting the current levels of tranquility of the DAA/DIA. In addition, among the vulnerable groups that may be exposed to the aforementioned situations, there are women, children and the elderly.

Regarding the road signaling, it is expected that the projects undertaken by the MOPC in the area, will make the provisions related to the signaling, but these could be reinforced by the project, giving express indications of reduction in the area of entry and exit of trucks to the Industrial Mill as well as in areas where vulnerable groups or groups of children and people in general settle (schools, health centers, churches, others located on the roads of nearby communities). Along these lines, IFC PS 4 on “Community Health and Safety” will be observed by the project.

Support to the strengthening of community identity : Measure by which it is intended to generate activities that promote the strengthening of the existing community nexus between communities; accompanying the process of change that could be generated with the implementation of the project. The activities may include the participatory development of joint projects; including vulnerable groups (women, children, people with disabilities and the elderly), the establishment of community centers, the preparation of training plans in coordination with the regional offices of the MIC, SNPP, USF (training in preventive measures against COVID-19, HIV, and other public health issues), the organization of cultural events, etc.

<u>Characterization of the impact</u>

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Time of occurrence:	Medium Term	2
Temporarily or duration:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Type III Accumulation	
Magnitude:	Medium	2

Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Mitigation measures

Carry out a dissemination work with the workers and subcontracted companies to orient the workers on: child prostitution, drugs, sexually transmitted diseases, etc., in the Environmental Education Program with own employees and third parties

Perform Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations

Support to the strengthening of community identity

Perform Equal Opportunities and Non-Discrimination Program

Perform Women's Empowerment Program

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

The implementation of PARACEL's mitigation measures will make it possible to minimize impacts to vulnerable people.

10.1.4.3 Works Deactivation phase

10.1.4.3.1 Socioeconomic environment

10.1.4.3.1.1 Reduction in the number of jobs

Environmental aspect

Termination of the company's construction work

Impact-Generating Factor

Demobilization of temporary work

Technical justification

The workforce required for the construction of the mill is estimated at approximately 8,000 workers in the most labor-intensive and assembly period.

This labor needed for the construction and assembly of the project will be hired preferably in the region of Concepción.

The completion of the works will represent the dismissal of the labor hired temporarily for such activity. Non-residents of the region must, little by little, return to their places of origin. The elimination of demands for goods and services will represent the reduction of previously produced income, with the closure or reduction of the capital of some companies providing services

In addition, PARACEL may require some service providers to continue their work during the operation phase of the mill, without requiring their demobilization.

PARACEL must also provide training and qualification of people from the region for the pulp sector, or mechanical, electrical and instrumentation maintenance, to enable the retention of people for the operation of the pulp mill.

The program to raise awareness and follow up with contractors and workers regarding compliance with regulations will ensure that all contractors comply with the Human Resources Policy and the principles and regulations they must comply with, which will also minimize the impact

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA and DIA	

Mitigation measures

- Carry out the demobilization in accordance with the legal procedures of the contracting regime through the Contractor and Worker Awareness and Monitoring Program on compliance with regulations;
- Provide in the contract with service providers, a commitment that all hired employees will be encouraged and supported to return to their places of origin, once the contracted work is completed; in addition, monitor demobilizations of hotels, rental properties and lodging;
- Maintain the commitment to prioritize the hiring of local labor for the operational phase of the mill;
- Promote the training and qualification of people in the region for the pulp production, equipment maintenance, mechanical, electrical and instrumentation sectors, encouraging the possibility of contracting for the mill's operational phase, through the Local Labor Development and Partnership Program, signing partnerships with associations and educational institutions

Responsibility for the implementation of the measures

PARACEL together with the educational institutions.

Forecast after implementation of measures

The reduction of the workforce after the completion of the works is inevitable, however, it will be minimized by the implementation of these mitigation measures.

10.1.4.4 Operation Phase

10.1.4.4.1 Physical Environment

10.1.4.4.1.1 Noise related disturbances

Environmental aspect

Noise generation from the pulp mill.

Impact-Generating Factor

Operational activities for the manufacture of pulp.

Technical justification

To obtain the current noise level (background), the surrounding sound pressure level was measured at 05 (five) different points, during the day and night, around the area planned for the implementation of the PARACEL pulp mill.

The results of the environmental sound pressure level measurement around the area planned for the implementation of the PARACEL pulp mill ranged from 34.5 dB(A) to 50.7 dB(A) during the day; and from 35.0 dB(A) to 50.2 dB(A) at night, being below the limits of the legislation.

The sources of noise in the pulp mill will come from industrial activity, the main noise generating areas are presented below:

- Wood handling
- Cooking (digester)
- Fiber line
- Pulp warehouse
- Evaporation
- Recovery boiler
- Causticizing and Lime Kiln
- Compressed air system (compressor)
- Biomass boiler
- Turbogenerator
- Effluent treatment
- Waste treatment area

In the area surrounding the company, agricultural activities predominate. The most immediate presence of population agglomeration is the Piquete Cue community, which is about 400 meters from the boundary of the property in which will be installed the PARACEL pulp mill.

To verify the impact of noise, the noise propagation study generated by plant operations and the baseline data available for the area were carried out, determining the project's incremental contribution.

The characterization of the sound environment around the industrial plant was quantified by determining the sound pressure levels in 27 receivers: sensitive homes located around the plant, whose identification and location was provided by PARACEL.

In all cases, the sound pressure levels modelled were compared with the applicable reference standards, determined by the reference regulatory framework constituted by Law # 1100/97 and the applicable regulations of the Republic of Paraguay.

Considering the most conservative operational dynamics, 6 different modeling scenarios were defined: 4 scenarios considering the operation of all equipment in the plant, maximum internal vehicle travel and two access options for maximum truck and light vehicle flow and only maximum light vehicle flow. Two scenarios were then modeled in order to evaluate the effectiveness of including a vegetation barrier as a mitigation measure with the operation of all equipment in plant and maximum internal vehicle travel.

The modeling results indicated that in only 1 of the 27 receivers the noise level was 1.4 to 1.8 dB(A) above the norm, at night and in only 2 scenarios.

The above results do not imply that the operation of the industrial plant is imperceptible from the point of view of NPS emission, or that it does not have the potential to generate nuisance in some cases, since perception is a subjective parameter that is not directly linked to absolute values of emission. However, it can be assured from an objective point of view, through the quantification of the effect of increasing SPL and its comparison with reference standards, that its impact would not be significant when the objective values of noise quality are met.

Finally, it should be noted that the plant barrier would have no effect on the attenuation of the NPS of emission for the receivers considered, since none of the results of the model are modified when the barrier is introduced into the model.

In order to minimize disturbances to this community, PARACEL must ensure that low noise machines and equipment are used and whenever possible will acoustically isolate equipment, as well as continue to monitor environmental noise.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA y DIA	

Mitigation measures

- Use machines and equipment with low noise level;
- Wherever possible, soundproof the equipment by aiming for a low noise level;
- Implementing the Noise Monitoring Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be affirmed that the operation of the mill will be imperceptible in terms of increasing the noise level, however, it does not rule out the possibility of complaints, since the perception of noise is subjective and can vary from person to person. However, disturbances to the community in relation to the noise generated by the company will be mitigated, as the measures will be implemented and monitored

10.1.4.4.1.2 Change in soil and/or surface water and groundwater quality

Environmental aspect

Inappropriate generation and disposal of solid waste

Impact-Generating Factor

Operation of the pulp mill.

Technical justification

During the operation phase, industrial and non-industrial solid waste will be generated at the pulp mill.

The solid industrial waste generated by the pulp production process will come from the wood handling, causticizing, boiler, and water and effluent treatment plant areas.

This category includes the following main wastes:

- Wood preparation waste;
- Biomass boiler ash
- Dregs, grits and lime mud;
- Sludge from the water treatment plant; and,
- Primary, secondary and tertiary sludge from the effluent treatment plant

Non-industrial solid waste will also be generated, corresponding to all the materials discarded by the administrative and operational support activity covering office, cafeteria and maintenance activities.

This category includes the following main waste:

- Metal
- Paper or cardboard
- Plastic
- Glass
- Recyclable and non-recyclable organics

- Waste from health services
- Contaminated with oil and fats
- Used lubricating oil
- Fluorescent lamps and batteries

The management of solid waste generated during the operation of the pulp mill will include best practices.

The mill will have a system of selective collection which aims to segregate materials with similar features at source in advance. In the case of administrative and operational collectors, the segregation will adopt the color pattern, following current standards and legislation, in such a way as to eliminate risks to human health and the environment.

Solid waste shall be destined for treatment and/or final disposal as described in the following Table:

Table 11 – Treatment and/or final disposal of solid waste

Waste	Treatment or final disposal
Waste wood + sand	Production of compost (forest application) or burning in PARACEL's biomass boiler or industrial landfill
Dregs	Production of soil acidity corrector (forestry application) or PARACEL industrial landfill
Grits	Production of soil acidity corrector (forestry application) or PARACEL industrial landfill
Lime mud	Production of soil acidity corrector (forestry application) or PARACEL industrial landfill
Ashes + sand	Production of soil acidity corrector (forestry application) or PARACEL industrial landfill
Primary sludge of ETP	Production of compost (forest application) or burning in the biomass boiler or recycling or industrial landfill PARACEL
Biological sludge of ETP	Production of compost (forest application) or burning in PARACEL's biomass boiler or industrial landfill
Tertiary sludge of ETP	PARACEL Industrial Landfill
Sludge from WTP	PARACEL Industrial Landfill
Metal	Recycling
Paper or cardboard	Recycling
Plastics	Recycling
Glass	Recycling
Recyclable and non-recyclable	PARACEL sanitary landfill (organic)
Waste from health services	Decontamination and sanitary landfill (external)
Contaminated with oil and fats	Incineration or coprocessing

Waste	Treatment or final disposal
Used lubricating oil	Recycling
Fluorescent lamps and batteries	Decontamination and recycling (external)

All solid waste generated in the operation of the pulp mill must follow the procedures of the Solid Waste Management Program (PGRS in Spanish), giving preference to the reuse and recycling of waste and whenever it is necessary to send it for treatment and/or final disposal to duly authorized companies.

The residues generated in the pulp production processes, such as bark and wood yard residues, primary and secondary sludges from the treatment of liquid effluents, may be previously submitted to the composting process by accelerated fermentation.

An alternative to the composting process, which may be used by PARACEL, is the burning of primary and biological sludge together with biomass in the biomass boiler (designed for this purpose).

The inorganic residues of causticizing (dregs/grits, lime mud, precipitator lime) and the biomass boiler (ash) will be used for the production of soil acidity corrector.

An industrial landfill will also be implemented to receive industrial solid waste.

In addition, a sanitary landfill (organic) will be implemented to receive waste from cafeterias (food processing waste, leftover meals, napkins, and the like), bathrooms (toilets), and non-recyclable waste. This measure will prevent the final disposal of waste in existing landfills.

The system for protecting soil and groundwater from contamination (waterproofing) will be properly implemented in all areas where solid industrial waste is handled, processed, treated, and disposed.

To verify that water is not contaminated, the groundwater quality monitoring program must be implemented.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and Indirect	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Medium Term	2
Timing or length:	Permanent	3

	Qualitative	Quantitative
Reversibility:	Irreversible	2
Accumulation:	Type I and III	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA and DIA	

<u>Mitigation measures</u>

- Apply best practices in solid waste management, in accordance with applicable laws and regulations;
- Implement the Solid Waste Management Program (SWMP);
- To train operators for the correct disposal of the waste generated;
- Implementing a system to protect soil and groundwater contamination (waterproofing) in all areas where industrial solid waste is handled, processed, treated, and disposed of;
- Implement and properly operate a sanitary (organic) landfill and an industrial landfill, as well as the composting system and the production process for correcting soil acidity;
- Implement the Groundwater Quality Monitoring Program.

<u>Responsibility for the implementation of the measures</u>

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

<u>Forecast after implementation of measures</u>

It can be assumed that through the implementation of mitigation measures the quality of the soil and/or the groundwater will not be affected.

10.1.4.4.1.3 Change in air, soil and/or surface water and groundwater quality

<u>Environmental aspect</u>

Inappropriate storage and handling causing chemical leaks or spills.

Impact-Generating Factor

Use of chemical products

Technical justification

The use of chemicals in the process, such as: sodium hydroxide, hydrogen peroxide, sulfuric acid, magnesium sulfate, sodium sulfate, methanol, sodium chlorate, virgin lime, aluminum sulfate, starches, calcium carbonate, among others, for the production of pulp, in addition to the operations of storage of inputs and transport of products can cause accidents.

The chemical plant will have the following equipment and structures for storage, containment, control, and safety:

Chemical discharge platforms, provided with containment through thorns or low walls;

Storage of liquid products in metal tanks, made of carbon steel, stainless steel or fiberglass (the material will depend on the type of chemical to be stored);

Concrete containment dikes for chemical storage tanks;

Containment channels in the production areas and in the stock of chemical products;

Process monitoring instruments (level, pressure, temperature, among others) operated remotely, to minimize the need for operators in the production or chemical storage area. Remote operation can be performed by dedicated remote control systems;

With respect to chlorine dioxide, the following measures are foreseen:

- Chlorine dioxide leak detection system;
- Constant ventilation system for the tanks (with redundant source)
- Fixed foam system around the containment dyke to prevent gas emissions in case of leakage.

Atmospheric Discharge Protection Systems (known as ADPS), provided with grounding networks or lightning arresters;

One of the points of attention regarding chemical products from the PARACEL pulp mill is that the transfer system from the Chemical Plant to the points of use will be carried out by means of aerial piping through a pipe bridge (known as Pipe Rack), which avoids manipulation by operators and minimizes the risk of accidents.

Where appropriate, tanks shall be equipped with a fixed internal foam dispersal system.

Fire Department regulations also require the installation of signs in the area reserved for fire extinguishers.

In the event of risk of leaks and spills, the spill collection and handling system has been designed so that accidental discharges can be collected as close to the source as possible and recycled directly to their own process stage.

The main approaches are:

Dam with retaining walls around tanks and equipment where there are black or white chemicals or liquors. In the event of an accidental leak or spill, the material will be collected and returned directly to the process;

Tank systems and equipment that will allow excess liquor to be properly conducted when emptying is required for maintenance. Process liquor will be taken to a spill tank and returned directly to the process instead of being discharged to the effluent network;

In areas with potential for spills, there will be an interconnection of floor channels with pumping wells, from which the liquids will be returned to the process;

Emergency effluent treatment pond, where the main effluents can also be directed in the event of spills that have not been contained with the means previously provided;

Appropriate instrumentation for on-line monitoring of effluent, and a good supervision system to help operators detect accidental discharges and take appropriate corrective measures; and

Training of operators, process managers and implementation of information systems, where environmental problems and accidental discharges require continuous attention.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and Indirect	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Medium Term	2
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type I and III	
Magnitude:	High	3
Importance:	Medium	2
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

Implement containment and waterproofing systems in the areas surrounding the chemical tanks, in addition to implementing maintenance plans and inspections;

Train operators involved in the handling, storage and transport of chemical products;

Implement and operate the system for collecting and handling spills and leaks.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be stated that with the implementation of mitigation measures there will be no change in the quality of air, soil and/or surface and ground water in the event of improper storage and handling causing chemical leaks or spills.

10.1.4.4.1.4 Conflicting water usage

Environmental aspect

Availability of water from the Paraguay River.

Impact-Generating Factor

Water consumption during mill operation.

Technical justification

During the operation of the mill, water will be captured from the Paraguay River, through a surface capture system consisting of a channel and a grid, to a Water Treatment Plant (WTP) to serve the consumption of the PARACEL pulp mill.

It should be noted that the collection will be of the "water mirror operation" type, that is, no dam system will be built.

Four pumps of 2,350 m^3/h each will be installed, with a total intake flow of 7,000 m^3/h to supply the pulp mill.

A 1,100 mm diameter raw water pipe will be installed.

The raw water, which arrives at the Water Treatment Plant, will be treated with aluminum sulfate, sodium hydroxide and sodium hypochlorite, the latter used to promote the elimination of iron, in addition to oxidizing the organic matter present. After the coagulation process, polyelectrolyte will be added to promote flocculation.

Then, by gravity, the flocculated water will go to the solids removal unit, through a dissolved air flotation system or similar. The sludge formed will be periodically and automatically discharged into the central discharge channel. The collected sludge will be compacted and dewatered and then sent for final disposal.

By gravity, the clarified water will be conducted through channels to the gravity filters. After filtration, the treated water will be stored in the treated water tank that will supply the pulp mill's various consumption points, including water for fire control and drinking water.

The total production capacity of treated water will be 6,700 m³ /h.

With regard to the impacts resulting from water consumption, the studies confirm the availability of water from the Paraguay River, which has a minimum flow (Q7.10) of 1,093 m3/s and an average flow of 2,179 m3/s. Water intake for industry operation is estimated at 0.09% of the average river flow, and about 80% of this volume (effluent) will return to the Paraguay River.

That said, there will be no conflicting use of the Paraguay River, which is positive, but PARACEL will apply best practices in water management, seeking continuous improvement of processes in order to minimize water consumption.

In addition, PARACEL shall ensure that water is available in accordance with drinking water standards for human consumption and for use in the pulp mill's operations, through the monitoring of the Water Treatment Plant (WTP).

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative/Positive	- +
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Long Term	3
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA	

Mitigation measures

- Monitor the Water Treatment Plant (WTP) to ensure the availability of water in accordance with the standards of potability for human consumption and for use in mill operations;
- Follow the best water management practices, seeking continuous improvement of processes with the aim of minimizing water consumption.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

There will be no conflicting use of the Paraguay River, given that water intake for industry operations is estimated at 0.09% of the average river flow, and about 80% of this volume will return to the Paraguay River as effluent. In addition, PARACEL will follow best practices in water management, seeking to continuously improve processes in order to minimize water consumption.

10.1.4.4.1.5 Change in river quality

Environmental aspect

Discharging of liquid effluents generated in the Paraguay River.

Impact-Generating Factor

Pulp mill operation.

Technical justification

Basically, the sources of liquid effluent generation that will correspond to the activities of the pulp production process and other auxiliary activities are the following:

- ✓ Effluents from the wood preparation area;
- ✓ Effluents from the brown pulp cooking and washing area;
- ✓ Alkaline filtrates and acid bleach;
- ✓ Effluents from the drying machine;
- ✓ Effluents from evaporation and recovery;
- ✓ Effluents from the causticizing and lime kiln area;
- ✓ Contaminated condensate;
- ✓ Sanitary sewers;
- ✓ Contaminated rainwater; and
- ✓ Miscellaneous (spills, leaks, cleaning of various areas, etc.)

Industrial liquid effluents from the plant will be measured for flow, temperature, pH and conductivity and, depending on the results, diverted to emergency ponds.

Effluents from the chlorine dioxide plant, ash leaching, and the boiler renovation water plant will also be segregated from the main lines, as they have no organic load, requiring only pH control prior to release. The specific neutralized effluents will be added to the other treated effluents in the treated effluent tank for disposal in the Paraguay River.

Sanitary wastewater generated at the plant will be collected from the sanitary effluent network and sent to the ETP directly for biological treatment.

Effluents from the PARACEL pulp mill will be treated at the ETP, which will have the biological treatment system adopted for activated sludge. The activated sludge process is a proven technology commonly used in the pulp and paper industries worldwide.

After the biological treatment, the effluents will undergo a tertiary treatment to minimize phosphorus, color and COD, through a physicochemical process with the application of aluminum sulfate and polymer in coagulation and flocculation tanks, and then be directed to the Dissolved Air Flotation (DAF) system. As an alternative to the physicochemical flotation system, tertiary treatment can be carried out by injecting ozone into the effluent.

The treated effluent will be discharged into the Paraguay River through an underwater emissary.

The emissary is intended to discharge treated effluent into the Paraguay River in a controlled and safe manner by means of underwater discharge under conditions that prevent the formation of foam and promote more efficient dispersion in the receiving body.

It is worth mentioning that the treated effluents will comply with the emission standards established by Resolution # 222/02 and IFC effluent standards.

It should be noted that the PARACEL pulp mill will adopt kraft process production based on Best Available Techniques (BAT), which will minimize the generation of liquid effluents (flow and organic load).

In order to evaluate the quality of surface water in the company's region before the construction and operation of the pulp mill, to be considered as a background and reference for impact studies and future monitoring, three campaigns were carried out to collect and analyze surface water during the dry and rainy seasons in preparation for this ESIA.

The analyses included the parameters established in Resolution # 222/02.

The results showed that most of the parameters analyzed are within the conditions required for class 2 surface water bodies, according to the law in force.

The parameters of total phosphorus, total Kjeldahl nitrogen, color value and metals aluminum and iron exceeded the value of the legislation at some time and/or in some campaigns.

Phosphorus and nitrogen parameters are nutrients naturally originated from the dissolution of compounds present in the soil and from the decomposition of organic matter, which may have contributed to the results found. Because it is a region with agricultural activities, nutrient concentrations above the permitted limit may also be associated with fertilizer use and with rainwater runoff from livestock deposition.

Aluminum and iron values are at odds with the legislation, they may be related to the substrate layer of the region's soils, and therefore may be considered as natural from surface waters.

As for the color parameter in point FW01 in disagreement with the legislation, it is believed that such non-conformity is associated with the time of sampling, the rainy season of the region, since there may be an increase of suspended and dissolved solids, mainly organic and inorganic colloidal and suspended material, thus corroborating the alteration of this parameter.

It should also be noted that the Paraguay River presented, in the third campaign, carried out in February/2020, a greater concentration of dissolved salts than in the first and second campaigns, carried out in October and December/2019, respectively. This must be due to the severe drought recorded in October, November and December. The increase in precipitation in the region contributed to the alteration of the concentrations of the parameters under analysis, decreasing the electrical conductivity and all the cations and anions.

It should be noted that the Paraguay River has good homogeneity, very good quality conditions and excellent resources for its use in industrial purposes.

In order to verify the impact of the release of effluents into the river, the Water Dispersion Study was simulated.

According to the results of the simulations, it is observed that in order to comply with the quality standards established by SEAM Resolution 222/2002, with respect to BOD, color, nitrogen and phosphorus parameters, both under the most critical conditions (minimum flow - Q7.10) and under average flow conditions, the distances required for the mixing zone of the effluents treated by PARACEL in the Paraguay river vary between 0.37 and 0.50 m. In the case of AOX, to reach a concentration equal to that obtained in the quality campaigns, the distances required are 0.50 m.

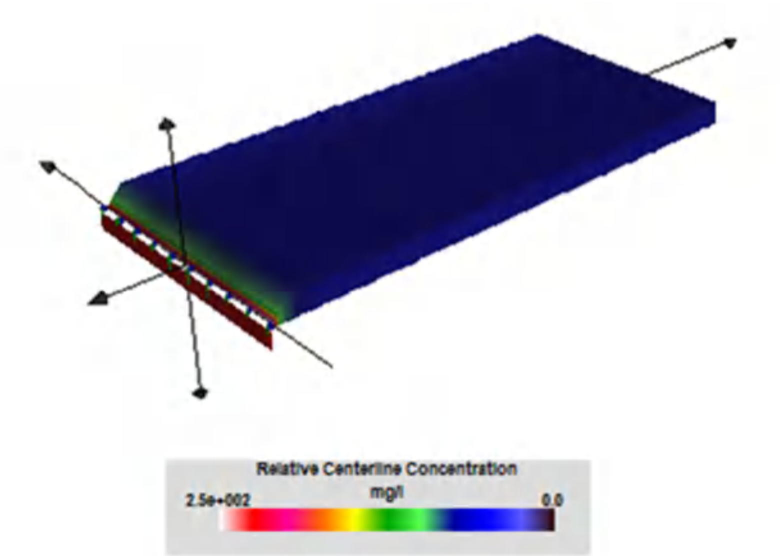


Figure 4 – Example of a 3-dimensional dispersion plume simulation

(Color, Minimum flow - $Q_{7,10}$)

In general, due to the results obtained, the dispersion of PARACEL treated effluents into the Paraguay River is rapid and occurs very close to the point of effluent discharge. Because of this, the simulation for the far field was not performed. However, it is important to note that the mathematical model does not consider the BOD, color, nitrogen, phosphorus, and AOX concentrations of the Paraguay River. However, according to the simulation the distance at which the near field variables cease to prevail, i.e., the distance from the near field is 50 m.

It should be noted that the mill's water intake point will be located downstream of the effluent discharge point. This reinforces PARACEL's compliance with environmental issues and demonstrates the commitment and security that PARACEL must have with respect to the mill's future effluent treatment system in order to maintain the quality standard of the water of the Paraguay River.

In addition, it is important to note that the discharge of the effluent from PARACEL's pulp mill will not cause a cumulative impact on the waters of the Paraguay River, due to the existence of few industrial discharges into the river and a high flow of the same.

Other than that, the robustness of the WASP tool enabled the mathematical modeling of the self-depuration process along the Paraguay River between Concepción and Assunción.

The simulations for the current and future situation after the treated effluent discharge of a pulp and paper industry will not impact on the surface water quality of Paraguay River. The behavior of the various parameters is maintained.

The high dissolved oxygen concentrations along the Paraguay River will maintain aquatic life and the ammonia, nitrate and total phosphorus concentrations do not have potential to change trophic state in the watercourse.

<u>Characterization of the impact</u>

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Spatial coverage area:	Local and regional	2
Probability of occurrence:	Possible	1
Time of occurrence:	Medium Term	2
Temporarily or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II and III	
Magnitude:	Medium	2

Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA	

Mitigation measures

- ✓ Use the best available technologies (BAT) in the production process to minimize the generation of liquid effluents (flow and organic load);
- ✓ Implement an effluent treatment plant based on the best available practical technology (modern and safe), the activated sludge system and tertiary treatment;
- ✓ To properly operate the effluent treatment plant so that the discharge of treated liquid effluents complies with current legislation;
- ✓ Carry out a periodic inspection of the emissary system and its diffusers;
- ✓ Carry out the Effluent Treatment Plant (ETP) Monitoring Program;
- ✓ To carry out the Surface Water Quality Monitoring Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be stated that, through the mitigation measures implemented, the water quality of the Paraguay River will not change significantly even under the minimum flow conditions of the river.

10.1.4.4.1.6 Change in air quality

Environmental aspect

Generation of atmospheric emissions.

Impact-Generating Factor

Operational activities for pulp production.

Technical justification

The main sources of atmospheric emissions from the pulp mill will be generated from the following equipment:

- Recovery boiler;

- Lime Kilns; and
- Biomass boiler

The main control parameters related to significant air emissions from a pulp mill correspond to:

- Particulate matter;
- TRS (Total Sulfur Reduction);
- SOx (sulphur oxides);
- NOx (oxides of nitrogen); and
- CO (carbon monoxide).

The minimization, control and monitoring of air emissions will be based on the technologies already established and used with great success, which are listed below:

- Use of low odor recovery boiler;
- High dry solids content of at least 80% in the liquor burned in the recovery boiler, which minimizes SOx emissions
- Use of high efficiency electrostatic precipitators for the recovery boiler, biomass boiler and lime kilns
- Collection of concentrated non-condensable gases from the digester and evaporation, and their incineration in the recovery boiler or biomass boiler (protected flame incineration);
- Extensive collection of diluted non-condensable gases from the digester, brown pulp line, evaporation, with treatment in the recovery boiler;
- Treatment of gases from the solution tank in the recovery boiler itself;
- Efficient cleaning of bleach plant relief gases; and
- Real-time gas monitoring systems and control system, rapid identification and correction of operational disturbances.

It should be noted that the PARACEL pulp mill will adopt a kraft pulp production process based on the Best Available Technologies (BAT), which will enable the reduction, control and monitoring of greenhouse gas emissions.

It is worth noting that all emission sources will be properly dispersed through a chimney with a height of 140 meters.

The control of emission sources and air quality will also be monitored.

It is important to emphasize that, according to the environmental diagnosis, and in relation to the preferred direction of the winds, these present preferential direction from the south, followed by northeast winds for this. Therefore, even in accidental cases of emergency, atmospheric emissions should not reach the municipality of Concepción since it is located about 15 km south of the future company.

In the air quality assessment, as presented in the environmental assessment, two monitoring campaigns were carried out at three sampling points in the area near the project area.

In these campaigns it was possible to verify that, with respect to the particulate pollutants sampled: Total Suspended Particles - TSP and Inhalable Particles - IP (PM10), they were presented in accordance with current air quality legislation. However, the parameter Breathable Particles - RP (PM2.5) presented concentrations above those established in the regulations, possibly due to the material associated with the suspension of particles originating from unpaved roads and the emission from diesel-powered vehicles.

The parameters NO_2 - Nitrogen dioxide, O_3 - Ozone, CO - Carbon monoxide and SO_2 - Sulphur dioxide were also below the limit set in the standard.

In the technical literature there is no reference for emission limits for the parameter of H_2S - Hydrogen Sulfide and Total Reduced Sulfur.

To evaluate the future concentration of pollutants in the atmosphere from the fixed source of the PARACEL pulp mill, an atmospheric dispersion study was carried out.

According to this study, atmospheric dispersion simulations generated low concentration values of pollutants CO, TRS, NO_2, PM_{10} and SO_2. The maximum concentration values are below the air quality standards established by the General Directorate of Air of the Environmental Secretariat (SEAM) of Paraguay for CO, NO_2, PM_{10} and SO_2 and also below the odor perception limit indicated by the World Health Organization for TRS (Total Sulfur Reduction). Specifically, the maximum concentrations of PM10 are even below the air quality standards for $PM_{2.5}$, considering both the daily average (24 h) and the annual average. Peaks in maximum concentration of all pollutants occur near the mill, at distances between 165 and 2,428 m. The concentrations of pollutants at discrete receptors, chosen to supplement the air quality assessment in the area of interest, are below air quality standards.

Therefore, the air quality in Concepción and the region studied will be in accordance with the air quality standards established by the legislation even after the operation of the PARACEL pulp mill.

It is recommended to prevent that in extraordinary situations (starts, stops and exits of regime), not covered by the modeling, odor events can be caused that will be occasional and with no risk for health, but that can generate a slight and temporary discomfort in some receivers.

PARACEL must implement a program to manage complaints, claims and concerns, which will serve to monitor the resolution and closure of claims.

Other than that it should be noted that the vehicle and boat emissions for wood and pulp transportation will increase, impacting on air quality as well.

<u>Characterization of the impact</u>

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	

Area of spatial coverage:	Local	1
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type I and III	
Magnitude:	Media	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA	

Mitigation measures

Follow best practices for air emissions management, as listed below:

- Use of low odor recovery boiler;
- High dry solids content (minimum 80%) in the black liquor burned in the recovery boiler, which minimizes SOx emissions
- Use of high efficiency electrostatic precipitators for the recovery boiler, biomass boiler and lime kilns;
- Collection of concentrated non-condensable gases from the digester and evaporation, and their incineration in the recovery boiler or biomass boiler (protected flame incineration);
- Extensive collection of diluted non-condensable gases from the digester, brown pulp line, evaporation, with treatment in the recovery boiler;
- Treatment of gases from the solution tank in the recovery boiler itself;
- Efficient cleaning of bleach plant relief gases; and
- Real-time gas monitoring systems and control system, rapid identification and correction of operational disturbances.

To adopt a cleaner energy matrix in its production process, based on the use of renewable fuels, producing pulp with minimum carbon emissions;

Implementing highly efficient emission control equipment, such as electrostatic precipitators;

Install chimney with defined height in the atmospheric dispersion model;

Implement an Atmospheric Emissions Monitoring Program;

Monitor the sources of atmospheric emissions through on-line measurements;

Implement an Air Quality Monitoring Program;

Implementing the Complaints, Grievances and Concerns Management Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be said that the air quality in Concepción and the region studied will be in accordance with the air quality standards established by the legislation even after the operation of the mill, according to the study of atmospheric dispersion. In extraordinary situations (starts, stops and regime exits), not covered by the modeling, odor events may occur that will be punctual and without any risk to health, but that may generate a slight and temporary discomfort in some receptors. It should also be noted that the Program for the Management of Complaints, Claims and Concerns will be implemented. This will serve to monitor the resolution and closure of complaints.

10.1.4.4.1.7 Fugitive emissions increase

Environmental aspect

Generation of atmospheric emissions.

Impact-Generating Factor

Operational activities for the pulp mill.

Technical justification

Kraft pulp mills were, in the past, easily identified by citizens because of the characteristic odor of rotten things they possessed. Controlling odor emission has always been one of the main challenges of kraft pulp mills.

Atmospheric emissions and odor compounds are associated with wood digestion, evaporation and combustion processes for black liquor recovery (recovery boiler), calcination of lime mud (lime kiln), thermal energy generation (biomass boiler), etc. The formation of these pollutants is closely associated with the burning processes of some fuel containing nitrogen, carbon sulfur, chlorine, etc. In addition to the quality of the fuel, the characteristics of design, design, operation, maintenance and efficiency of combustion equipment are important in this process.

Combustion systems are huge equipment, burn large amounts of fuel every day and launch fantastic gas flows through their chimneys. In general, combustion exhaust gases constitute a mixture of gases containing nitrogen, oxygen, water vapor, reduced compounds and oxidized compounds, as well as particulate matter (ash or soot).

It turns out that in addition to combustion equipment, there are other important sources of odor in pulp mills. Many sources are said to be fugitives, where the odor releases from liquor, effluent, filtrates, pulp, sludge from the effluent treatment plant, industrial landfills. These gases have a range of action of only a few hundred meters. As a result, we have odors both in the vicinity of the plant and a few tens of kilometers from it (due to the displacement of the gas plume from the combustion equipment).

The perception of the odor is then greatly affected by the climatic conditions, being more pronounced on rainy days, fog, or thermal inversion. Because these types of days often happen in any type of location, the company needs to be aware of them as much as in its operations. It is no longer accepted to cause discomfort to neighboring populations and the mill's employees themselves are not satisfied by breathing polluted gases.

Many of the diluted non condensable gases (DNCG) are also understood as fugitive emissions, that is, low concentration emissions that are released from liquor tanks, unwashed pulp, effluent ponds contaminated with liquor, wells and channels, causticizing sectors, etc. The best way to combat these fugitive emissions is to encapsulate the sources, collecting them under vacuum and intended for burning in a combustion system (recovery boiler, lime kiln or power boiler).

In addition, some of these pollutants have a strong odor, such as fugitive emissions from the emergency pond of the effluent treatment plant, when an anaerobic decomposition of its organic matter occurs. Some fugitive emissions are also TRS-type gases. They occur near digester feeding silos, liquor tanks, areas where contaminated condensates occur, pulp overflows, mass washing, condensate channels, etc.

However, the state-of-the-art technological mills (as the case of PARACEL) have state-of-the-art equipment and systems for environmental protection; and this is already conceptually introduced in the concepts and engineering of these equipment, such as boilers, lime kiln, etc. New and modern eucalyptus kraft pulp mills, which began operations in the 21st century, are able to operate virtually odorless and with minimal emissions.

It is important to note that the recovery boiler, lime kilns and biomass boiler at the PARACEL plant are designed on the basis of the best available techniques (BAT) worldwide, which minimizes generation of pollutants for the atmosphere.

For the recovery boiler:

The most effective way to reduce TRS and SOx emissions from pulp mills is related to the concentration of black liquor in order to produce a black liquor with a higher content of dry solids (> 80%). This makes the liquor burning conditions in the furnace much more suitable and TRS and SOx emissions are minimized.

In addition, TRS and SOx emissions in the recovery boiler will also be minimized with the following operational controls:

– Maintaining higher temperatures and high content of dry solids in black liquor. Therefore, higher amounts of sodium (Na) will vaporize, absorbing SO_2 and forming Na_2SO_4, thus reducing SOx emissions;
– Adequate ratio of sulfur/sodium (S/Na) in liquor;
– Supply of excess air, temperature and distribution of combustion air;
– Maintaining the load in the furnace at optimum operating levels.

In the case of lime kilns, the main measures are presented as follow:

TRS and SOx emissions are directly related to the sulfur content in the fuel, as well as the quality of the lime mud. Thus, the use of fuels with low sulfur levels is a key element to minimize these emissions.

From an operational point of view, TRS and SOx emissions will be minimized through optimized combustion, based on an efficient control system that includes: the air/fuel ratio; temperature; residence time; excess oxygen content and good air/fuel mixture.

As for the biomass boiler, SOx emissions will depend on the fuel to be used. In the case of the use of biomass, SOx emissions are minimal because eucalyptus wood has low sulfur content.

In the case of the PARACEL pulp mill, these measures have been adopted and are summarized below, by emission source.

Regarding the PARACEL recovery boiler:

Reduction/minimization of TRS and SOx:

– Burning of concentrated black liquor (> 80% dry solids);
– Maintenance of higher temperatures and high content of dry solids in black liquor;
– Control of the adequate rate of sulfur/sodium (S/Na) in the liquor;
– Control of excess air, temperature and combustion air distribution;
– Maintaining the load in the furnace at optimum operating levels.

Regarding the PARACEL lime kilns:

Reduction/minimization of TRS and SOx:

– Use of fuel oil with low sulfur content, whenever possible;
– Optimized combustion.

Regarding the PARACEL biomass boiler:

Reduction/minimization of SOx:

– SOx emissions will be minimal because eucalyptus wood has low sulfur content.

These measures will be adopted by PARACEL, and consist of the best available techniques (BAT), they will be responsible for low concentrations of TRS, SOx, NOx and CO emissions that will be within or very close to the BAT reference values as presented in this ESIA.

Impact Characterization

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	

Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type I and III	
Magnitude:	Medium	2
Importance:	Medium	2
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA	

Mitigation measures

Follow best practices for air emissions management, as listed below:

- Burning of concentrated black liquor (> 80% dry solids);
- Maintenance of higher temperatures and high content of dry solids in black liquor;
- Control of the adequate rate of sulfur/sodium (S/Na) in the liquor;
- Control of excess air, temperature and combustion air distribution;
- Maintaining the load in the furnace at optimum operating levels;
- Use of fuel oil with low sulfur content, whenever possible;
- Optimized combustion;
- SOx emissions will be minimal because eucalyptus wood has low sulfur content;

Implementing the Complaints, Grievances and Concerns Management Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be said that since PARACEL will adopt the Best Available Techniques in its processes, the fugitive emissions will be under control. In extraordinary situations (starts, stops and regime exits), odor events may occur that will be punctual and without any risk to health, but that may generate a slight and temporary discomfort in some receptors. So it should also be noted that the Program for the Management of Complaints, Claims and Concerns will be implemented. This will serve to monitor the resolution and closure of complaints.

10.1.4.4.2 Biotic environment

10.1.4.4.2.1 Higher risk of running over animals

Environmental aspect

Increasing vehicle traffic.

Impact-Generating Factor

Movement of vehicles.

Technical justification

In the operation phase, it is estimated that several truck journeys are required daily to transport eucalyptus logs to the pulp mill. It is estimated one truck every 4 minutes.

The increase in vehicle traffic increases the risk of animals being run over on the main access roads to the company.

Losses of animals due to being run over are certain and frequent, mainly in similar rural environments where, on the one hand, the scarcity of native vegetation represents, among other aspects, the need for the transit of animals in relatively large areas to look for food and/or for procreation, simultaneous to the lack of shelter for the movement of these same animals. On the other hand, the network of secondary roads (neighborhood and rural routes) that cross the extensive and continuous cultivation areas, constitutes a scenario of inherent risk.

Therefore, the increase in traffic will lead to an increase in the frequency of being run over, with the consequent loss of wild animals.

Environmental education work, which addresses the issue of "wildlife running over" is extremely important for driver awareness and the application of traffic signs will provide a significant reduction in the risk of animals being run over.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Possible	1

Time of occurrence:	Short term	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Simple	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	Medium	
Area of influence:	DIA and IIA	

Mitigation measures

- Install signage plates on the main access routes to the plant area;
- Inform and raise awareness among vehicle drivers about defensive driving through the Road Safety Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be stated that the risk of running over animals will be minimized by the implementation of the proposed mitigation measures.

10.1.4.4.2.2 Injury or death to fauna and flora due to improper waste disposal, including spills

Environmental aspect

Inappropriate generation and disposal of solid waste and spills.

Impact-Generating Factor

Operation of the pulp mill.

Technical justification

The earth’s ecosystem is very delicate. Every living thing on the planet needs fresh air and clean water, and it is incumbent upon humans to make sure the environment stays healthy and sustainable. Humans create a lot of waste, much of which is toxic to many forms of life. There is a right way and a wrong way to dispose of that waste.

During the operation phase, industrial and non-industrial solid waste will be generated at the pulp mill.

The solid industrial waste generated by the pulp production process will come from the wood handling, causticizing, boiler, and water and effluent treatment plant areas.

This category includes the following main wastes:

- Wood preparation waste;
- Biomass boiler ash
- Dregs, grits and lime mud;
- Sludge from the water treatment plant; and,
- Primary, secondary and tertiary sludge from the effluent treatment plant

Non-industrial solid waste will also be generated, corresponding to all the materials discarded by the administrative and operational support activity covering office, cafeteria and maintenance activities.

This category includes the following main waste:

- Metal
- Paper or cardboard
- Plastic
- Glass
- Recyclable and non-recyclable organics
- Waste from health services
- Contaminated with oil and fats
- Used lubricating oil
- Fluorescent lamps and batteries

The management of solid waste generated during the operation of the pulp mill will include best practices.

All solid waste generated in the operation of the pulp mill must follow the procedures of the Solid Waste Management Program (PGRS in Spanish), giving preference to the reuse and recycling of waste and whenever it is necessary to send it for treatment and/or final disposal to duly authorized companies.

The system for protecting soil and groundwater from contamination (waterproofing) will be properly implemented in all areas where solid industrial waste is handled, processed, treated, and disposed.

To verify that water is not contaminated, the groundwater quality monitoring program must be implemented.

In the event of risk of leaks and spills, the spill collection and handling system has been designed so that accidental discharges can be collected as close to the source as possible and recycled directly to their own process stage.

The main approaches are:

- Dam with retaining walls around tanks and equipment where there are black or white chemicals or liquors. In the event of an accidental leak or spill, the material will be collected and returned directly to the process;
- Tank systems and equipment that will allow excess liquor to be properly conducted when emptying is required for maintenance. Process liquor will be taken to a spill tank and returned directly to the process instead of being discharged to the effluent network;
- In areas with potential for spills, there will be an interconnection of floor channels with pumping wells, from which the liquids will be returned to the process;
- Emergency effluent treatment pond, where the main effluents can also be directed in the event of spills that have not been contained with the means previously provided;
- Appropriate instrumentation for on-line monitoring of effluent, and a good supervision system to help operators detect accidental discharges and take appropriate corrective measures; and
- Training of operators, process managers and implementation of information systems, where environmental problems and accidental discharges require continuous attention.

<u>Characterization of the impact</u>

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and Indirect	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Medium Term	2
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type I and III	
Magnitude:	High	3

Importance:	Medium	2
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DAA	

Mitigation measures

- Apply best practices in solid waste management, in accordance with applicable laws and regulations;
- Implement the Solid Waste Management Program (SWMP);
- To train operators for the correct disposal of the waste generated;
- Implementing a system to protect soil and groundwater contamination (waterproofing) in all areas where industrial solid waste is handled, processed, treated, and disposed of;
- Implement and properly operate a sanitary (organic) landfill and an industrial landfill, as well as the composting system and the production process for correcting soil acidity;
- Implement the Groundwater Quality Monitoring Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be assumed that through the implementation of mitigation measures the fauna and flora will not be affected.

10.1.4.4.2.3 Change in aquatic ecosystems

Environmental aspect

Launching of liquid effluents generated in the waters of the Paraguay River.

Impact-Generating Factor

Pulp mill operation.

Technical justification

The effluents generated by the operation of the industrial unit will be treated and released through an emissary into the waters of the Paraguay River.

The PARACEL pulp mill will adopt a kraft pulp production process based on Best Available Technologies (BAT), which will minimize the generation of liquid effluents (flow and organic load).

It is worth mentioning that the treated effluents will comply with the emission standards established by Resolution # 222/02.

According to the results of the simulations, it can be seen that in order to comply with the quality standards established by SEAM Resolution # 222/2002, with respect to the parameters of BOD, color, nitrogen and phosphorus, both under the most critical conditions (minimum flow - Q7.10) and under average flow conditions, the distances required for the mixing zone of the effluents treated by PARACEL on the Paraguay River vary between 0.37 and 0.50 m. In the case of AOX, to reach a concentration equal to that obtained in the quality campaigns, the distances required are 0.50 m.

In general, due to the results obtained, the dispersion of PARACEL treated effluents into the Paraguay River is rapid and occurs very close to the point of effluent discharge. Because of this, the simulation for the far field was not performed. However, it is important to note that the mathematical model does not consider the BOD, color, nitrogen, phosphorus, and AOX concentrations of the Paraguay River. However, according to the simulation the distance at which the near field variables cease to prevail, i.e., the distance from the near field is 50 m.

It should be noted that the mill's water intake point will be located downstream of the effluent discharge point. This reinforces PARACEL's compliance with environmental issues and demonstrates the responsibility and security that PARACEL must have with respect to the mill's future effluent treatment system in order to maintain the quality standard of the water of the Paraguay River.

In addition, it is important to note that the discharge of the effluent from the PARACEL pulp mill will not cause a cumulative impact on the waters of the Paraguay River, due to the existence of few industrial discharges in the river and a high flow of the same.

Since there will be no change in the quality of the Paraguay River, it is also not expected to affect the aquatic communities.

The possible change in the structure of the aquatic communities due to the release of treated effluents into the waters of the Paraguay River will be monitored through the Biodiversity Monitoring Program on the industrial site.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1

Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type I Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	Medium	
Area of influence	DIA	

Mitigation measures

- Use the best available technology (BAT) in the production process to minimize the generation of liquid effluents (flow and organic load);
- Adequately operate the effluent treatment plant so that the discharge of treated liquid effluents is in accordance with current legislation;
- Implement the Program for Monitoring Aquatic Communities on the Paraguay River.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be stated that, since there will be no change in the quality of the Paraguay River due to the release of treated effluents from the PARACEL pulp mill, the aquatic communities are not expected to be affected.

10.1.4.4.2.4 Noise related disturbance on fauna

Environmental aspect

Replacement of Habitats with pulp mill.

Impact-Generating Factor

Pulp mill operation.

Technical justification

The generation of noise during the operation of the project will be due to the activities of the industrial process.

PARACEL will employ noise treatment systems and protective measures for its employees and third parties in industry, which are based on environmental law and technical standards, such as Law 1,100/1997 on the prevention of noise pollution and IFC Guidelines.

The main noise generating areas and their respective maximum levels (sound pressure) are shown in the following table:

Table 12 – Main places of noise generation

Area	**Noise dB(A)**
Wood Handling	115
Cooking and Fiber Line	110
Drying	105
Chemical preparation	100
Chlorine Dioxide Plant	100
Oxygen Plant	105
Evaporation	110
Recovery boiler	110
Causticizing and Lime Kiln	110
Biomass boiler	105
Turbines	85
Cooling towers	110
Water treatment	95
Equipment	
Control valves	75
Electric motor	78
Ventilation process	75
Air compressors, pumps, drive units	80
Safety valves and starter valves	85
Safety valve outputs	110

Source: PARACEL Study of noise intensity, 2020.

Considering the total noise accumulation using the formula:

=10*LOG((10^(D5/10)+10^(C6/10));10)

NPS (R 2) = 10 log (10^(R 1/10)+10^(R 2/10)) = 120dB A(A) in the worst conditions case, not considering the open space as a disseminator of the noise.

Then after only 200 m the mill noise is in accordance with Day time standard in line with Law 1,100/1997 and within 1 km at Night time.

Distância (m)	**Ruído dB(A)**
1	120,1
50	86,1
100	80,1
150	76,6
200	74,1
250	72,1
500	66,1
1000	60,1
1500	56,6
2000	54,1
2500	52,1
3000	50,6

With such just distance it is not expected to impact the local fauna.

That law sets the maximum permissible noise levels. For PARACEL's pulp mill, the limits are those of Article 9 and 10.

Scope	**Night 20:00 to 07:00**	**Day 07:00 to 20:00 14:00 to 19:00**	**Day (Occasional peak) 07:00 to 12:00**
	Measured in decibels "A". Db(a) 20 to 40		
Residential areas of specific use, public spaces: recreation areas, parks, squares and public roads.	45	60	80
Mixed areas, transition zones, urban centers, specific programs, service zones and public buildings	55	70	85
Industrial area	60	75	90

Source: Law 1.100/1997

The noise level guidelines, according to the World Bank Group General EHS Guidelines is shown in the table below.

Table 13 – Noise limits established by World Bank Group General EHS Guidelines

Receptor	Daytime (07:00 – 22:00)	Nighttime (22:00 – 07:00)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Other than that, the sound pressure will be attenuated by:

– Construction of buildings and facilities designed with adequate acoustics, such as control rooms, offices and other facilities for individual and collective use;

– Use of appropriate materials during the construction of facilities;

– Facilities provided with vibration and shock isolators, with flexible joints;

– Acquisition of machines and equipment with low noise levels;

– Installation of equipment in suitable locations;

– Acoustic enclosure for equipment with a high sound pressure level;

– Installation of silencers, attenuators, sound energy absorbers.

In addition, PARACEL will have health and safety programs as a way to control and/or minimize the exposure of its employees and partners to industrial noise.

<u>Impact Characterization</u>

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Moment of occurrence:	Short term	1
Time or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	

Magnitude:	Medium	2
Importance:	Medium	2
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA, DIA	

Mitigation measures

- Acquire machines and equipment with low noise levels;
- Acoustic enclosure for equipment with a high sound pressure level;
- Install silencers, attenuators, sound energy absorbers, if necessary;
- Perform a health and safety programs as a way to control and/or minimize the exposure of its employees and partners to industrial noise.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

The actions adopted by PARACEL will minimize the impact.

10.1.4.4.2.5 Impact of oil spills in river due to river transportation

Environmental aspect

Change in the physical-chemical conditions of soil, water and/or air.

Impact-Generating Factor

Accidental oil leakage or spill.

Technical justification

Environmental issues associated with river transportation operations primarily include the following: management of hydrocarbons and hazardous materials, wastewater and other effluents, air emissions, and the generation and management of solid waste.

The operations and maintenance of vessels used to freight transportation can generate hazardous or potentially hazardous waste (e.g. used lubricants, paint removed in hull maintenance, and chemicals from painting and cleaning, which includes degreasers used for hull and engine tasks).

Accidental leaks of fuel and cargo can occur as a result of accidents during navigation or the transfer of materials at sea, river or port, therefore the following procedures for the operation will be requested from the ship contractor (s):

- Operational certification of the vessel in accordance with the applicable requirements depending on the function and capacity of the vessel.
- Have procedures for the prevention of discharges from fuel supply activities in the port and the sea / rivers.
- Carry out cargo oil transfer activities between ships in compliance with specific safety rules and guidelines to minimize the risk of spills.
- Have procedures for the prevention of spills during the loading and unloading of liquid bulk in accordance with the applicable standards and guidelines that deal specifically with advanced communication and planning with the receiving terminal;
- Properly secure oil and hazardous materials containers on deck;
- Maintain the emergency plans necessary to address accidental spills of oil and harmful liquid substances;
- Maintain the necessary plans and procedures for the prevention of oil spills and harmful liquid substances for operations in special areas.

Likewise contracted shipping companies must implement a system for the proper control, acceptance and transportation of packaged dangerous substances.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and Regional	2
Probability of occurrence:	Possible	1
Time of occurrence:	Short term	1
Timing or duration:	Permanent	1
Reversibility:	Irreversible	2
Accumulation:	Type II	
Magnitude:	Medium	2
Importance:	High	3

Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Mitigation measures

Perform River transportation Management Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

It can be said that, with the implementation of these mitigation measures, the risk of accidents will be minimal.

10.1.4.4.2.6 Artificial night light impacts to fauna

Environmental aspect

Use of artificial light.

Impact-Generating Factor

Operation of the pulp mill.

Technical justification

Light pollution within parks and protected lands can have a measurable impact upon the habitat quality of the park, even if the light itself originates outside of the park's administrative boundary. Minimizing ecological impacts requires that land managers adopt an ethic of using only the minimum light necessary for human needs and being cautious when introducing light into or near a natural landscape.

The evaluation of the impact of artificial light on fauna seems to be meaningless when the habitat undergoes such a modification that it is no longer suitable for that fauna (e.g. substitution of a grazing meadow for a factory). In general terms, it can be said that some species will be directly benefited (e.g. insectivorous bats) and for others, artificial light will act as a protective deterrent, driving them away from the industrial platform to the quieter conservation areas within the property, which will remain without lighting. In addition, experience shows that the fauna for the most part easily get used to a regularly illuminated environment.

Characterization of the impact

	Qualitative	Quantitative

Nature:	Negative/Positive	-+
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II and III	
Magnitude:	Medium	2
Importance:	Medium	2
Possibilities of potentiation:	Medium	
Degree of potentiation	Medium	
Mitigation possibilities	Mitigated	
Degree of resolution of measures:	Medium	
Area of influence:	DIA and IIA	

<u>Mitigation measures/enhancement</u>

Use mainly anthropic areas.

<u>Responsibility for the implementation of the measures</u>

PARACEL.

<u>Forecast after implementation of measures</u>

The fauna will get used to a regularly illuminated environment.

10.1.4.4.3 Socioeconomic environment

10.1.4.4.3.1 Generation of direct and indirect jobs

<u>Environmental aspect</u>

Hiring of workforce for the operation of the pulp mill.

Impact-Generating Factor

Manpower demand for the operation of the pulp mill.

Technical justification

The operational regime will be 24 hours a day, 7 days a week and 12 months a year. The effective production period will be approximately 354 days, considering the general annual maintenance stop of the equipment.

The total labor force, considering own employees and third parties, necessary for the operation of the mill will be approximately 1,200 people.

The working days of the employees in the industrial area will be carried out in 3 shifts of 8 hours each. In the administrative area, the working day will be 8 hours and will take place during business hours.

The operation of the plant will require skilled and unskilled labor for the production of pulp, for maintenance of equipment and machinery, for administrative tasks, cleaning, transportation, security, and other related services. It is estimated that 20% of those hired will be professionals, 70% technicians and 10% suitable. As for qualified and/or specialized labor, depending on the specialty, foreign personnel will possibly be hired, even foreign, if necessary, since there may be no specific experience related to the pulp production sector in the area of influence. In the same vein, local people will be able to cover the demand for employment that does not require specialized training for production and/or for the maintenance of equipment and machinery; therefore, it is expected that most of the unskilled labor can be provided by the local population.

Some of the jobs in the operation phase may not require the recruitment of new personnel, but may instead rehire personnel already involved in the construction phase of the Project.

Vacancies in these sectors should be offered by companies that provide this type of service through the Dissemination and Communication Program.

In addition, the jobs offered will provide training to the personnel, which is a positive aspect related to the hiring itself.

The Project will provide formal employment links, i.e. in compliance with current national legislation, thus improving working conditions with respect to existing IIA job offers, the characteristics of which were already described for the construction phase.

The formalization of contracts, which will be less in number but of medium and long term duration (during the operation of the Plant), will improve the quality of life of the people directly employed and their dependents by increasing the level of present and future labor and social security.

It is key that the PARACEL considers IFC's Performance Standard 2, as well as the labor standards and working conditions recommended by the World Bank.

As in the construction phase, the Project will promote the training of interested people who can be employed in the operation phase of the Industrial Plant. This will be in order to counteract, to some extent, the lack of qualified manpower existing locally and to enhance the existing one according to PARACEL's specific technical needs.

On the other hand, this training will address what was referred to by the DIA population in the field survey, the fear that there is a "low absorption of local labor" because "they are not trained". Along these lines, the training provided by PARACEL will have a positive impact on the personal training of the future workers of the operation and on the level of hiring of local labor.

Therefore, it is recommended that PARACEL articulate with professional education bodies and institutions for the conclusion of agreements aimed at the professional training of the local population.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Positive	+
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local, regional and strategic	3
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type III Accumulation	
Magnitude:	Medium	2
Importance:	Large	3
Possibilities of potentiation:	High	
Degree of potentiation	High	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Measures of enhancement

Promote a dissemination campaign to hire labor for the operation phase of the pulp mill through the Dissemination and Communication Program;

Articulate with professional education organizations and institutions for the professional training of the local population through the Program for the Development and Linking of Local Labor.

<u>Responsibility for the implementation of the measures</u>

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

<u>Forecast after implementation of measures</u>

Following the implementation of the enhancement measures, it can be assumed that PARACEL will promote the hiring of available labor in the municipality of Concepción and the region, as well as train the local population.

10.1.4.4.3.2 Higher risk of accidents

<u>Potential environmental impact</u>

Risk of accidents in the mill.

<u>Impact-Generating Factor</u>

Pulp mill operation.

<u>Technical justification</u>

The installations contemplated in the PARACEL pulp mill involve a series of chemical products. The following Table shows the main products and their risk class/subclass established by the UN.

Table 14 – Major products and UN class/subclass

Product	Un number	Class of Risk	Risk label
Methanol	1230	3 - Flammable Liquid	
Caustic Soda	1824	8 - Corrosive substance	
Sulfuric Acid	1830	8 - Corrosive substance	
Diesel Oil	1202	3 - Inflammable Liquid	

Product	Un number	Class of Risk	Risk label
Fuel Oil	3256	3 - Inflammable Liquid	
Sodium Chlorate	2428	5.1 - Oxidizing	
Chlorine Dioxide	3139	6.1 - Toxic Gas	
Sodium bisulfite	2693	8 - Corrosive substance	
Oxygen	1072	2.2 - Non-toxic compressed gas	
Hydrogen peroxide	2014	5.1 - Oxidizing	

NOTE: * It should be noted that, conservatively, chlorine was considered to be a representative substance for chlorine dioxide, assuming that in a possible release of chlorine dioxide, the product released will be chlorine. It should also be noted that PARACEL will not use chlorine in its bleaching process (**it will use the ECF Process - Elemental Chlorine Free)**.

From the initial characterization of the products, to give continuity to the Preliminary Risk Analysis Study, the most representative liquid or gaseous chemicals in terms of flammability and toxicity were selected.

From the application of the Preliminary Hazard Analysis (PHA) methodology to identify the hazards related to the facilities and operations with the products handled at PARACEL, 53 hazards were identified, always considering relevant accidental situations, i.e., events caused by non-condensable gas, methanol and chlorine dioxide leaks, which are significant in the plant in question.

The possible effects associated with the accident scenarios identified in the PPP were classified according to severity, always considering two types of phenomena, where appropriate; namely, large and medium leaks, associated with the lack of containment of these products.

The distribution of effects associated with these accident scenarios (hazards) was as follows:

- 13 hazards (24%) classified as negligible risk;
- 10 hazards (19%) rated as Minor Risk;
- 26 hazards (49%) of Moderate Risk;
- 4 hazards (8%) classified as Serious Risk;
- None of the hazards classified as Critical Risk

The following Figure presents the risk matrix with the quantification of the assumptions according to the classifications adopted.

		FREQUENCY OF OCCURRENCE				
		A	B	C	D	E
SEVERITY	IV					
	III		**3**	**4**	**4**	
	II	**3**	**10**	**6**	**22**	
	I				**1**	

Figure 5 – Risk matrix with hypothesis quantification

In this risk analysis, it was verified, through the application of the APP (Preliminary Risk Study) methodology, that no hazard was classified as Critical, and that the majority (92%) of the identified risks are classified as Negligible, Minor or Moderate.

In order to prevent and give a prompt response to social contingencies in the constructive and operational stage of the undertaking, the Social Contingency Prevention and Management Program will be implemented.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	

Area of spatial coverage:	Local	1
Probability of occurrence:	Possible	1
Time of occurrence:	Short Term	1
Timing or length:	Temporary	1
Reversibility:	Irreversible	2
Accumulation:	Simple	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

- Follow the guidelines of the Risk Analysis Study, including
    - ✓ Implement containment and waterproofing systems in the areas surrounding the chemical tanks, in addition to implementing maintenance and monitoring plans;
    - ✓ Provide training to operators involved in the handling, storage and transportation of hazardous products;
    - ✓ Install firefighting and control systems
- In the event of an operational emergency, implement the Emergency Action Plan;
- Use the appropriate PPE (Personal Protective Equipment) on the pulp mill facilities;
- Implement the Program for Prevention and Management of Social, Environmental and Labor Contingencies.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

The risk analysis study concluded that no hazard was classified as Critical, and that most of the identified risks are classified as Negligible, Minor or Moderate, and accidents will be limited to the internal area of PARACEL's industrial plant, even though the planned prevention and mitigation measures must be implemented.

10.1.4.4.3.3 Increasing tax collection and Boosting the economy

Environmental aspect

Growth in the production of goods and services.

Impact-Generating Factor

Demand for products and services.

Technical justification

Trade in the region tends to benefit from the emergence of demand for products linked both directly to the operation of the mill and indirectly, through consumption by the workforce linked to the activity.

The demand for formal trade products and services in the region tends to increase. This dynamization may lead to the opening of new small and medium-sized enterprises, products and services, as well as the strengthening of existing ones. The growth in the number of jobs in the region is a foreseeable consequence.

The operation of the pulp mill in the municipality of Concepción, as well as the creation of direct and indirect jobs, will promote an increase in tax collection, which will provide the government with investment possibilities in social and economic areas. This process is called the multiplier effect and is based on economic theories to estimate the economic impact of the main initiatives.

Thus, the increase in the collection of taxes derived from the company is considered a positive impact and of great importance.

This dynamism of the local economy can be demonstrated through indicators, which can be the significant increase in public investment, the increase in tax revenue.

The informal economy will also benefit. The low-skilled population, or those unable to enter formal activity, tends to resort to emerging informal activities, due to the demand generated by the presence of the labor contingent in the operation phase. The emergence of bars, food stalls and other consumer items may occur in the area near the company.

Informal commercial activities are usually not recorded neither legal. If there are no records, there is no way to evaluate the benefits that could be generated for the public treasury and to monitor the quality of services.

On the other hand, this trade can be analyzed in a favorable perspective, considering the generation of income and economic activities that will promote the circulation of currency in municipalities and regions.

Therefore, there will be dynamism in the local economy from the construction phase and will remain during the operation phase of the mill, with the government having the responsibility to monitor informal activities and reinvest the taxes collected in improvements to the municipality.

Also, the effect of operating the PARACEL project in energy terms can be considered positive, although the pulp mill will be an exporter of clean energy generated by the combustion of eucalyptus biomass in the production process.

The tax collection will also come from the sale of pulp since preferably, all the production will be destined to export, directed to the markets of Latin America, United States, Western Europe and Asia.

By prioritizing the acquisition of local goods and services and requiring fiscal compliance from contractors and subcontractors, tax collection in the region will be increased.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Positive	+
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local, regional and strategic	3
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	High	3
Importance:	Large	3
Possibilities of potentiation:	High	
Degree of enhancement:	High	
Degree of resolution of measurements:	High	
Area of influence:	DIA and IIA	

Measures of enhancement

- Give preference to companies, service providers and trade in the region through the Promotion and Development of Local Suppliers Program.
- Encourage the purchase of services and products preferably in Concepción and the region through the Promotion and Development of Local Suppliers Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

The pulp production will boost the economy of the municipality of Concepción, and the region through the purchase of inputs and services from the local economy and tax collection.

The company will generate an increase in tax revenue, in accordance with current tax law, which will be enhanced through the Promotion and Development Program for local suppliers.

10.1.4.4.3.4 Road transportation increase

Environmental aspect

Increasing vehicle traffic and Increasing running over animals.

Impact-Generating Factor

Movement of vehicles.

Technical justification

The access to PARACEL pulp mill, from Concepción will be done through a main access, as shown in the following figure.

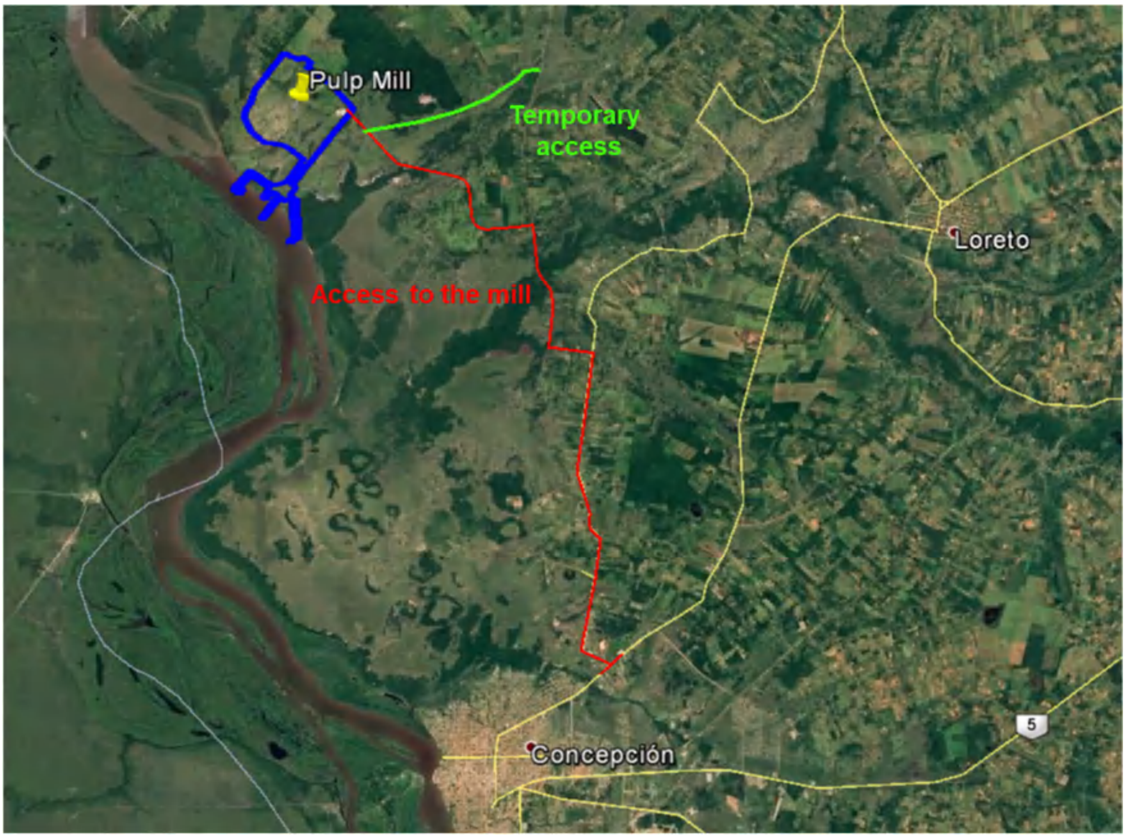


Figure 6 – Access to PARACEL pulp mill. Source: Google Earth, 2020.

Other than that, the process of forest transportation which starts in farms (own or third parties) in which harvesting activity takes place, and comprehends the transportation of logs from the plantation site to the point of delivery (PARACEL's pulp mill in Concepción) will also increase road transportation. It includes the steps of loading, transportation and unloading, for wood coming from properties owned by PARACEL as well as leased properties. The transportation is made by truck, which transits through public and private paved or unpaved roads.

Giving the 6-year period necessary for PARACEL'S own forests to grow and start supplying the market, the early stages of the project will depend on wood bought from the market. This wood will be sourced from different producers in Brazil, Argentina and Paraguay, aiming to achieve a share of 70/30 of FSC certified forests and controlled wood sources.

The logistics for wood bough from the market, from the source to the PARACEL mill site, will consider river transportation for wood coming from Argentina and both river and road transportation for wood coming from Paraguay and Brazil. This is a measure that will prevent accidents and traffic due to road transportation.

It should be noted that "infrastructure and road safety" is the aspect most often mentioned by representatives of DIA institutions and communities in relation to the aspects necessary for the further development of their communities/districts. In this sense, they have highlighted the need to improve the state of the roads and the neighbourhood roads. The inadequate condition of some roads in the DAA/DIA plus the already existing perception of these roads in the DIA and the loading of the vehicles of the Project construction give a notion that the impact of the Project will be important on the road infrastructure from the social perspective.

Therefore, it is recommended that these routes undergo constant maintenance and are properly signposted, and it is necessary to inform and raise awareness among vehicle drivers about defensive driving to avoid accidents.

On the main access roads to the internal area of the pulp mill project, PARACEL must install road signs, warning of dangers and speeds. In addition, proper maintenance of the engines of the machines, trucks and vehicles used, together with a Road Safety Program will prevent accidents due to the increase in vehicle traffic.

The increase in vehicle traffic also increases the risk of animals being run over on the main access roads to the company.

From the point of view of improving the infrastructure conditions of and for the communities, as well as the development of the quality of life in the area, the project will determine an incremental benefit over time in the structural improvement and of paving of all public routes to be used for the transport of wood, which would have a positive impact, through: i) decrease in travel times (note that traveling the 70 km between Jhugua Ñandu and Puentesiño takes today 1,5 hours), ii) improvement of road safety; iii) reduction of the emission of rolling dust, with its consequent benefits to the environment and public health in general, iv) facilitation of access to/from emergency services (ambulances, police, firefighters). In relation to potential cumulative negative impacts, the impact on infrastructure and road safety is mentioned, since in the operational stage of the forest fields (during the harvest season and transportation of wood to the industrial plant), the movement of vehicles at the rate of one truck every 4 minutes approximately from years 6 - 7 after the installation of the plantations in each forest field. If to this we add the development of new similar ventures, this rate could increase. Although better roads lead to drivers going faster, therefore PARACEL will inform and raise awareness among vehicle drivers about defensive driving through the Road Safety Program, other than that priories the river transport.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Possible	1
Time of occurrence:	Long term	3
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Simple	
Magnitude:	Medium	1
Importance:	Medium	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Mitigation measures

- Consider river transportation for wood to prevent accidents and traffic on roads;
- Install signage plates on the main access routes to the plant area;
- Inform and raise awareness among vehicle drivers about defensive driving through the Road Safety Program.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It can be stated that the risk of personal accidents and running over animals on roads will be minimized by the implementation of road signs and drivers training about defensive driving, other than using river transportation for wood.

10.1.4.4.3.5 Impacts from the Transmission line and substation

Environmental aspect

Risk of accidents and electromagnetic field.

Impact-Generating Factor

Pulp mill operation.

Technical justification

It is important to highlight that the TL will be built along and within the right-of-way belt of pre-existing public roads through a suburban area. In this context, the screening of impacts made it possible to rule out the impacts on the physical environment and on the biotic environment as they were clearly non-significant. For this reason, the impact of the TL is analyzed in the section on socioeconomic impacts.

The electrical energy required is estimated at 7 MW for the implementation stage of the plant and will be supplied through generators until the high voltage transmission line is completed. These generators will supply the offices, bathrooms, cafeteria, and other facilities, as well as the pumps of the temporary effluent treatment system.

At the peak of the works, four 1,250 kVA diesel generators will be installed. The estimated diesel consumption for each generator is 30 liters/hour during 12 hours of operation, for a total of 1,500 liters per day, which will be supplied by the storage tank with a capacity of less than 15,000 liters and also supplied by trucks.

The generators and their respective diesel tanks will be installed on a waterproofed area, protected by metal trays, preventing any spillage from contaminating the soil.

Thus, the infrastructure required for the construction of the pulp mill consists of water intake, discharge of treated effluent, transmission line, road access and river port for the outbound of pulp.

As already mentioned, there will be a cogeneration system in the pulp mill, beginning with the production of high-pressure steam by the recovery boiler and the biomass boiler.

The high-pressure steam will undergo expansion in the turbine blades and will be extracted at different pressure levels for use in the pulp manufacturing process.

Turbogenerators will have the purpose of transforming the thermal energy of the high-pressure steam into mechanical energy to activate the electrical energy generators.

The supply of steam to the turbogenerators will cover the operation, plus the contingency. The contingency is considered to absorb any variation in steam production in the recovery boiler due to variations in the solids contained in the liquor or even considering calorific value.

It is planned to install 2 turbogenerators for total generation of up to 220 MW for producing pulp for paper. The pulp production will consume about 120 MW, with a surplus of 100 MW to be exported to the grid.

Therefore the project involves the construction, assembly and commissioning of the 220 kV Simple Air Transmission Line, of which the stretch will be between the Concepción Substation and the new Estancia Zapatero Cue Substation, presenting an approximate 33 km length.

Operation phase

At the operating stage the electromagnetic field that will occur during the period of operation of the installations is because the high voltage lines near the conductors cause partial depressions in the air around them, causing alterations recognized as the "crown effect", noises in radio broadcasts, interference in television signals and in telecommunications. It is possible to decrease the power of the fields, both electrical and magnetic, if the distance of the transmission lines is greater. Atmospheric disturbances such as rains and mists favor the appearance of this phenomenon while the aging of the driver slows it down.

However, these effects will not be very relevant when it comes to public health as the electro-magnetic field effect will be mild, remaining at values below the limits set by the World Health Organization (WHO).

In the Project the impact of the electric and magnetic fields to be generated during the operation of the line, in terms of the possible health effects due to the exposure of people, will be minimized due to the release of the bondage strip of the line and implementation of the safety and service zone.

Estimates indicate that field values will be below the maximum values recommended by the World Health Organization (WHO) and established by Decree 10.071/07.

- Generation of particulate matter

There will also be some generation of particulate matter that will be of little importance and already during the operation of the system will be imperceptible.

- Risk of accidents

In the operation phase of the transmission line, the risk of accidents will already be very low.

Likewise, some contamination of surface water from oil spills, fuels, solid waste, etc., during the maintenance stage of the line, impacts that can be minimized by strict compliance with the Environmental Management Plan of the transmission line could occur.

Appropriate techniques should also be used in the clearing and control of vegetation in the bondage strip to clean vegetation from the right of way and control the quantity and type of the new vegetation. Selective clearing using mechanical means is preferable and should be analyzed in the project ESIA. Aerial dew of herbicides should be avoided because it is not selective and introduces large quantities of chemicals into the environment, and is also an imprecise application technique and can contaminate surface water as well as terrestrial food chains.

– Risk of bird /bat collision

There is also the risk of bird / bat collision or physical collision of birds with transmission line cables, especially in rural areas. In general the vulnerability of the group of birds to collisions appears to be a low risk factor, however this impact should be taken into account in specific habitats that are more vulnerable.

To find a solution to the problem of bird collision with transmission lines, it is envisaged that flight diverters will help migratory birds to have a visual image of vivid colors to avoid colliding with high voltage lines.

– Local labor

Local labor may also be used at the operating stage for the maintenance activities of the bondage strip, resulting in a positive impact to improve local income levels.

In addition, the electric transmission line may induce development alongside road rights or on nearby lands that have become more accessible to the development of the Project.

However, the most relevant and permanent positive impact can be considered to occur in the global economy because of the increased supply of electricity that will be available to generate sustainable productive activities and new investments in the country's industrial development, which will ultimately result in greater well-being of the population and these benefits will already be permanent in nature.

– Impacts associated with substation operation are:

a) Exposure to electromagnetic fields

Exposure to electric and magnetic fields shall be given by permanent personnel attached to the future Substation. Public exposure is considered not significant because nearby populations or dwellings are not observed in the indirect area determined above.

Other potential negative impacts

During operation, maintenance tasks for line installations and power equipment to be installed in substations are considered minimal. Changes in transformer gel silica, when required, are made under strict safety conditions. On the other hand, safety systems and standards used in the design of electrical installations ensure reasonable protection against accident risks that endanger the health of workers and third parties.

b) Impact on electricity service

The most significant impact attributable to the project is given by the benefits it will represent for the performance of the Transmission System, allowing to meet the demand for electrical energy with reliability and quality.

c) Noises and other environmental factors

Noise emitted by the Substation is considered not significant. In addition, the environmental impact on the medium air is punctual and dissipates as the distance to the source of generation increases.

<u>Characterization of the impact</u>

	Qualitative	Quantitative

Nature:	Negative/Positive	-+
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local and regional	2
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II and III	
Magnitude:	Medium	2
Importance:	Medium	2
Possibilities of potentiation:	Medium	
Degree of potentiation	Medium	
Mitigation possibilities	Mitigated	
Degree of resolution of measures:	Medium	
Area of influence:	DIA and IIA	

Mitigation measures/enhancement

Perform workers training to prevent accidents, through Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations.

Minimize the impact of the electric and magnetic fields to be generated during the operation of the line, due to the release of the bondage strip of the line and implementation of the safety and service zone.

Envisage flight diverters that will help migratory birds to have a visual image of vivid colors to avoid colliding with high voltage lines.

Use safety systems and standards in the design of electrical installations to ensure reasonable protection against accident risks that endanger the health of workers and third parties.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

The Transmission line and substation implantation and operation will not cause any significant impact to the physical and to the biotic environments, neither to the communities because they will be placed on anthropized areas along existing road rights sides. The most relevant and permanent positive impact can be considered to occur in the global economy because of the increased supply of electricity that will be available to generate sustainable productive activities and new investments in the country's industrial development, which will ultimately result in greater well-being of the population and these benefits will already be permanent in nature.

10.1.4.4.3.6 Port operation

Environmental aspect

Risk of accidents.

Impact-Generating Factor

Maneuver, loading and unloading.

Technical justification

The river port of the pulp mill will be a terminal-type construction on the left bank of the Paraguay River, built as an elevated platform on a structure composed of: an operating platform, an access bridge for vehicles and people, and a shed structure for the pulp transport area. All the structures will be made of reinforced concrete and the loading roof will be made of a metal structure. It will be implemented from the shore through the sustainable methodology of the Cantitraveller type with prefabricated elements.

The port will move the following loads:

- Pulp transport by river barges at an average rate of 1,500,000 t/year;
- Reception of logs with volumes varying between 2 and 5 million m^3 s sc/year;
- Reception of inputs for the pulp mill (liquid or bulk) up to 450,000 t/year.

The boats that will operate in the port will be the current models in circulation in the fluvial section of the Paraguay River with the format of convoys according to the official conditions of navigation. The typical pulp convoy will consist of barges) with a unit capacity of up to 2,500 tonnes each.

The boats for wood and inputs will be suitable for each of the operations/products and will be regulated by the navigation conditions.

No dredging actions will be required for the approach channel, the evolution basin and the anchorage area of the vessels (barges and pusher craft). For platform or access bridge construction services, bottom forming services may occasionally be required at the site of underwater structures.

The selection of the positioning of the river port was defined according to the format of the pulp mill area and the morphological characteristics of the Paraguay river, shown in the following figure.

The selected point is characterized by having natural draft conditions for boats (pulp barges) without the need for deepening actions or maintenance of dredging, and preserves the conditions of regular distance from the navigation channel, in accordance with the premises and institutional regulations.

The train anchorage areas are located upstream of the river port for empty trains awaiting cargo and downstream for loaded trains awaiting final train formation.

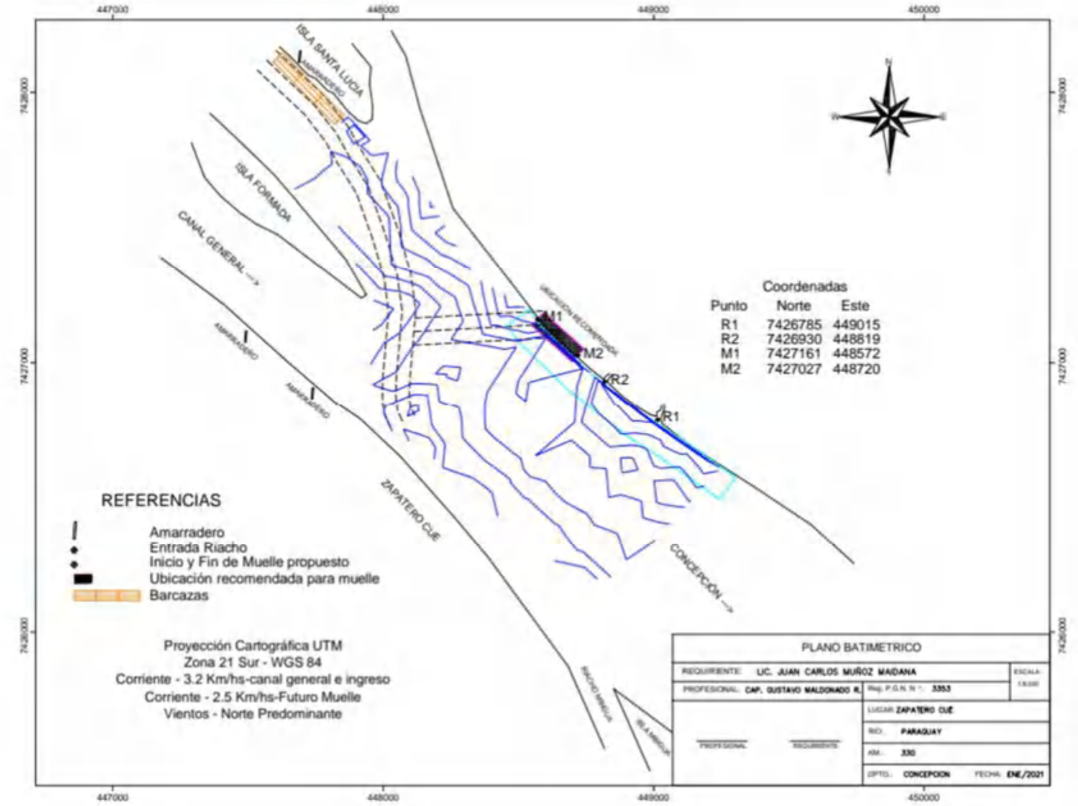


Figure 7 – Location for the port

The logistics for wood bough from the market, from the source to the Paracel mill site, will consider river transportation for wood coming from Argentina and both river and road transportation for wood coming from Paraguay and Brazil. This is a measure that will prevent accidents and traffic due to road transportation, although vessel accidents should also be avoided thought good maneuver, loading and unloading procedure.

The pulp waterway route to Nueva Palmira is presented in the picture below.

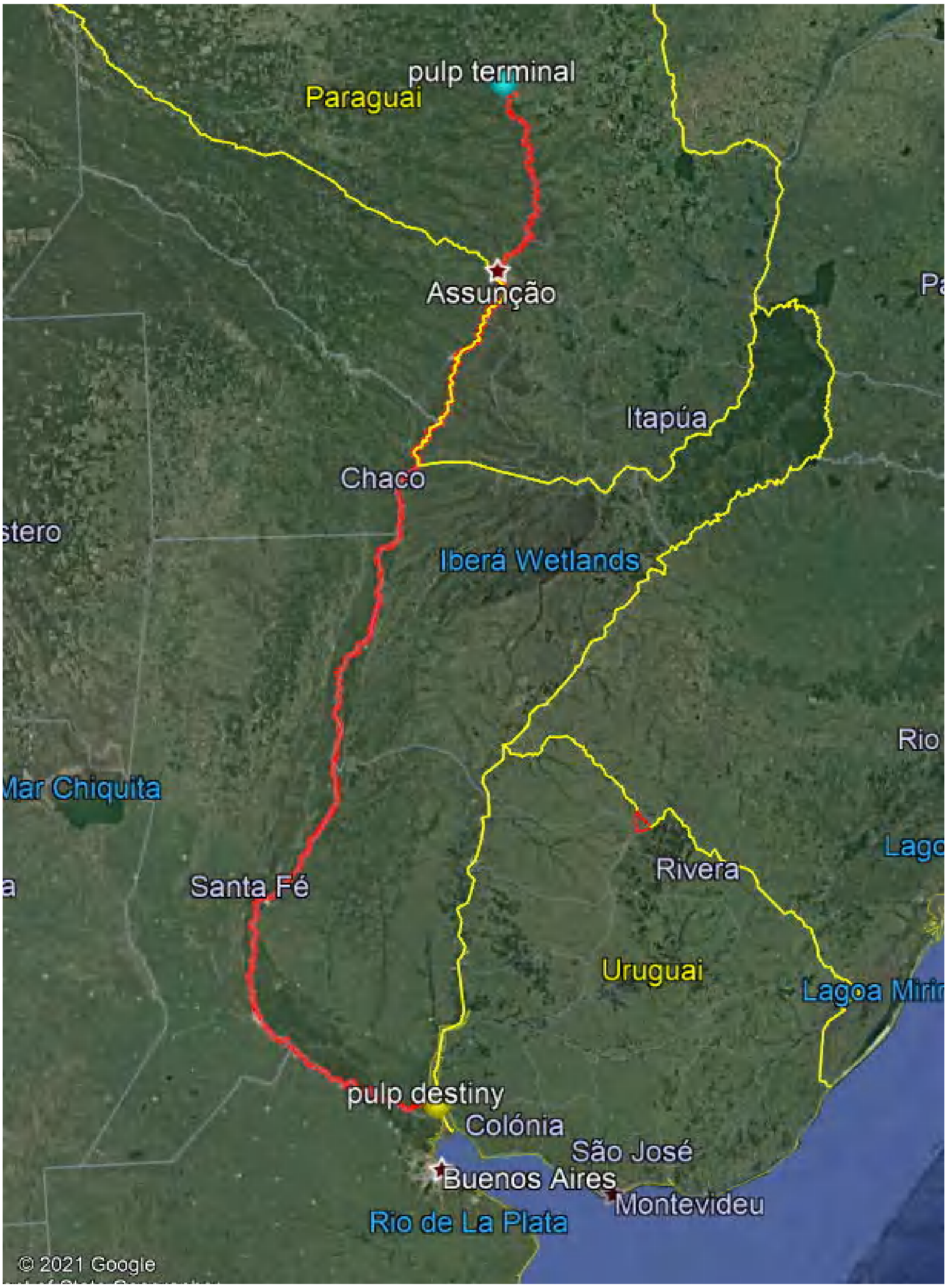


Figure 8 – Pulp waterway route

<u>Facilities Description</u>

AWT

The AWT (All Weather Terminal) will be completely developed in metallic structure, therefore, the covering, the closings and the beams will be metallic. The 56 t capacity crane support columns will be made of precast concrete.

Support Building

This building will have a conventional concrete structure, structural masonry, precast slab and metal roof. The support building will have house bathrooms, meeting rooms and control rooms.

Mooring Points

The design includes tie-down points, main protection points and protection points of the AWT roof columns. It is planned to use metal jacketed perforated inclined piles filled with reinforced concrete and their respective blocks, which consist of a precast bark element for the second subsequent concreting step.

Barge Pier

The barge dock will have reinforced concrete platform. Its structure will be made of perforated metal-clad piles filled with reinforced concrete, beams and precast slabs in solidarity with the reinforced concrete in situ.

Access Bridge

As well as the pier, the access bridge will be made up of wide reinforced concrete structure. Its structure will be made of perforated metal-clad piles filled with reinforced concrete, beams and precast slabs in solidarity with the reinforced concrete in situ.

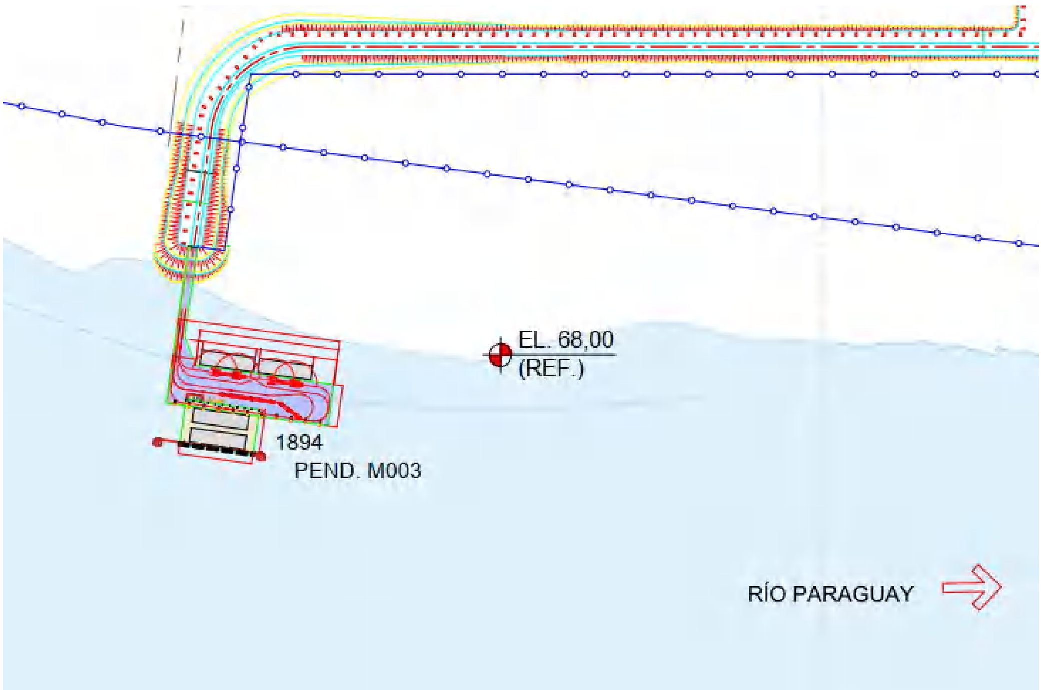


Figure 9 – River Port

It should be noted that PARACEL will require the best practices from all its service providers, and require periodic maintenance in all operating boats, but in case of fuel leak in Paraguay River an Emergency Plan should be started immediately to contain the spill to cause the least possible impact.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Temporality or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

Perform good maneuver, loading and unloading procedure to prevent accidents due to river transportation.

Require the best practices from the services providers.

Perform an Emergency Manual in the Port.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

It is difficult to foresee the intensity of these risks, but they can be efficiently minimized through the application of proceedings in port structures.

10.1.4.4.3.7 River transportation increase

Environmental aspect

Risk of accidents.

Impact-Generating Factor

Port operation.

Technical justification

The commercial navigation of the Paraguay River began in 1870 with the export of tannin in ships of the Mihanovich Company to which, later, the products of the cement industry (Vallemí SA) were added, the supply of the populations located at North (to the town of Bahía Negra and even extending to the towns of Corumbá and Cuyabá) as well as commercial traffic between the cities of Asunción and Buenos Aires.

In its current conditions, coinciding with an alternation of periods of high and low water, which occurred between 1911 and 1961, navigation began in the mid-1950s with the exploitation of the iron deposits of the Mutún and Urucum (in the surroundings of Corumbá and Puerto Quijarro), being interrupted in the period of low water developed between the years 1962 - 1973.

Subsequently, as of 1974 and taking advantage of a new period of high waters, both navigation and economic activities for the production of bulk cargoes (iron ore and manganese, soybeans and by-products, wheat, oil and derivatives, forest products, clinker and calcareous materials).

In more recent years, particularly as of 1998, a new period of low water seems to have begun (although the great interannual variability is preserved), and it should be noted that, at the time of preparing this report, the Paraguay River is in a situation of extraordinary downspout, having reached, in the town of Asunción and on October 25, a minimum value of –0.54 m at Local Zero, which is even below the historical minimum (–0.16 m in 1938, – 0.19 m in 1944, –0.36 m in 1967, –0.14 m in 1968, –0.40 m in 1969, –0.25 m in 1970 and – 0.14 m in 1971).

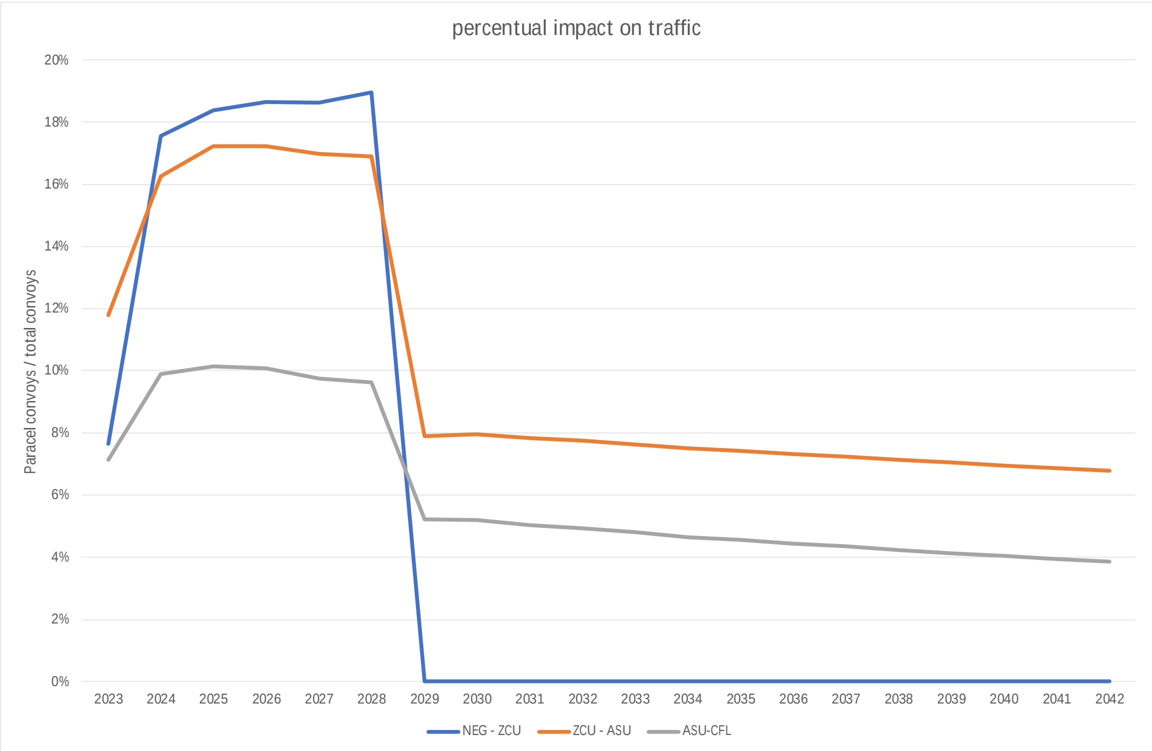
Regarding its use, the inland waterway of the Paraguay River is, for the most part, operated by convoys of barges that transport solid bulk (soybeans and its by-products, wheat, iron and manganese ore, clinker, calcareous materials, cement) and liquids (petroleum and its derivatives, oils) and that carry out the traffic between ports of the Brazilian SW (Corumbá and Ladario), of the Bolivian West (Jennefer, Aguirre and Gravetal) and of the own Paraguay (Vallemí, Concepción and other smaller ports) with ports of Argentina, Uruguay and Paraguay itself.

The main problems are related to the conditions of the inland waterway and the navigation itself. Indeed, within the framework of studies, between 2009 and 2011, various interviews and consultations were carried out with officials of the Ministry of Public Works and Communications (MOPC) and the Management of Navigation and Hydrography (GNH) of the National Administration of Navigation and Ports (ANNP) as well as with captains of the main navigation companies (Panchita G SA, Transbarge de Navegación SA and UABL Paraguay SA) and members of the Societies of Captains and Pilots of the North and South Zones of the Paraguay River.

Such difficulties necessarily imply cost overruns for the economies of the companies involved (not only shipping companies but also those related to production and other diverse items). Additionally, the non-optimal use of the available resources and the delays in navigation, invariably cause delays in the delivery of the cargo and in the transfers of the transshipments (with the concomitant risks of loss of products or the need to use the own barges as "floating tanks", at least until the corresponding load transfer is achieved).

The logistics for wood bough from the market, from the source to the Paracel mill site, will consider river transportation for wood coming from Argentina and from both river and road transportation for wood coming from Paraguay and Brazil. It is known that river transport causes less environmental impacts than roads impacts specially when the load is not hazardous, because it is basically wood. Therefore it is recommended for PARACEL which aims to introduce this venture covering all concepts of sustainability, following the principles and criteria of the best environmental certifications.

It was done a study to calculate the impacts within the existing ports in Paraguay River from the Paracel project. According to the figure bellow, it can be seen that the greatest impact will be from Rio Negro to Paracel Port (in blue) being the increase up to 19% of its current capacity, but it will occur only in the first 6 years of operation, the traffic from Paracel Port to Assunción port will increase by 17% on the first 6 years and then keep the boats traffic increase within only 8%-7%, and the least impacted river path will be from Assunción port to Confluencia port, where within the first 6 years will increase traffic in about 10% and then keep the movement in this path about 4% greater then todays traffic. But the ports are able to support this increment.



It should be noted that river transportation has many advantages from road transportation, like:

– Greater energy efficiency;
– Greater load concentration capacity;
– Longer infrastructure life;
– Longer equipment and vehicles life;
– Lower fuel consumption;
– Reduced pollutant emissions (climate change and greenhouse effect);
– No traffic congestion;
– Lower infrastructure cost;
– Less likely to have accidents;
– Lower operating cost; and
– Minimize noise emission.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative/Positive	-+
Form of incidence:	Direct	
Area of spatial coverage:	Local	1
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Temporality or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type II Accumulation	
Magnitude:	Medium	2
Importance:	Small	1
Mitigation possibilities:	Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

Priorate or balance wood from river transportation instead of road transportation.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

There are more environmental benefits by using river transportation instead of road transportation and PARACEL should balance both ways.

10.1.4.4.3.8 Visual impact

Environmental aspect

Change of landscape and land use.

Impact-Generating Factor

Construction of the pulp mill, consisting of buildings, towers and chimneys.

Technical justification

The pulp mill will be located in the municipality of Concepción, about 15 km from the city center.

City people may not see the impact on the landscape, however, everyone who lives nearby, or uses the roads and/or waterway near the company may feel the impact on the landscape.

According to the environmental diagnosis, the existing agricultural routes and activities throughout the study area have historically already led to a modification of the landscape, favoring generalist species, rather than those more sensitive to changes in the environment.

The area planned for PARACEL's industrial unit is located in a rural area of the cattle activity, however part of the water intake area, effluent emissary and river port are located in areas of natural vegetation.

Obviously, the industrial unit consisting of buildings, towers and chimneys will change the local landscape.

To mitigate the impact on the landscape the project must be implemented to favor the integration of the plant with the environment.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Negative	-
Form of incidence:	Direct	
Area of spatial coverage:	Local	1

Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1
Timing or duration:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type III Accumulation	
Magnitude:	Low	1
Importance:	Small	1
Mitigation possibilities:	Partially Mitigated	
Degree of resolution of measures:	High	
Area of influence:	ADA	

Mitigation measures

Implement the landscape project that favors the integration of the mill with the environment, reducing the effect of the contrast of the buildings and structures with the natural landscape, such as the implementation of tree curtains and reuse of the soil from earthworks in gardens within the industrial area in accordance with the Landscape Recomposition Program besides revegetation of riparian forests.

Responsibility for the implementation of the measures

PARACEL, as detailed in the "Health, Safety, Environment and Social Management System Manual" report.

Forecast after implementation of measures

The construction of the pulp mill will inevitably alter the landscape and local land use, which can be minimized by implementing the Landscape Rehabilitation Program.

10.1.4.4.3.9 Increase communication with local Stakeholders

Environmental aspect

Affected elements from the mill and Communities consultation.

Impact-Generating Factor

Pulp mill operation.

Technical justification

In order to develop a good management system during the different stages of the project, a comprehensive evaluation is required to identify impacts, risks and opportunities at the environmental and social levels. This requires the inclusion of stakeholders as part of participatory processes, as well as the dissemination of relevant information about the project.

The effective and systematic participation of stakeholders must be guaranteed through informed consultation and participation processes in the different phases of the project.

The program of relations with the community and local development refers, first of all, to the generation of mechanisms for the participation of the population of the areas involved in the project DAA/DIA for the industrial component. In actions that are oriented to the identification and formulation of alternatives to the changes that could occur with the implementation of this. Likewise, it seeks to contribute to the strengthening and development of communities, both in the social, economic, cultural, and other aspects; and the active involvement of the inhabitants in matters that make the transformation of the current conditions of their environment.

With the field work carried out for the preparation of the LBS (Social Line Basis) studies; in the first and second stages, information gathering and exchange activities were carried out with the population of the areas that make up the DIA of the component, enabling a first communication channel with them, which in turn could know the situation of these territories with respect to access to basic services, health, education, participation, others. This process and the international regulations involved constitute the basis for the generation of community development proposals in these areas, before which the following points should be considered:

- The importance of sustaining the communication, already initiated, in the territory by returning the results of the information survey; carried out for the baseline studies and the involvement of the various stakeholders and interest groups; already identified in the different spaces.
- All actions that involve the community must consider the prior elaboration of participatory diagnoses in consultation spaces, promoting equitable participation between women and men in the community, and permanent monitoring of the activities planned for this purpose.

The implementation of the activities with the aforementioned considerations ensure compliance with the principle of Equator No. 5; that highlights the importance of the "effective participation of Stakeholders in a continuous, structured and culturally appropriate manner for the Affected Communities; and, where appropriate, for Other Stakeholders", the importance of carrying out consultation processes according to the degree of adverse impacts that may occur in each area, adapted to their linguistic preferences; their decision-making processes, and the needs of disadvantaged and vulnerable groups.

The communities located on the access roads to the area surveyed for the construction of the plant have the particularity of becoming an area with an identity of cohesion between communities that are linked to each other and interdependent on each other. Saladillo, Mongelos and Roberto L. Petit are communities with greater capacity, in which educational institutions, health services, etc. are concentrated, to which residents of neighboring communities with less capacity attend daily.

In the areas involved in the project, community organizations, producer committees, neighborhood commissions, water and sanitation boards, among others, were also identified; as well as private initiatives for recreation such as watering places, and also small businesses and places with some type of service.

Taking into account this information and other characteristics surveyed, the following measures are proposed to strengthen local capacities by the project to be implemented:

– **Support for the strengthening of community identity**: Measure through which it is intended to generate activities that promote the strengthening of the existing community link between communities; accompanying the process of change that could be generated with the implementation of the project. Activities may include the participatory development of joint projects; including vulnerable groups (women, children, people with disabilities and the elderly), the setting up of community centers, the development of health appeasement in coordination with the regional offices of the MIC, SNPP, USF (training in preventive measures against COVID-19, HIV, and other public health issues), the organization of cultural events, etc.

– **Support for the strengthening of community organizations in the area**: In connection with the previous measure; it will seek to offer the organizations in the areas activities that promote their strengthening, placing special emphasis on productive committees (for example, in the forestry component, artisans dedicated to the production of karanday products), technical assistance with a gender approach and the provision of marketing spaces in coordination with different relevant actors in the district. In addition, actions related to the rational use of water, the importance of the prior purification of the water provided by the sanitation boards or commissions, water quality monitoring, among others, will be promoted.

– **Promotion and development of local initiatives**: Aiming to provide technical support for the improvement and sustainability of local initiatives such as MSMEs, small businesses, workshops and others. In addition to support and advice for legal issues; such as the provision of tourist and recreation spaces (watering places) in the area.

– **Improvement of existing infrastructure**: In coordination with departmental and municipal governments, support the generation or improvement of spaces for recreation and outdoor recreation (squares, parks, courts, etc.), road safety signs in areas with concurrence of people and especially children (squares, schools, churches); as well as the improvement of the local landscape and of all kinds of infrastructure of community relevance.

It is important to highlight that although the communities are important stakeholders, they are not the only ones. Therefore it was mapped the stakeholders divided by category and sectors as below:

Category	Sector
Control Agencies	Public sector (Ministries, Secretaries, etc..)
Project decision	Public sector (Ministries, Secretaries, etc..)
Interest in the project	Public sector (Ministries, Secretaries, etc..)

Category	Sector
Interest in the project	Private Sector (Gremios)
Interest in the project	Private Sector (Communication Media)
Interest in the project	Civil Society Organizations (Environment)
Control Agencies	Civil Society Organizations (Indigenous Communities)
Interest in the project	Civil Society Organizations (Inclusion / Sustainability)
Potential Benefits	Academy, educational and research institutions
Interest in the project	Religious institution
Potential Benefits / Potentials Affected	Micro territories
Potential Benefits / Potentials Affected	Suppliers
Potential Benefits / Potentials Affected	Collaborators
Project decision	Shareholders (investors)
Project decision	Investors (banks)
Potential Benefits	Communication and Monitoring Committee
Interest in the project	Civil Society Organizations (Forestry Rubro - Brazil)

According to the stakeholders evaluation, it was performed graphics of Preponderance, Power, Legitimacy and Urgency levels, as follows:

The resulting is a Power and Risk Matrix of the stakeholders, as follows:

By mapping the stakeholders, PARACEL can anticipate their needs, bring confidence and satisfaction regarding the implementation of the project, contributing to the good image and transparency of the company.

Other than that, Paracel provided communities consultation, specially the indigenous people, regarding the project. There will be impacts to indigenous people as a result of the pulp mill activities, but these are detailed in the Forestry ESIA. The only indigenous community near the site is called Redención, located about 13 km from the site.

Presidential Decree No. 1039 of 2018, which approves the "Protocol approving the process of consultation and free, prior and informed consent with the indigenous peoples inhabiting Paraguay", grants INDI the power to issue "the relevant regulations for the effective implementation of the Protocol, with the collaboration of the indigenous peoples". In this context, INDI produced Presidential Resolution No. 251/2019 on the Certificate of Non-Objection.

The consultant of the indigenous component, Urbano Palacio, advised that a protocol visit should be made to the authorities of INDI in order to inform them of the establishment of PARACEL pulp mill in the Department of Concepción, and to hear their recommendations on the preliminary study being conducted by the firm PARACEL S.A., in the process of conducting a free and informed prior consultation of the indigenous communities in the area on the possible impact of this industry.

It was performed by Fundación Natán the Free, Prior and Informed Consent about PARACEL project according with Paraguayan Law 234/94 and Regulated by Decree 1039/18. Successfully, after performed meetings and workshops, the community gave a written consent about the project. All members of the communities consulted expressed positive expectations about the PARACEL Project, thinking it can be a development opportunity for their communities, and hope to continue close and effective relationship throughout all processes involving them. The meetings conducted with indigenous people are described in more detail in Annex II, Socioeconomic of the Forestry ESIA.

Although it was verified that the community is interested in improving their health, education, safety and economic conditions. They also anticipated that the construction of the mill could affect migration activities with other communities leading to an increase in the volume of people within its community. Because the indigenous community lives in vulnerable conditions, the increase in people and economic development in Concepción could increase the risk of indigenous prostitution and human trafficking, mainly. (CLACSO, 2013)

So it is recommended that PARACEL carries out a conscious dissemination with direct and subcontractor workers to orient they about: child and indigenous prostitution, drugs, sexually transmitted diseases, etc., in the Environmental Education Program.

Other than that PARACEL should systematize, analyze and present the data in a Community Development Plan that will address people's integral needs.

A summary of PARACEL’S record of public consultations and stakeholder engagements are presented in ANNEX I.

Characterization of the impact

	Qualitative	Quantitative
Nature:	Positive	+
Form of incidence:	Direct and indirect	
Area of spatial coverage:	Local, regional and strategic	3
Probability of occurrence:	Certain	2
Time of occurrence:	Immediate	1

Timing or length:	Permanent	3
Reversibility:	Irreversible	2
Accumulation:	Type III Accumulation	
Magnitude:	Medium	2
Importance:	Large	3
Possibilities of potentiation:	High	
Degree of potentiation	High	
Degree of resolution of measures:	High	
Area of influence:	DIA and IIA	

Measures of enhancement

- Perform Community Relationship and Social Investment Program.
- Disseminate the project, informing the positive impacts that will be generated to the stakeholders through meetings and other means, in the Dissemination and Communication Program.
- Carry out a conscious dissemination with direct and subcontractor workers to orient they about: child and indigenous prostitution, drugs, sexually transmitted diseases, etc., in the Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations and Supplier Code of Conduct.

Responsibility for the implementation of the measures

PARACEL, as detailed in the “Health, Safety, Environment and Social Management System Manual” report.

Forecast after implementation of measures

By mapping the stakeholders, PARACEL can anticipate their needs, bring confidence and satisfaction regarding the implementation of the project, contributing to the good image and transparency of the company.

It can be stated that the dissemination of the project to all stakeholders (community, employees, suppliers, government, customers, etc.) and the clarification of doubts that may arise about the project, through meetings and other means, will bring confidence and satisfaction regarding the implementation of the project, contributing to the good image and transparency of the company.

Quantitative Assessment

For quantitative analysis, the maximum score will be - 893 (47 qualitatively identified impacts x - 19 points per impact). The following Table presents the quantitative analysis of the impact assessment.

Table 15 – Quantitative analysis of the impact assessment

Phase	Identified impacts	Coverage area	Probability of occurrence	Time of occurrence	Timing or length	Reversibility	Magnitude	Importance	Total Positive	Total Negative	Sum
Design	Generation of expectations in the population	-3	-1	-1	-1	-1	-3	-3	13	-13	**0**
	Generation of direct and indirect temporary jobs	3	2	1	1	1	2	3	13		**13**
	Hypothesis of non-realization of the project	-3	-1	-3	-3	-2	-3	-3	18	-18	**0**
Construction	Generation of erosive processes and sedimentation of the river	-1	-1	-1	-1	-2	-2	-1		-9	**-9**
	Conflicting water usage	-1	-1	-1	-1	-2	-2	-1		-9	**-9**
	Change in surface water quality	-2	-1	-1	-1	-1	-1	-1		-8	**-8**
	Change in air quality	-2	-2	-1	-1	-1	-1	-1		-9	**-9**
	Noise related disturbance	-2	-2	-1	-1	-1	-1	-1		-9	**-9**
	Change in soil and/or surface water and groundwater quality	-2	-1	-2	-1	-1	-2	-1		-10	**-10**

Phase	Identified impacts	Coverage area	Probability of occurrence	Time of occurrence	Timing or length	Reversibility	Magnitude	Importance	Total Positive	Total Negative	Sum
Construction	Impacts generated in the construction of the river port	-1	-2	-1	-1	-2	-2	-1		-10	**-10**
	Vegetation and land habitat loss	-1	-2	-1	-3	-2	-2	-2		-13	**-13**
	Dust generation due suppression of local vegetation	-2	-2	-1	-3	-2	-2	-2		-14	**-14**
	Change in water ecosystems	-1	-1	-1	-1	-2	-1	-1		-8	**-8**
	Higher risk of running over animals	-2	-1	-1	-1	-2	-1	-1		-9	**-9**
	Impact to Natural and modified habitat	1	2	1	3	2	2	2	13	-13	**0**
	Risk of harassment to flora and fauna by workers	-2	-1	-2	-3	-2	-2	-2		-14	**-14**
	Generation of direct and indirect temporary jobs	3	2	1	1	1	3	3	14		**14**
	Interference in infrastructure	-2	-2	-2	-1	-2	-2	-1		-12	**-12**
	Higher risk of accidents	-2	-1	-1	-1	-2	-2	-1		-10	**-10**
	Impact on the morphology	-1	-2	-1	-3	-2	-1	-1		-11	**-11**
	Interference with cultural heritage	-1	-1	-1	-3	-2	-1	-1		-10	**-10**

Phase	Identified impacts	Coverage area	Probability of occurrence	Time of occurrence	Timing or length	Reversibility	Magnitude	Importance	Total Positive	Total Negative	Sum
Construction	Increasing tax revenues and Boosting the Economy	3	2	1	3	2	3	3	17		**17**
	Worker influx Increase	-2	-1	-2	-3	-1	-2	-2	13	-13	**0**
	Impacts to community health and safety	-2	-2	-2	-1	-2	-2	-1		-12	**-12**
	Impacts to vulnerable groups	-2	-2	-2	-1	-2	-2	-1		-12	**-12**
Deactivation of construction	Reduction in the number of jobs	-2	-2	-1	-3	-2	-2	-1		-13	**-13**
Operation	Noise related disturbances	-1	-2	-1	-3	-2	-1	-1		-11	**-11**
	Change in soil and/or water quality	-1	-1	-2	-3	-2	-2	-1		-12	**-12**
	Change in air, soil and/or surface water and groundwater quality	-1	-1	-2	-3	-2	-3	-2		-14	**-14**
	Conflicting Water Use	-1	-1	-3	-3	-2	-1	-1	12	-12	**0**
	Change in river quality	-2	-1	-2	-3	-2	-2	-1		-13	**-13**
	Change in air quality	-1	-2	-1	-3	-2	-2	-1		-12	**-12**
	Fugitive emissions	-1	-1	-1	-3	-2	-2	-2		-12	**-12**
	Higher risk of running over animals	-2	-1	-1	-3	-2	-1	-1		-11	**-11**

Phase	Identified impacts	Coverage area	Probability of occurrence	Time of occurrence	Timing or length	Reversibility	Magnitude	Importance	Total Positive	Total Negative	Sum
Operation	Injury or death to fauna and flora due to improper waste disposal, including spills	-1	-1	-2	-3	-2	-3	-2		-14	**-14**
	Change in aquatic ecosystems	-1	-1	-1	-3	-2	-1	-1		-10	**-10**
	Noise related disturbances on fauna	-2	-2	-1	-3	-2	-2	-2		-14	**-14**
	Impact of oil spills in river due to river transportation	-2	-1	-1	-1	-2	-2	-3		-12	**-12**
	Artificial night light impacts to fauna	2	2	1	3	2	2	2	14	-14	**0**
	Generation of direct and indirect jobs	3	2	1	3	2	2	3	16		**16**
	Higher risk of accidents	-1	-1	-1	-1	-2	-1	-1		-8	**-8**
	Increasing tax collection and Boosting the Economy	3	2	1	3	2	3	3	17		**17**
	Road transportation increase	-2	-1	-3	-3	-2	-1	-1		-13	**-13**
	Impacts from Transmission line and substation	-1	-2	-1	-3	-2	-1	-1		-11	**-11**
	Port operation	2	2	1	3	2	2	2	14	-14	**0**
	River transportation	-1	-2	-1	-3	-2	-2	-1		-12	**-12**
	Visual impacts	1	2	1	3	2	2	1	12	-12	**0**

Phase	Identified impacts	Coverage area	Probability of occurrence	Time of occurrence	Timing or length	Reversibility	Magnitude	Importance	Total Positive	Total Negative	Sum
Operation	**Increase communication with local Stakeholders**	2	2	1	3	2	2	3	15		**15**
Full quantitative impact assessment									**187**	**-476**	**-289**

Note: For negative/positive impacts, the zero impact value is considered in the quantitative totalization. Positive impacts are added and negative impacts are subtracted.

In the quantitative assessment, the total sum of the impact assessment, adding the positive minus the negative resulted in - 289 (negative), as shown in the Table above; i.e. the quantitative sum of the negative impacts was greater than the sum of the positive impacts.

For evaluation purposes, the result of the total sum of the impact assessment was compared with the maximum achievable score (all negative impacts in the worst condition), which in this case was - 893 points (47 impacts x - 19 points per impact). This gave a result of 32.4%.

The score obtained if the mitigation measures are not applied and if there are no positive impacts, would be -476 points, or 53.3%.

In summary:

Total possible points: 893 points;

Total points added without the implementation of the proposed measures: 476 points, or 53.3%;

Total points added in this evaluation with the implementation of the proposed measures: 289 points, or 32.4%.

Since the percentage, with the implementation of the measures, is less than 50 %, it can be concluded that the company is environmentally feasible. However, it is recommended that PARACEL implements all the measures proposed in this assessment to further minimize the negative impacts generated by the construction and operation of the pulp mill.

10.1.5 Evaluation Summary Tables

Once the impacts were identified and evaluated, a synthesis framework - organized according to the affected environment and the respective phase of the project - allowed us to confront them with the attributes described above.

The evaluation of the environmental impacts in the areas involved, and the consequent proposal of mitigation or enhancement measures to be applied, were elaborated on the basis of the degree of change produced in the environmental components.

The following tables summarize the impacts expected for the design phase, construction, deactivation of the works and operation, respectively, of the pulp mill in the municipality of Concepción.

The tables show the impacts identified and attribute the degrees to each one according to the capital letters used in the item 10.1.2 Methodology for assessing environmental impacts.

Table 16 – Design Phase Impacts

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Dissemination of information about the company's implementation.	Generation of expectations of the population in relation to the opening of work fronts resulting from the company installation.	Generation of expectations in the population	P/N	D/I	L/R/E	P	I	T	R	S	A	G	M	A	Disseminate the project, informing the data of jobs that will be generated, as well as the strategy to prioritize the local workforce, in addition to the capacity data, the technology to be used, the environmental control systems, the information on the negative and positive impacts of the company, among others, through meetings with the community and also through other means, in the Dissemination and Communication Program.	-	A	It can be stated that the dissemination of the project with all interested parties (community, employees, suppliers, government, customers, etc.) and the clarification of doubts that may arise in the sector, will bring confidence and satisfaction to the population regarding the implementation of the project, contributing to the good image and transparency of the company.

(The tables show the impacts identified and attribute the degrees to each one according to the capital letters used in the item 10.1.2 Methodology for assessing environmental impacts).

Table 17 – Design Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Environmental studies for the generation of technical and scientific knowledge of the project region.	Hiring of services for the preparation of environmental studies.	Generation of direct and indirect temporary jobs	**P**	**D/I**	**L/R/E**	**C**	**CP**	**T**	**R**	**S**	**M**	**G**	**-**	**A**	Disseminate the project, informing data such as: the company's impacts and future monitoring programs, which may require labor through the Dissemination and Communication Program.	**A**	**A**	The dissemination of the environmental monitoring programs to be implemented at the time of construction and later in the operation phase of the project can be considered to generate new data and jobs, which will contribute to clear expectations of the jobs that will be generated.

Table 18 – Design Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Non-implementation of the project.	Stopping or non-execution of the project	Hypothesis of non-realization of the project	P/N	D/I	L/R/E	P	LP	P	I	S	A	G	M	-	To implement the pulp mill in a sustainable manner, reinforcing the company's commitment to the preservation of natural resources and the reduction of environmental impacts through the Environmental and Social Management System Program.	-	A	Paracel intends to implement the company in a sustainable manner, committed to the preservation of natural resources and the reduction of environmental impacts, and in accordance with current legislation. The hypothesis of not carrying out the project will have an impact on the economic aspects in the municipality of Concepción and will create frustration in the expectations of the population of the municipality and the region.

Table 19 – Construction Phase Impacts.

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Services of earthwork and works of water intake and emissary.	Earthworks and interventions in land areas near the river	Generation of erosion processes and river sedimentation	N	D	L	P	I	T	I	II	M	P	M	-	To implement the Monitoring and Containment of Erosive Processes Subprogram of the Environmental Management Program for Construction - PAC, which aims to: - Plan the earth-moving and land-preparation works preferably outside the rainy season, in order to reduce the possibility of erosion phenomena due to the susceptibility of the land; - Minimize the exposure time of uncovered areas in the construction phase; - Store the top organic layer of the soil in a suitable place, for later reuse in a landscaping project, in gardening within the pulp mill; - Build temporary drains and sedimentation boxes around the embankment service works, to retain the solids, avoiding sedimentation in the water body.	-	A	It can be said that there will be no change in water quality since the execution of earthmoving works and land preparation will be planned preferably outside the rainy periods and minimizing the exposure time of the areas without vegetation cover. In addition, the project includes solids retention cells, as well as drainage channels provided around the earthmoving area in order to retain sediments and avoid sedimentation in the local water bodies.

Table 20 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Water consumption during the construction phase.	Groundwater availability.	Water use conflict	N	D	L	P	I	T	I	II	M	P	M	-	- Send to MADES a diagram of the place where the well is to be drilled, in which possible points of interference will be presented, such as: other wells installed, existence of springs, water courses, possible sources of contamination, etc., all within a radius of 500 m from the point of interest, as well as their relative distances to the future well; - Carry out a hydrogeological study before the construction of the wells; - Carry out Groundwater Quality Monitoring; - Coat the well with pipes to prevent the entry of unwanted water and not allow the collapse of the soil layers; - Properly close the wells to avoid any contamination of the aquifer, at the end of the works; - If it is necessary to drill wells for housing, PARACEL will inform the MADES beforehand and take the same care to avoid any contamination of the aquifer, from drilling to closing the wells.	-	A	It can be affirmed that there will be no change in the quality or availability of the groundwater since the execution of the wells will be done in an environmentally correct way, according to a hydrogeological study before the drilling, and the captured flow will be little and temporary, in addition, at the end of the works the wells will be properly closed to avoid any contamination to the aquifer.

Table 21 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Construction works of pulp mill.	Inadequate generation and disposal of sanitary wastewater.	Change in Surface Water Quality	**N**	**D**	**L/R**	**P**	**I**	**T**	**R**	**II**	**B**	**P**	**M**	**-**	• Certify that the company hired to collect the wastewater from the chemical baths is properly regulated, and that the wastewater is disposed of in an environmentally sound manner; • Implement and operate a sanitary wastewater treatment plant to treat the wastewater generated during the construction phase after the chemical baths have been deactivated; • Perform Water and Effluent Management Program.	**-**	**A**	It can be stated that there will be no change in the quality of surface waters, since the sanitary wastewater generated during the works will be duly treated and disposed of in an environmentally appropriate manner and in accordance with the legislation in force.

Table 22 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Generation of dust due to the movement of machinery and vehicles	Movement of vehicles and machines for the implementation of the project.	Change in air quality	N	D/I	L/R	C	I	T	R	II	B	P	M	-	• Follow the guidelines of the Environmental Management Program for Construction - PAC, to minimize the generation of dust, such as: - Humidify the internal circulation routes and the work yard during the execution of services, when necessary; - Cover the trucks transporting earth, rocks and all powdery material with tarpaulins.	-	A	It can be stated that, through the implementation of mitigation measures, air quality will not be changed.

Table 23 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Noise generation due to the company's construction work.	Movement of vehicles and machines for the establishment of the company.	Disturbance related to noise	**N**	**D/I**	**L/R**	**C**	**I**	**T**	**R**	**II**	**B**	**P**	**M**	**-**	• Follow the guidelines of the Environmental Management Program for Construction (PAC) with respect to noise generation, such as: - Carry out maintenance on machine, truck and vehicle engines; - Carry out activities in the area predominantly in the daytime period; - Carry out noise monitoring during the construction phase.	**-**	**A**	It can be said that, through the implementation of mitigation measures, there will be no noise disturbance.

Table 24 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	The pulp mill's construction work.	Inappropriate generation and disposal of solid waste.	Changes in Soil and/or Surface Water and Groundwater Quality	N	D	L/R	P	MP	T	R	III	M	P	M	-	• Follow the guidelines of the Environmental Management Program for Construction - PAC, with respect to best practices in Solid Waste Management, among which: - To manage the solid waste generated in the construction of the PARACEL pulp mill with the best practices, in accordance with Law # 3,956/2009 and Decree # 7,391/ 2017 (Integral Management of Solid Waste in the Republic of Paraguay), among which are: • Minimize waste generation through the 3R principle (Reduce, Reuse, Recycle); • Segregation of solid waste according to color standard; • Collection, packaging, storage and transport of solid waste in accordance with current legislation; • Environmentally appropriate final destination (reuse, recycling, composting, energy use, etc.) and/or environmentally appropriate final disposal of solid waste generated in the company. • Arrange the materials (excavation soil), if necessary, in duly authorized external areas. • Implement a Temporary Solid Waste Storage Center that will be managed by a company specialized in this service. • Implement a Debris Landfill and a Sanitary Landfill (organic).	-	A	After the implementation of the measures, it can be said that there will be no changes in the quality of soil and/or water due to the generation and disposal of waste, without compromising the environmental quality of the area.

Table 25 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Civil works for the implementation of the port infrastructure.	Impacts on the physical, biotic and socioeconomic environment due to the port construction.	Impacts generated by the construction of the river port	N	D	L	C	I	T	I	II	M	P	M	-	• To inform local fishermen about the period and care during the works of the port through the Dissemination and Communication Program • Signal the port implementation area on the Paraguay River to avoid boat accidents.	-	A	It can be stated that, through the application of mitigation measures, the impacts generated by the construction of the river port will be minimal and temporary.

Table 26 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact: Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Earth movements and works in the site and for water intake and effluent discharge pipelines, routes and transmission line construction.	Removal of vegetation and alteration of associated habitats in the project area, including riverine habitat.	Vegetation and land habitat loss	N	D	L	C	CP	P	I	S	M	M	P M	-	• Follow the guidelines of the Environmental Management Program for Construction - CAP, regarding the criteria and operational controls that will be carried out in the suppression of vegetation, which are: -Picking to mark the area to be removed; -Use a team experienced in this suppression activity; -Properly dispose of organic waste and vegetation from the abatement activity; -Store the top organic layer of the soil in an appropriate place for later reuse in the landscape design of the industrial area; -Promote, as compensation, the replanting with native species of areas within the property today impacted by livestock activity, in an area equal to or greater than that occupied by the vegetation to be suppressed; -Implement the Flora Monitoring Program; -Implement the Terrestrial Fauna Monitoring Program; -Carry out the supervision and environmental control of the suppression; -Prohibit the use of fire for vegetation suppression.	-	A	It can be stated that by adopting mitigation measures, vegetation removal will be minimum, and any removal of natural vegetation will be adequately compensated with native trees, especially with the vegetation of the region, not interfering significantly with the local biota, since the area already suffers from a high degree of human intervention.

Table 27 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Dust generation due to earth movements and works in the site and for water intake and effluent discharge pipelines, routes and transmission line construction.	Removal of vegetation and alteration of associated habitats in the project area, including riverine habitat.	Dust generation due suppression of local vegetation	N	D	L/R	C	CP	P	I	II	M	M	M	-	Humidify the internal circulation routes and the work yard during the execution of services, when necessary; Cover the trucks transporting earth, rocks and all powdery material with tarpaulins; Perform small animals rescue, before suppression, in order to avoid or minimize the loss of populations occurrence such as arthropods and other animals with limited mobility; and Regenerate degraded areas and implement corridors in order to favor the displacement of fauna species.	-	A	The actions adopted by PARACEL preserve the areas of native vegetation, riparian permanent persevered areas and legal reserve of its own lands, in addition to the legal requirement, minimizes the impact.

Table 28 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Water intake and effluent emissary works.	Interventions in the riverbed and land areas near the river	Change in aquatic ecosystems	**N**	**D**	**L**	**P**	**I**	**T**	**I**	**I**	**B**	**P**	**M**	**-**	• Plan the execution of earthmoving works and land preparation preferably outside of the rainy periods; • Build a temporary structure for the containment of sediments; • Supervise the works during the project period; • Monitoring the quality of surface water in the construction phase	-	**A**	Se it can be assumed that, through the implementation of mitigation measures, the water quality of the Paraguay River will not change significantly in relation to turbidity and suspended solids, therefore, that aquatic communities are not expected to be affected. In addition, it should be noted that this activity is temporary.

Table 29 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Vehicle movements.	Increasing vehicle traffic.	Higher risk of running over animals	**N**	**D/I**	**L/R**	**P**	**I**	**T**	**I**	**S**	**B**	**P**	**M**	**-**	• Inform and make drivers aware of defensive driving, traffic legislation and local legislation through the Road Safety Program, in order to minimize the risk of accidents, including those involving wildlife.	-	**A**	There will be no risk of animals being run over due to the movement of vehicles for the construction of the company, as the company's own employees and third parties will receive training on preventive defensive driving, traffic legislation and local legislation through the Road Safety Program.

Table 30 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Opening accesses and roads and workers pass increase	Hunting risk	Risk of harassment to flora and fauna by workers	**N**	**D/I**	**L/R**	**P**	**MP**	**P**	**I**	**II**	**M**	**M**	**M**	**-**	Intensify surveillance activities in partnership with local authorities and neighbors to avoid animals hunt. Perform environmental education program to give conscious to fauna and flora preservation.	-	**A**	It can be stated that the risk on local fauna will be minimized by the implementation of the proposed mitigation measures.

Table 31 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Pulp mill construction	Replacement of Habitat with pulp mill and its infrastructure	Impact to Natural and modified habitat	**N/P**	**D/I**	**L**	**C**	**I**	**P**	**I**	**II/ III**	**M**	**M**	**M**	**-**	Implementation of the Restoration, Compensation and Management Program of Biodiversity in the Industrial Site, including revegetation, reforestation and restoration of natural habitat.	**M**	**A**	The industrial plant and associated civil structures of the PARACEL pulp mill will have a local impact on the vegetation, however, there will be no impact on the connectivity of the remaining environment because it is located in a strongly anthropized area, used for cattle rising and as a compensation measure there will be an increase in the native area of approximately 150% in relation to the current situation.

Table 32 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Mobilization of work.	Hiring of temporary workforce.	Generation of direct and indirect temporary jobs	P	D/I	L/R/E	C	I	T	R	III	A	G	-	A	•Promote an information dissemination campaign for the hiring workforce for the construction phase through the Dissemination and Communication Program, giving priority to the hiring of local people through the Local Labor Development and Linkage Program.	A	A	It can be stated that PARACEL will generate jobs for the construction of the project and this impact can be enhanced by the insertion of other companies that provide services in the region, mitigating the effects of displacement migration and generating direct and indirect jobs in the region of Concepción.

Table 33 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Mobilization of work.	Pressure on local infrastructure due to the increase in the population represented by the workforce in the construction phase.	Interference on infrastructur e	N	D/I	L/R	C	MP	T	I	III	M	P	M	-	• Disseminate the existing options of educational institutions in the municipality to workers who decide to migrate with their families, as well as to support, if possible, the competent educational bodies in the technical training of the population; • Provide an outpatient and inpatient structure for own and external employees; • Promote a zero accident practice that minimizes dependence on the region's health infrastructure; • Implement and operate on the construction site the basic sanitation system composed of: water supply service, wastewater collection and treatment, and solid waste collection and treatment service; • Accommodate workers coming from outside the region in accommodation, hotel network and rental housing already existing in the region with basic sanitation • Provide for improvements in the public service system, together with the responsible public agencies, to meet the additional demand of the population of the region through the Community and Stakeholder Relations Program; • Implement the mechanisms for transporting workers between the municipalities involved and the construction site; • Identify the effects generated by the definition of the design of the construction site and accesses, seeking to minimize the effects on the ADA population, with emphasis on vulnerable groups through the Social Management Program for ADA communities; • Carry out a dissemination work with the subcontracted companies to orient the workers on: child prostitution, drugs, sexually transmitted diseases, etc., in the Environmental Education Program with own employees and third parties; • Address issues such as health, hygiene and safety in the Environmental Education Program with the community; • Request public agencies to supervise safety, to inhibit illegal acts; • Implement a Program for Social Monitoring	-	A	There will be interference in the local infrastructure considering that there is already a deficit in public health, sanitation, transport and security services in the region. However, the implementation of PARACEL's mitigation measures and partnerships with the public authorities responsible under the Community and Stakeholder Relations Program and the Social Monitoring Program will make it possible to compensate for the additional demand generated by the increase in population in the region.

Table 34 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Movement of vehicles.	Increasing vehicle traffic	Higher risk of accidents	N	D/I	L/R	P	CP	T	I	II	M	P	M	-	- Install signage plates on the main internal access roads to the pulp mill's implementation area; - Perform maintenance on the engines of machines, trucks and vehicles used by the company; - Informing and raising awareness among vehicle drivers about defensive driving through the Road Safety Program.	-	A	It can be said that, with the implementation of these mitigation measures, the risk of accidents will be minimal. In order to provide improvements in the road system due to the additional traffic, PARACEL can establish partnerships with the responsible public agencies to mitigate and compensate the impacts generated.

Table 35 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Implementation of the pulp mill, consisting of buildings, towers and chimneys	Change of landscape and land use.	Impact on morphology	N	D	L	C	I	P	I	III	B	P	P M	-	Implement the landscape project that favors the integration of the plant with the environment, reducing the effect of the contrast of the buildings and structures with the natural landscape, such as the implementation of tree curtains and the reuse of the land in gardens within the plant in accordance with the Landscape Rehabilitation Subprogram of the Environmental Management Program for Construction (PAC).	-	A	The implementation of the pulp mill will inevitably alter the landscape and local land use, which can be minimized by implementing the landscaping project.

Table 36 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Possibility of affecting cultural heritage sites.	Earthmoving activities.	Interference with cultural heritage	N	D	L	P	I	P	I	S	B	P	M	-	Take actions to ensure that the construction activities of the pulp mill do not affect or destroy the cultural property considered as protected heritage through the ADA's Program for the Safeguarding and Enhancement of Cultural Heritage.	-	A	It is possible to affirm that there will be no interference with the cultural heritage, taking into account that the area where the project will be implemented is significantly anthropized. Furthermore, all mitigation measures will be taken so that there is no possible interference with the cultural heritage in accordance with the law in force.

Table 37 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Demand for products and services by the company and the workforce employed.	Growth of activities producing goods and services.	Increasing tax collection and Boosting the local economy	P	D/I	L/ R/ E	C	I	P	I	II	A	G	-	A	Prioritize the acquisition of services and goods in the construction phase of the venture, preferably in Concepción and the region through the Promotion and Development of Local Suppliers Program.	A	A	The implementation of the pulp mill will generate an increase in tax collection at the municipal, departmental and national levels, which will be enhanced through the Promotion and Development of Local Suppliers Program. However, it is up to the government to reverse the taxes collected in improvements to the municipality and region.

Table 38 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Mobilization of workforce.	Demand for workforce.	Worker influx increase	N/P	D/I	L/R	P	MP	P	R	II/ III	M	M	M	M	• Give priority to hire local people through the Local Labor Development and Linkage Program; • Accommodate workers coming from outside the region in accommodation, hotel network and rental housing already existing in the region with basic sanitation, the provide camps for the workers; • Carry out a dissemination work with the subcontracted companies to orient the workers on: child prostitution, drugs, sexually transmitted diseases, etc., in Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations with own employees and third parties; • Carry out the social perception monitoring through the Social Monitoring Program in order to identify in time inconveniences in the fulfillment of the objectives established, and to allow taking corrective actions in a timely manner; • Carry out the demobilization in accordance with the legal procedures of the contracting regime through the Contractor and Worker Awareness and Monitoring Program on compliance with regulations; • Provide in the contract with service providers, a commitment that all hired employees will be encouraged and supported to return to their places of origin, once the contracted work is completed; in addition, monitor demobilizations of hotels, rental properties and lodging; • Promote the training and qualification of people in the region for the pulp production, equipment maintenance, mechanical, electrical and instrumentation sectors, encouraging the possibility of contracting for the mill's operational phase, through the Local Labor Development and Partnership Program, signing partnerships with associations and educational institutions.	M	A	By giving priority to hire local people through the Local Labor Development and Linkage Program, accommodate properly the workers from outside Concepción, carry out the demobilization in accordance with the legal procedures of the contracting regime and promote the training and qualification of people in the region for the pulp production, equipment maintenance, mechanical, electrical and instrumentation sectors, the negative impacts due to workers influx will decrease and by the end of the construction ate least the people will be better qualified.

Table 39 – Construction Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Mobilization of work.	Pressure on local infrastructure due to the increase in the population.	Impacts to community health and safety	N	D and I	L and R	C	MT	T	I	III	M	S	M	-	Perform Relationship Plan with the Community and other Social Actors Plan; Perform Community Health and Safety Program.		H	The implementation of PARACEL's mitigation measures and partnerships with the public authorities responsible under the Community and Stakeholder Relations Program and the Social Monitoring Program will make it possible to compensate for the additional demand generated for health and safety by the increase in population in the region.
	Mobilization of work.	Pressure on local infrastructure due to the increase in the population.	Impacts to vulnerable groups	N	D and I	L and R	C	MT	T	I	III	M	S	M	-	Carry out a dissemination work with the workers and subcontracted companies to orient the workers on: child prostitution, drugs, sexually transmitted diseases, etc., with own employees and third parties Perform Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations Support to the strengthening of community identity Perform Equal Opportunities and Non-Discrimination Program Perform Women's Empowerment Program		H	The implementation of PARACEL's mitigation measures will make it possible to minimize impacts to vulnerable people.

Table 40 – Impacts of the Deactivation Phase.

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Demobilization of temporary work	Termination of the company's construction work	Reduction in the number of jobs	N	D/I	L/R	C	I	P	I	II	M	P	M	-	• Carry out the demobilization in accordance with the legal procedures of the contracting regime through the Contractor and Worker Awareness and Monitoring Program on compliance with regulations; • Provide in the contract with service providers, a commitment that all hired employees will be encouraged and supported to return to their places of origin, once the contracted work is completed; in addition, monitor demobilizations of hotels, rental properties and lodging; • Maintain the commitment to prioritize the hiring of local labor for the operational phase of the mill; • Promote the training and qualification of people in the region for the pulp production, equipment maintenance, mechanical, electrical and instrumentation sectors, encouraging the possibility of contracting for the mill's operational phase, through the Local Labor Development and Partnership Program, signing partnerships with associations and educational institutions	-	A	The reduction of the workforce after the completion of the works is inevitable, however, it will be minimized by the implementation of these mitigation measures.

Table 41 – Operation Phase Impacts.

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Operational activities for the manufacture of pulp.	Noise generation from the pulp mill.	Noise related disturbance s	**N**	**D**	**L**	**C**	**I**	**P**	**I**	**II**	**B**	**P**	**M**	**-**	• Use machines and equipment with low noise level; • Wherever possible, soundproof the equipment by aiming for a low noise level; • Implementing the Noise Monitoring Program	-	**A**	It can be affirmed that the operation of the mill will be imperceptible in terms of increasing the noise level, however, it does not rule out the possibility of complaints, since the perception of noise is subjective and can vary from person to person. However, disturbances to the community in relation to the noise generated by the company will be mitigated, as the measures will be implemented and monitored

Table 42 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Operation of the pulp mill.	Inappropriate generation and disposal of solid waste	Change in soil and/or surface water and groundwater quality	**N**	**D/I**	**L**	**P**	**MP**	**P**	**I**	**I/ III**	**M**	**P**	**M**	**-**	• Apply best practices in solid waste management, in accordance with applicable laws and regulations; • Implement the Solid Waste Management Program (SWMP); • To train operators for the correct disposal of the waste generated; • Implementing a system to protect soil and groundwater contamination (waterproofing) in all areas where industrial solid waste is handled, processed, treated, and disposed of; • Implement and properly operate a sanitary (organic) landfill and an industrial landfill, as well as the composting system and the production process for correcting soil acidity; • Implement the Groundwater Quality Monitoring Program.	-	**A**	It can be assumed that through the implementation of mitigation measures the quality of the soil and/or the groundwater will not be affected.

Table 43 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Use of chemical products	Inappropriate storage and handling causing chemical leaks or spills.	Change in air, soil and/or surface water and groundwater quality	**N**	**D/I**	**L**	**P**	**MP**	**P**	**I**	**I/ III**	**A**	**M**	**M**	**-**	Implement containment and waterproofing systems in the areas surrounding the chemical tanks, in addition to implementing maintenance plans and inspections; Train operators involved in the handling, storage and transport of chemical products; Implement and operate the system for collecting and handling spills and leaks.	-	**A**	It can be stated that with the implementation of mitigation measures there will be no change in the quality of air, soil and/or surface and ground water in the event of improper storage and handling causing chemical leaks or spills.

Table 44 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Water consumption during mill operation.	Availability of water from the Paraguay River.	Conflicting water usage	N/P	D	L	P	LP	P	I	II	B	P	M	-	• Monitor the Water Treatment Plant (WTP) to ensure the availability of water in accordance with the standards of potability for human consumption and for use in mill operations; • Follow the best water management practices, seeking continuous improvement of processes with the aim of minimizing water consumption.	-	A	There will be no conflicting use of the Paraguay River, given that water intake for industry operations is estimated at 0.09% of the average river flow, and about 80% of this volume will return to the Paraguay River as effluent. In addition, PARACEL will follow best practices in water management, seeking to continuously improve processes in order to minimize water consumption.

Table 45 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Pulp mill operation.	Discharging of liquid effluents generated in the Paraguay River.	Change in river quality	**N**	**D**	**L/R**	**P**	**MP**	**P**	**I**	**II/ III**	**M**	**P**	**M**	**-**	- Use the best available technologies (BAT) in the production process to minimize the generation of liquid effluents (flow and organic load); - Implement an effluent treatment plant based on the best available practical technology (modern and safe), the activated sludge system and tertiary treatment; - To properly operate the effluent treatment plant so that the discharge of treated liquid effluents complies with current legislation; - Carry out a periodic inspection of the emissary system and its diffusers; - Carry out the Effluent Treatment Plant (ETP) Monitoring Program; - To carry out the Surface Water Quality Monitoring Program.	-	**A**	It can be stated that, through the mitigation measures implemented, the water quality of the Paraguay River will not change significantly even under the minimum flow conditions of the river.

Table 46 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Operational activities for pulp production.	Generation of atmospheric emissions.	Change in air quality	N	D	L	C	I	P	I	I/ III	M	P	M	-	Follow best practices for air emissions management, as listed below: - Use of low odor recovery boiler; - High dry solids content (minimum 80%) in the black liquor burned in the recovery boiler, which minimizes SOx emissions - Use of high efficiency electrostatic precipitators for the recovery boiler, biomass boiler and lime kilns; - Collection of concentrated non-condensable gases from the digester and evaporation, and their incineration in the recovery boiler or biomass boiler (protected flame incineration); - Extensive collection of diluted non-condensable gases from the digester, brown pulp line, evaporation, with treatment in the recovery boiler; - Treatment of gases from the solution tank in the recovery boiler itself; - Efficient cleaning of bleach plant relief gases; and - Real-time gas monitoring systems and control system, rapid identification and correction of operational disturbances. To adopt a cleaner energy matrix in its production process, based on the use of renewable fuels, producing pulp with minimum carbon emissions; Implementing highly efficient emission control equipment, such as electrostatic precipitators; Install chimney with defined height in the atmospheric dispersion model; Implement an Atmospheric Emissions Monitoring Program; Monitor the sources of atmospheric emissions through on-line measurements; Implement an Air Quality Monitoring Program; Implementing the Complaints, Grievances and Concerns Management Program.	-	A	It can be said that the air quality in Concepción and the region studied will be in accordance with the air quality standards established by the legislation even after the operation of the mill, according to the study of atmospheric dispersion. In extraordinary situations (starts, stops and regime exits), not covered by the modeling, odor events may occur that will be punctual and without any risk to health, but that may generate a slight and temporary discomfort in some receptors. It should also be noted that the Program for the Management of Complaints, Claims and Concerns will be implemented. This will serve to monitor the resolution and closure of complaints.

Table 47 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentation	Degree of resolution of measures	Forecast after implementation of measures
Physical	Operational activities for the pulp mill.	Generation of atmospheric emissions.	Fugitive emissions increase	N	D	L	P	I	P	I	I/ III	M	M	M	-	Follow best practices for air emissions management, as listed below: - Burning of concentrated black liquor (> 80% dry solids); - Maintenance of higher temperatures and high content of dry solids in black liquor; - Control of the adequate rate of sulfur/sodium (S/Na) in the liquor; - Control of excess air, temperature and combustion air distribution; - Maintaining the load in the furnace at optimum operating levels; - Use of fuel oil with low sulfur content, whenever possible; - Optimized combustion; - SOx emissions will be minimal because eucalyptus wood has low sulfur content; - Implementing the Complaints, Grievances and Concerns Management Program.	-	A	It can be said that since PARACEL will adopt the Best Available Techniques in its processes, the fugitive emissions will be under control. In extraordinary situations (starts, stops and regime exits), odor events may occur that will be punctual and without any risk to health, but that may generate a slight and temporary discomfort in some receptors. So it should also be noted that the Program for the Management of Complaints, Claims and Concerns will be implemented. This will serve to monitor the resolution and closure of complaints.

Table 48 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact												Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement				
Biotic	Movement of vehicles.	Increasing vehicle traffic.	Higher risk of running over animals	N	D/I	L/R	P	CP	P	I	S	B	P	M	-	• Install signage plates on the main access routes to the plant area; • Inform and raise awareness among vehicle drivers about defensive driving through the Road Safety Program.	-	M	It can be stated that the risk of running over animals will be minimized by the implementation of the proposed mitigation measures.

Table 49 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Operation of the pulp mill.	Inappropriate generation and disposal of solid waste and spills.	Injury or death to fauna and flora due to improper waste disposal, including spills	N	D/I	L	P	MP	P	I	I/ III	A	M	M	-	• Apply best practices in solid waste management, in accordance with applicable laws and regulations; • Implement the Solid Waste Management Program (SWMP); • To train operators for the correct disposal of the waste generated; • Implementing a system to protect soil and groundwater contamination (waterproofing) in all areas where industrial solid waste is handled, processed, treated, and disposed of; • Implement and properly operate a sanitary (organic) landfill and an industrial landfill, as well as the composting system and the production process for correcting soil acidity; • Implement the Groundwater Quality Monitoring Program.	-	A	It can be assumed that through the implementation of mitigation measures the fauna and flora will not be affected.

Table 50 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Pulp mill operation.	Launching of liquid effluents generated in the waters of the Paraguay River.	Change in aquatic ecosystems	**N**	**D/I**	**L**	**P**	**I**	**P**	**I**	**I**	**B**	**P**	**M**	**-**	– Use the best available technology (BAT) in the production process to minimize the generation of liquid effluents (flow and organic load); – Adequately operate the effluent treatment plant so that the discharge of treated liquid effluents is in accordance with current legislation; – Implement the Program for Monitoring Aquatic Communities on the Paraguay River.	-	**M**	It can be stated that, since there will be no change in the quality of the Paraguay River due to the release of treated effluents from the PARACEL pulp mill, the aquatic communities are not expected to be affected.

Table 51 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Pulp mill operation.	Replacement of Habitats with pulp mill.	Noise related disturbance on fauna	**N**	**D**	**L/R**	**C**	**CP**	**P**	**I**	**II**	**M**	**M**	**M**	**-**	- Acquire machines and equipment with low noise levels; - Acoustic enclosure for equipment with a high sound pressure level; - Install silencers, attenuators, sound energy absorbers, if necessary; - Perform a health and safety programs as a way to control and/or minimize the exposure of its employees and partners to industrial noise.	-	**A**	The actions adopted by PARACEL will minimize the impact.

Table 52 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Biotic	Accidental oil leakage or spill.	Change in the physical-chemical conditions of soil, water and/or air.	Impact of oil spills in river due to river transportation	**N**	**D and I**	**L and R**	**P**	**ST**	**P**	**I**	**II**	**M**	**H**	**M**		Perform River transportation Management Program.		**H**	It can be said that, with the implementation of these mitigation measures, the risk of accidents will be minimal.

Table 53 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Manpower demand for the operation of the pulp mill.	Hiring of workforce for the operation of the pulp mill.	Generation of direct and indirect jobs	P	D/I	L/ R/ E	C	I	P	I	III	M	G	-	A	Promote a dissemination campaign to hire labor for the operation phase of the pulp mill through the Dissemination and Communication Program; Articulate with professional education organizations and institutions for the professional training of the local population through the Program for the Development and Linking of Local Labor.	A	A	Following the implementation of the enhancement measures, it can be assumed that PARACEL will promote the hiring of available labor in the municipality of Concepción and the region, as well as train the local population.

Table 54 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Pulp mill operation.	Risk of accidents in the mill.	Higher risk of accidents	N	D	L	P	CP	T	I	S	B	P	M	-	• Follow the guidelines of the Risk Analysis Study, including: -Implement containment and waterproofing systems in the areas surrounding the chemical tanks, in addition to implementing maintenance and monitoring plans; -Provide training to operators involved in the handling, storage and transportation of hazardous products; -Install firefighting and control systems • In the event of an operational emergency, implement the Emergency Action Plan; • Use the appropriate PPE (Personal Protective Equipment) on the pulp mill facilities; • Implement the Program for Prevention and Management of Social, Environmental and Labor Contingencies.	-	A	The risk analysis study concluded that no hazard was classified as Critical, and that most of the identified risks are classified as Negligible, Minor or Moderate, and accidents will be limited to the internal area of PARACEL's industrial plant, even though the planned prevention and mitigation measures must be implemented.

Table 55 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Demand for products and services.	Growth in the production of goods and services.	Increasing tax collection and Boosting the Economy	P	D/I	L/ R/ E	C	I	P	I	II	A	G	-	A	Encourage the purchase of services and products preferably in Concepción and the region through the Promotion and Development of Local Suppliers Program.	A	A	The company will generate an increase in tax revenue, in accordance with current tax law, which will be enhanced through the Promotion and Development Program for local suppliers.

Table 56 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Movement of vehicles.	Increasing vehicle traffic and Increasing running over animals.	Road transportation increase	N	D/I	L/R	P	LP	P	I	S	M	M	M	-	• Consider river transportation for wood to prevent accidents and traffic on roads; • Install signage plates on the main access routes to the plant area; • Inform and raise awareness among vehicle drivers about defensive driving through the Road Safety Program.	-	A	It can be stated that the risk of personal accidents and running over animals on roads will be minimized by the implementation of road signs and drivers training about defensive driving, other than using river transportation for wood.

Table 57 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Pulp mill operation.	Risk of accidents and electromagnetic field.	Impacts from the Transmission line and substation	N/P	D/I	L/R	C	I	P	I	II/ III	M	M	M	M	Perform workers training to prevent accidents, through Health and Safety Education Program. Minimize the impact of the electric and magnetic fields to be generated during the operation of the line, due to the release of the bondage strip of the line and implementation of the safety and service zone. Envisage flight diverters that will help migratory birds to have a visual image of vivid colors to avoid colliding with high voltage lines. Use safety systems and standards in the design of electrical constructions to ensure reasonable protection against accident risks that endanger the health of workers and third parties.	M	M	The Transmission line and substation implantation and operation will not cause any significant impact to the physical and to the biotic environments, neither to the communities because they will be placed on anthropized areas along existing road rights sides. The most relevant and permanent positive impact can be considered to occur in the global economy because of the increased supply of electricity that will be available to generate sustainable productive activities and new investments in the country's industrial development, which will ultimately result in greater well-being of the population and these benefits will already be permanent in nature.

Table 58 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Maneuver, loading and unloading.	Risk of accidents.	Port operation	N	D	L	C	I	P	I	II	M	P	M	-	Perform good maneuver, loading and unloading procedure to prevent accidents due to river transportation. Require the best practices from the services providers. Perform an Emergency Manual in the Port.	-	A	It is difficult to foresee the intensity of these risks, but they can be efficiently minimized through the application of proceedings in port structures.

Table 59 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Port operation.	Risk of accidents.	River transportati on increase	N/P	D	L	C	I	P	I	II	M	P	M	-	Priorate or balance wood from river transportation instead of road transportation.	-	A	There are more environmental benefits by using river transportation instead of road transportation and PARACEL should balance both ways.

Table 60 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Implementation of the pulp mill, consisting of buildings, towers and chimneys.	Change of landscape and land use.	Visual impact	**N**	**D**	**L**	**C**	**I**	**P**	**I**	**III**	**B**	**P**	**P M**	**-**	Implement the landscape project that favors the integration of the mill with the environment, reducing the effect of the contrast of the buildings and structures with the natural landscape, such as the implementation of tree curtains and reuse of the soil from earthworks in gardens within the industrial area in accordance with the Landscape Rehabilitation Program besides revegetation of riparian forests.	-	**A**	The implementation of the pulp mill will inevitably alter the landscape and local land use, which can be minimized by implementing the Landscape Rehabilitation Program.

Table 61 – Operation Phase Impacts. (*cont.*)

Component	Activity (Impact-Generating Factor)	Aspect	Impact	Characterization of the impact															
				Nature	Form of incidence	Spatial coverage area	Probability of occurrence	Moment/Time of occurrence	Time or length of time	Reversibility	Accumulation	Magnitude	Importance	Possibilities of mitigation	Possibilities of enhancement	Mitigation measures or enhancement	Degree of potentiation	Degree of resolution of measures	Forecast after implementation of measures
Socioeconomic	Pulp mill operation.	Affected elements from the mill and Communities consultation.	Increase communication with local Stakeholders	P	D/I	L/ R/ E	C	I	P	I	III	M	G	-	A	• Perform Community and Stakeholder Relationship Program. • Disseminate the project, informing the positive impacts that will be generated to the stakeholders through meetings and other means, in the Dissemination and Communication Program. • Carry out a conscious dissemination with direct and subcontractor workers to orient they about: child and indigenous prostitution, drugs, sexually transmitted diseases, etc., in the Environmental Education Program.	A	A	By mapping the stakeholders, PARACEL can anticipate their needs, bring confidence and satisfaction regarding the implementation of the project, contributing to the good image and transparency of the company. It can be stated that the dissemination of the project to all stakeholders (community, employees, suppliers, government, customers, etc.) and the clarification of doubts that may arise about the project, through meetings and other means, will bring confidence and satisfaction regarding the implementation of the project, contributing to the good image and transparency of the company.

10.2 Mitigation, Compensation and Enhancement

Based on the evaluation of impacts, measures are recommended to minimize, eliminate, compensate for negative impacts and, in the case of positive impacts, maximize them, always with measures to be implemented through environmental management programs.

The following are the proposed measures:

Design phase

- Disclose the project, informing the data about jobs that will be generated, as well as the strategy prioritization of hiring the local workforce, and data about capacity, technology to be used, the environmental control systems, information about the negative and positive impacts of the company, among others, such as future monitoring programs, which may require workforce, through meetings with the community and also through other parts, in the Dissemination and Communication Program;
- Implement the mill in a sustainable manner, reinforcing the company's commitment to the natural resources preservation and the reduction of environmental impacts through the Health, Safety, Environment and Social Management System Manual.

Construction phase

- Implement the Erosive Process Control and Monitoring Program, which aims to:
  - Plan the implementation of earthworks and land preparation works preferably outside the rainy season, to reduce the possibility of erosion effects due to the susceptibility of the soil;
  - Minimize the exposure time of areas without vegetation cover, during the construction phase;
  - Store the top organic layer of the soil in a suitable place, for later reuse in a landscaping project, such as in gardens inside the plant;
  - Build temporary drainage and sedimentation boxes around the earthworks to retain solids, preventing sedimentation into the water body.
- Send to MADES a diagram of the place where the well is to be drilled, in which possible points of interference will be presented, such as: other wells installed, existence of springs, water courses, possible sources of contamination, etc., all within a radius of 500 m from the point of interest, as well as their relative distances to the future well;
- Carry out a hydrogeological study before the construction of the wells;
- Carry out Groundwater Quality Monitoring;
- Coat the well with pipes to prevent the entry of unwanted water and not allow the collapse of the soil layers;
- Properly close the wells to avoid any contamination to the groundwater, at the end of the works;

- If it is necessary to drill wells for housing, PARACEL will inform MADES beforehand and take the same actions to avoid any contamination to the groundwater, from drilling to closing the wells phases;
- Certify that the company hired to collect wastewater from the chemical toilet is duly licensed, and that the wastewater is disposed in an environmentally appropriate way;
- Implement and operate a sanitary wastewater treatment plant to treat the wastewater generated during the construction phase after the chemical toilets have been deactivated;
- Follow the guidelines of the ManagementWater and Effluent Management Program, which aims to:
  - Manage sanitary sewage during the construction phase;
  - Perform audits and inspections of the sanitary wastewater treatment system during the construction phase;
  - Comply with the sanitary sewage emission regulations determined by Resolution 222/02 standards.
- Follow the guidelines of the Vehicular Emissions and Dust Control Program, regarding minimize the generation of dust, such as:
  - Humidify the internal circulation routes and the work yard during the execution of services, when necessary;
  - Cover the trucks transporting earth, rocks and all powdery material with protective tarpaulins.
- Follow the guidelines of the Noise Monitoring Program, such as:
  - Carry out maintenance on machine, truck and vehicle engines;
  - Carry out activities in the area predominantly in the daytime period;
  - Carry out noise monitoring during the construction phase.
- Follow the guidelines of the Waste Management and Monitoring Program, among which they stand out:
  - Manage the solid waste generated in the construction phase of the PARACEL pulp mill with the best practices, in accordance with Law # 3,956/2009 and Decree # 7,391/ 2017 (Integral Management of Solid Waste in the Republic of Paraguay), among which are:
    - Minimize waste generation through the 3R principle (Reduce, Reuse, Recycle);
    - Segregation of solid waste according to color standard;
    - Collection, packaging, storage and transport of solid waste in accordance with current legislation;
    - Environmentally appropriate final destination (reuse, recycling, composting, energy use, etc.) and/or environmentally appropriate final disposal of solid waste generated in the company.
- Dispose the materials (excavation soil), if necessary, in duly authorized external areas.

- Implement a Temporary Solid Waste Storage Center that will be managed by a company specialized in this service.
- Implement a Debris and a Sanitary (organic) Landfill;

- Implement the Monitoring and Containment of Erosive Processes Subprogram of the Environmental Management Program for Construction - PAC, which aims to:

- Plan the implementation of earthworks and land preparation works preferably outside the rainy season, in order to reduce the possibility of erosion phenomena due to the susceptibility of the land;
- Minimize exposure time for areas without plant cover in the construction phase;
- Store the top organic layer of the soil in a suitable place, for later reuse in a landscaping project, in gardens within the mill;
- Build temporary drains and sedimentation boxes around the earthworks to retain solids, preventing sedimentation in the water body.
- Implementation of the quay in the river port with the least number of pillars possible;
- Supervise the environmental performance of the works during the project period;
- Monitor the quality of surface water in the construction phase;
- To inform local fishermen about the period and care during the works of the port through the Dissemination and Communication Program
- Signal the port implementation area on the Paraguay River to avoid boat accidents.
- Follow the guidelines of the Vegetation Suppression Program on Industrial Site, which are:
  - Picking to mark the area to be removed;
  - Use a team experienced in this suppression activity;
  - Properly dispose of organic waste and vegetation from the abatement activity;
  - Store the top organic layer of the soil in an appropriate place for later reuse in the landscape design of the industrial area;
  - Promote, as compensation, the replanting with native species of areas within the property today impacted by livestock activity, in an area equal to or greater than that occupied by the vegetation to be suppressed;
  - Implement the Biodiversity Monitoring Program on the Industrial Site;
  - Carry out the supervision and environmental control of the suppression;
  - Prohibit the use of fire for vegetation suppression.
- Humidify the internal circulation routes and the work yard during the execution of services, when necessary;
- Cover the trucks transporting earth, rocks and all powdery material with tarpaulins;
- Perform small animals rescue, before suppression, in order to avoid or minimize the loss of populations occurrence such as arthropods and other animals with limited mobility;

- Regenerate degraded areas and implement corridors in order to favor the displacement of fauna species;
- Plan the execution of earthmoving works and land preparation preferably outside of the rainy periods;
- Build a temporary structure for the containment of sediments;
- Supervise the works during the project period;
- Monitoring the quality of surface water in the construction phase;
- Inform and make drivers aware of defensive driving, traffic legislation and local legislation through the Road Safety Program, in order to minimize the risk of accidents, including those involving wildlife;
- Intensify surveillance activities in partnership with local authorities and neighbors to avoid animals hunt;
- Perform environmental education program to give conscious to fauna and flora preservation;
- Promote an information dissemination campaign for the hiring workforce for the construction phase through the Dissemination and Communication Program, giving priority to the hiring of local people through the Local Labor Development and Linkage Program;
- Disseminate the existing options of educational institutions in the municipality to workers who decide to migrate with their families, as well as to support, if possible, the competent educational bodies in the technical training of the population;
- Provide an outpatient and inpatient structure for own and external employees;
- Promote a zero accident practice that minimizes dependence on the region's health infrastructure;
- Implement and operate on the construction site the basic sanitation system composed of: water supply service, wastewater collection and treatment, and solid waste collection and treatment service;
- Accommodate workers coming from outside the region in accommodation, hotel network and rental housing already existing in the region with basic sanitation
- Provide for improvements in the public service system, together with the responsible public agencies, to meet the additional demand of the population of the region through the Community Relationship and Social Investment Program;
- Implement the mechanisms for transporting workers between the municipalities involved and the construction site;
- Identify the effects generated by the definition of the design of the construction site and accesses, seeking to minimize the effects on the DAA population, with emphasis on vulnerable groups through the Social Management Program for DAA communities;
- Carry out a dissemination work with the subcontracted companies to orient the workers on: child prostitution, drugs, sexually transmitted diseases, etc., in the

Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations with own employees and third parties;

- Address issues such as health, hygiene and safety in the Community Health and Safety Program;
- Request public agencies to supervise safety, to inhibit illegal acts;
- Implement a for Social Management Program;
- Install signage plates on the main internal access roads to the pulp mill's implementation area;
- Perform maintenance on the engines of machines, trucks and vehicles used by the company;
- Informing and raising awareness among vehicle drivers about defensive driving through the Road Safety Program;
- Implement the landscape project that favors the integration of the plant with the environment, reducing the effect of the contrast of the buildings and structures with the natural landscape, such as the implementation of tree curtains and the reuse of the land in gardens within the plant in accordance with the Landscape Recompositing Program;
- Take actions to ensure that the construction activities of the pulp mill do not affect or destroy the cultural property considered as protected heritage through the DAA's Program for The Protection and Valorization of Cultural Heritage;
- Prioritize the acquisition of services and goods in the construction phase of the venture, preferably in Concepción and the region through the Promotion and Development of Local Suppliers Program;
- Give preference to companies, service providers and trade in the region through the Promotion and Development of Local Suppliers Program;
- Give priority to hire local people through the Local Labor Development and Linkage Program;
- Accommodate workers coming from outside the region in accommodation, hotel network and rental housing already existing in the region with basic sanitation, the provide camps for the workers;
- Carry out the social perception monitoring through the Social Monitoring Program in order to identify in time inconveniences in the fulfillment of the objectives established, and to allow taking corrective actions in a timely manner;
- Carry out the demobilization in accordance with the legal procedures of the contracting regime through the Contractor and Worker Awareness and Monitoring Program on compliance with regulations;
- Provide in the contract with service providers, a commitment that all hired employees will be encouraged and supported to return to their places of origin, once the contracted work is completed; in addition, monitor demobilizations of hotels, rental properties and lodging;
- Promote the training and qualification of people in the region for the pulp production, equipment maintenance, mechanical, electrical and instrumentation sectors,

encouraging the possibility of contracting for the mill's operational phase, through the Local Labor Development and Partnership Program, signing partnerships with associations and educational institutions.

Works Deactivation Phase

- Carry out the demobilization in accordance with the legal procedures of the contracting regime through the Program for Awareness and Monitoring of Contractors and Workers on compliance with regulations;
- Provide in the contract with the providers, a commitment that all hired employees will be encouraged and supported to return to their places of origin, once the contract work is completed; in addition, the providers will monitor demobilizations of hotels, rental properties and lodging;
- Maintain the commitment to prioritize the hiring local workforce for the operational phase of the mill;
- Promote training and qualification of people in the region for the pulp production sector, equipment maintenance, mechanical, electrical and instrumentation sectors, encouraging the possibility of hiring local people for the operation phase of the mill, through the Program for Development and Partnership to Hire Local Workforce, signing partnerships with associations and educational institutions.

Operation phase

- Use machines and equipment with low noise level;
- Wherever possible, use acoustical isolation for equipment targeting a low noise level;
- Implement the Noise Monitoring Program;
- Apply best practices in solid waste management, in accordance with applicable laws and regulations;
- Implement the Solid Waste Management Program (SWMP);
- To train operators for the correct disposal of the waste generated;
- Implementing a system to protect soil and groundwater contamination (waterproofing) in all areas where industrial solid waste is handled, processed, treated, and disposed of;
- Implement and properly operate a sanitary (organic) landfill and an industrial landfill, as well as the composting system and the production process for correcting soil acidity;
- Implement the Groundwater Quality Monitoring Program;
- Implement containment and waterproofing systems in the areas surrounding the chemical tanks, in addition to implementing maintenance plans and inspections;
- Train operators involved in the handling, storage and transport of chemical products;
- Implement and operate the system for collecting and handling spills and leaks;

- Monitor the Water Treatment Plant (WTP) to ensure the availability of water in accordance with the standards of potability for human consumption and for use in mill operations;
- Follow the best water management practices, seeking continuous improvement of processes with the aim of minimizing water consumption;
- Use the best available technologies (BAT) in the production process to minimize the generation of liquid effluents (flow and organic load);
- Implement an effluent treatment plant based on the best available practical technology (modern and safe), the activated sludge system and tertiary treatment;
- To properly operate the effluent treatment plant so that the discharge of treated liquid effluents complies with current legislation;
- Carry out a periodic inspection of the emissary system and its diffusers;
- Carry out the Effluent Monitoring Program;
- To carry out the Surface Water Quality Monitoring Program;
- Follow best practices for air emissions management, as listed below:
    - Use of low odor recovery boiler;
    - High dry solids content (minimum 80%) in the black liquor burned in the recovery boiler, which minimizes SOx emissions
    - Use of high efficiency electrostatic precipitators for the recovery boiler, biomass boiler and lime kilns;
    - Collection of concentrated non-condensable gases from the digester and evaporation, and their incineration in the recovery boiler or biomass boiler (protected flame incineration);
    - Extensive collection of diluted non-condensable gases from the digester, brown pulp line, evaporation, with treatment in the recovery boiler;
    - Treatment of gases from the solution tank in the recovery boiler itself;
    - Efficient cleaning of bleach plant relief gases; and
    - Real-time gas monitoring systems and control system, rapid identification and correction of operational disturbances.
- Adopt a cleaner energy matrix in its production process, based on the use of renewable fuels, producing pulp with minimum carbon emissions;
- Implementing highly efficient emission control equipment, such as electrostatic precipitators;
- Install chimney with defined height in the atmospheric dispersion model;
- Implement an Atmospheric Emissions Monitoring Program;
- Monitor the sources of atmospheric emissions through on-line measurements;
- Implement an Air Quality Monitoring Program;
- Implementing the Complaints, Grievances and Concerns Management Program.

- Follow best practices for air emissions management, as listed below:
  - Burning of concentrated black liquor (> 80% dry solids);
  - Maintenance of higher temperatures and high content of dry solids in black liquor;
  - Control of the adequate rate of sulfur/sodium (S/Na) in the liquor;
  - Control of excess air, temperature and combustion air distribution;
  - Maintaining the load in the furnace at optimum operating levels;
  - Use of fuel oil with low sulfur content, whenever possible;
  - Optimized combustion;
  - SOx emissions will be minimal because eucalyptus wood has low sulfur content;
  - Implementing the Complaints, Grievances and Concerns Management Program;
- Install signage plates on the main access routes to the plant area;
- Inform and raise awareness among vehicle drivers about defensive driving through the Road Safety Program;
- Apply best practices in solid waste management, in accordance with applicable laws and regulations;
- Implement the Solid Waste Management Program (SWMP);
- To train operators for the correct disposal of the waste generated;
- Implementing a system to protect soil and groundwater contamination (waterproofing) in all areas where industrial solid waste is handled, processed, treated, and disposed of;
- Implement and properly operate a sanitary (organic) landfill and an industrial landfill, as well as the composting system and the production process for correcting soil acidity;
- Implement the Groundwater Quality Monitoring Program;
- Use the best available technology (BAT) in the production process to minimize the generation of liquid effluents (flow and organic load);
- Adequately operate the effluent treatment plant so that the discharge of treated liquid effluents is in accordance with current legislation;
- Implement the Program for Monitoring Aquatic Communities on the Paraguay River;
- Acquire machines and equipment with low noise levels;
- Acoustic enclosure for equipment with a high sound pressure level;
- Install silencers, attenuators, sound energy absorbers, if necessary;
- Perform a health and safety programs as a way to control and/or minimize the exposure of its employees and partners to industrial noise;
- Maintain high forests and riparian forests.
- Maintain representative samples interconnected.

- Monitor the Cerrado biodiversity;
- Promote a dissemination campaign to hire labor for the operation phase of the pulp mill through the Dissemination and Communication Program;
- Articulate with professional education organizations and institutions for the professional training of the local population through the Program for the Development and Linking of Local Labor;
- Follow the guidelines of the Risk Analysis Study, including:
  - ✓ Implement containment and waterproofing systems in the areas surrounding the chemical tanks, in addition to implementing maintenance and monitoring plans;
  - ✓ Provide training to operators involved in the handling, storage and transportation of hazardous products;
  - ✓ Install firefighting and control systems
- In the event of an operational emergency, implement the Emergency Action Plan;
- Use the appropriate PPE (Personal Protective Equipment) on the pulp mill facilities;
- Implement the Program for Prevention and Management of Social, Environmental and Labor Contingencies;
- Give preference to companies, service providers and trade in the region through the Promotion and Development of Local Suppliers Program;
- Encourage the purchase of services and products preferably in Concepción and the region through the Promotion and Development of Local Suppliers Program;
- Consider river transportation for wood to prevent accidents and traffic on roads;
- Install signage plates on the main access routes to the plant area;
- Inform and raise awareness among vehicle drivers about defensive driving through the Road Safety Program;
- Perform workers training to prevent accidents, through Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations;
- Minimize the impact of the electric and magnetic fields to be generated during the operation of the line, due to the release of the bondage strip of the line and implementation of the safety and service zone;
- Envisage flight diverters that will help migratory birds to have a visual image of vivid colors to avoid colliding with high voltage lines;
- Use safety systems and standards in the design of electrical installations to ensure reasonable protection against accident risks that endanger the health of workers and third parties;
- Perform good maneuver, loading and unloading procedure to prevent accidents due to river transportation;
- Require the best practices from the services providers;
- Perform an Emergency Manual in the Port;

- Priorate or balance wood from river transportation instead of road transportation;
- Implement the landscape project that favors the integration of the mill with the environment, reducing the effect of the contrast of the buildings and structures with the natural landscape, such as the implementation of tree curtains and reuse of the soil from earthworks in gardens within the industrial area in accordance with the Landscape Recomposition Program besides revegetation of riparian forests;
- Perform Community Relationship and Social Investment Program;
- Disseminate the project, informing the positive impacts that will be generated to the stakeholders through meetings and other means, in the Dissemination and Communication Program;
- Carry out a conscious dissemination with direct and subcontractor workers to orient they about: child and indigenous prostitution, drugs, sexually transmitted diseases, etc., in the Awareness and Follow-Up Program for Contractors and Workers Regarding Compliance with Regulations, Supplier Code of Conduct.

11 INTEGRATED ANALYSIS OF ENVIRONMENTAL IMPACTS (CUMMULATIVE IMPACT ANALYSIS)

The integrated analysis of the environmental impacts presented in this point was elaborated with the purpose of highlighting the most significant impacts, that is, those with high importance of negative or positive nature, with the direct and indirect occurrence in the physical, biotic and socioeconomic environments in a joint way, making not only a synthesis of environmental impacts, but identifying the interrelations among them by accumulation or synergy and the importance of these in the construction and operation phases of the company.

All impacts were evaluated according to the Accumulation and Synergy, as described below:

- Simple (S): is not characterized by bioaccumulation or biomagnification processes; does not accumulate in time or space; does not induce or enhance any other impact; does not interact in any way with other impact(s); and does not increase in past and present actions (European Commission, 2001);
- Type I (I) accumulation: accumulation by bioaccumulation;
- Type II (II) accumulation: accumulation by repetition or overlap, accumulating in time and/or space;
- Type III (III) accumulation: accumulation by interactivity or synergy.

Among the impacts identified, it should be noted that assertive measures should be applied in relation to the main synergies with the population, referring to: adequate disposal of solid waste and effluents, control of atmospheric emissions, interference in infrastructure, change in morphology (landscape), dynamism of the economy and generation of jobs.

It should be noted that as regards the impacts related to the generation of waste, PARACEL will carry out the management of waste with the best practices, in accordance with Law # 3956/2009 and Decree # 7. 391/ 2017 (Integral Management of Solid Waste in the Republic of Paraguay), among which the following stand out: Minimizing the generation of waste by using the 3R principle (Reduce, Reuse, Recycle); Segregation of solid waste, in accordance with the color standard; Collection, packaging, storage and transportation of solid waste, in accordance with current legislation; and Environmentally appropriate final destination (reuse, recycling, composting, energy use, etc.) and/or environmentally appropriate final disposal of solid waste generated in the company. Most of the waste generated will be treated within PARACEL's pulp mill, with the implementation of a debris landfill, a sanitary landfill (organic), and an industrial landfill, as well as the composting system and the process of corrective soil acidity production, significantly reducing the pressure on the local population's garbage collection system and preventing its accumulation over the public system.

With regard to the impacts resulting from water consumption, the studies confirm the availability of water from the Paraguay River, which has a minimum flow ($Q_{7.10}$) of 1,093 m^3/s and an average flow of 2,179 m^3/s. Water intake for industry operation is estimated at 0.09% of the average river flow, and about 80% of this volume (effluent) will return to the Paraguay River.

The generation of liquid effluents (referring to flow and organic load) is minimized by adopting the Kraft pulp production process based on the best available technologies (BAT). In addition, effluents from the PARACEL pulp mill will be treated at the ETP, which will have the biological treatment system adopted for activated sludge. The activated sludge process is a proven technology commonly used in the pulp and paper industries worldwide. After the biological treatment, the effluents will undergo a tertiary treatment for the removal of phosphorus, color and COD, through a physicochemical process with the application of aluminum sulfate and polymer in flocculation tanks, and will then be directed to a dissolved air flotation (DAF) system. Or as an alternative to the physicochemical flotation system, the tertiary treatment can be carried out by injecting ozone into the effluent.

The minimization of effluent generation and adequate treatment based on the best available technologies reduce the accumulation of the PARACEL plant's impact with other companies in the region, as well as with the population's wastewater treatment.

The minimization, control and monitoring of air emissions will be based on the technologies already established and used with great success, which are listed below:

- Use of low odor recovery boiler;
- High dry solids content of at least 80% in the liquor burned in the recovery boiler, which minimizes SOx emissions;
- Use of high efficiency electrostatic precipitators for the recovery boiler, biomass boiler and lime kilns;
- Collection of concentrated non-condensable gases from the digester and evaporation, and their incineration in the recovery boiler or biomass boiler (protected flame incineration);
- Extensive collection of diluted non-condensable gases from the digester, brown pulp line, evaporation, with treatment in the recovery boiler;
- Treatment of gases from the solution tank in the recovery boiler itself;
- Efficient cleaning of bleach plant relief gases; and
- Real-time gas monitoring systems and control system, rapid identification and correction of operational disturbances.

As mentioned, the Kraft pulp production process based on Best Available Techniques (BAT) will be adopted at the PARACEL pulp mill, allowing the reduction, control and monitoring of greenhouse gas emissions.

Minimization, control and monitoring of air emissions based on established technologies reduce the accumulation of the PARACEL plant's impact with other companies in the region.

As can be seen, the other impacts identified with greater synergy with the population are concentrated in the socioeconomic environment and especially in the construction phase for which mitigation measures were proposed, which are actions aimed at reducing or minimizing these impacts.

Within the framework of the social evaluation of the PARACEL pulp mill, located in Zapatero Cue, District of Concepción, Department of Concepción, Paraguay, the analysis of cumulative impacts was carried out and it was presented in a separate document called "Cumulative Impact Assessment (CIA)", as established in IFC Good Practice Handbook "Cumulative Impacts Assessment and Management: Guidance for the Private Sector in Emerging Markets". This standard (IFC, 2012) indicates that cumulative impacts are limited to those impacts that are generally considered important according to scientific criteria and based on the concerns expressed by affected communities.

This means that other existing constructions must be considered, projects planned or defined in the area of influence of the project, for which the projects identified in the characterization of the baseline of the social evaluation, where emphasis was given to the development projects promoted by the Government, are taken into account, and relevant (private) industrial projects in the area, identified either in the interview process or through the media and official government institutions such as the Ministry of Industry and Trade (MIC), the Ministry of Environment and Sustainable Development (MADES) and the Ministry of Public Works and Communications (MOPC).

Following the IFC Manual (IFC, 2015), it defines six (6) steps for a Rapid Cumulative Impact Assessment, as summarized below:

Step 1 - Determination of valued environmental and social components (VECs), spatial and temporal boundaries.

Step 2 - Evaluation of other activities

Step 3: Establishing the current condition of the VECs

Steps 4 and 5: Evaluation of cumulative impacts and significance on VEC

Step 6: Management measures that are part of the Social and Environmental Management Plan of the venture

For the study we have considered the projects identified in the DIA of the enterprise that integrates four (4) Municipalities or Districts of Concepción, Belén, Loreto and Horqueta.

A time limit has been established for the start-up of the projects in the period 2020-2025 (5 years), where both the PARACEL pulp mill and the other ventures could be in operation.

In order to define the valued social-environmental components (VECs), the impacts on which assertive measures must be taken with respect to the main synergies with the population were taken, referring to: population expectations, interference in urban infrastructure, changes in morphology (landscape), adequate disposal of solid waste and effluents, control of atmospheric emissions, dynamization of the economy and generation of jobs.

Planned and ongoing initiatives have been identified in the project's DIA. These were also complemented with other projects known through official institutions of the National Government such as the MIC, MADES, MOPC, the DNCP or the

Municipality, and their websites. Other undertakings were mentioned by the communities in the framework of the interviews carried out. As follows:

PLANNED PROJECTS

- Project "Sanitary sewerage system and wastewater treatment plant for the city of Horqueta
- Project "Environmental adaptation of the sanitary sewage system of Concepción - ESSAP S.A."
- Project "Improvement of local roads in Concepción"
- Project "Improvement of the physical connectivity of the department of San Pedro - Punta Riel - Belén section"
- Project "Habilitation and maintenance of the Pozo Colorado - Concepción section".
- Improvement of the electrical system of Concepción (Section SE Horqueta - SE Concepción)
- Improvement of the dredging of the Paraguay - Paraná Waterway

PROJECTS IN OPERATION

- Projects "Drinking Water System and Complementary Activities of ESSAP in the City of Concepción" and "Improvement of the Potable Water System for Regional Development in the Republic of Paraguay - ESSAP S.A Ciudad de Concepción".
- Project "Frigorífico Concepción"
- Project "JBS - Belen"

Once the projects have been correlated, the strong synergy between industrial projects, i.e. PARACEL and the slaughterhouses in the DIA area, can be seen. This could occur because this type of enterprise, in the operational stage, has a strong positive impact on employment generation and on the development of the local, regional and extra-regional economy, and negative impacts due to the pressure on public/non-public services and infrastructure, associated with the people employed and induced by the projects in the DAI and the increase in truck traffic in the area of influence.

The minimization of cumulative impacts, from PARACEL, would be to strictly attend all the measures indicated in the Social and Environmental Management Plan; however, it could also require the articulation with other companies or with local, regional and/or national institutions for the due attention to the impacts on road infrastructure and public/non-public services, and to contribute to the development of local capacities, in order to avoid the migration of people/workers (unskilled, technicians and professionals) between companies and/or productive sectors.

12 CONCLUSION

In order to analyze the environmental feasibility to install PARACEL pulp mill in Concepción, Department of Concepción, an Environmental and Social Impact Assessment report (ESIA) was prepared. This study performed a systemic approach of the new mill, taking into account its main characteristics, as well as the physical, biotic and socioeconomic environment at its areas of influence. Later, in the analysis of the environmental impacts, the possible impacts, at the same environments, resulting from the implementation and operation of the industrial plant were pointed out, as well as their respective mitigation and enhancement measures.

The mill will have a total capacity of 1,500,000 tons per year of bleached pulp for paper. The pulp production will be through the kraft process, involving the areas of wood preparation, fiber line, drying and packing, chemical recovery (evaporation, recovery boiler, lime kilns/causticizing), chemical plant and utilities (biomass boiler, water treatment plant - WTP, boiler water treatment plant - BWTP and effluent treatment plant - ETP), in addition to raw water intake, effluent emissary pipeline, fuel system, laboratory and waste treatment plant, including debris, organic and industrial waste landfills, composting areas and soil acidity corrector production plant and the river port.

This pulp mill will also produce electricity through the burning of black liquor and biomass which are renewable sources of energy, with a total nominal capacity of 220 MW of cogeneration for the production of bleached pulp. The energy consumption of the bleached pulp plant will be about 120 MW. Therefore, there will be a surplus to export to the grid of 100 MW if the plant when manufacturing bleached pulp.

It should be noted that, with respect to the environmental control systems, the plant will adopt the Best Available Technologies (BAT) in order to reduce, control, and monitor the liquid effluents, air emissions, and solid waste generated, as well as apply the Best Practice Environmental Management (BPEM).

Throughout the environmental study, detailed studies were carried out for the physical, biotic, and socioeconomic environments, identifying the area's current sensitivities and environmental vulnerabilities.

An evaluation of the environmental impacts was made, based on the characterization of the project and the environmental diagnosis, considering the synergic and cumulative impacts, and the consultant responsible for the study found:

- In the design phase, there were found 3 impacts on the socio-economic environment, which 2 are positive and negative at the same time, and 1 is positive;
- In the construction phase, there were found 6 negative impacts on the physical environment, 6 negative impacts on the biotic environment and 1 both positive and negative; and 10 impacts on the socio-economic environment, being 7 negative, 2 positive and 1 both positive and negative;
- In the phase of deactivation of works, 1 negative impact on the socioeconomic environment was identified;
- In the operation phase, there were found 7 impacts on the physical environment, being 6 negative and 1 both positive and negative, 6

negative impacts on the biotic environment and 1 positive/negative; and 9 impacts on the socioeconomic environment, being 3 negative, 4 positive and 2 positive and negative.

Most of the negative impacts identified are concentrated in the physical environment, mainly during the construction phase, for which mitigation measures have been proposed, which consist of actions aimed to reduce or minimize these impacts.

All negative impacts identified in the operation phase of the pulp mill are mitigable.

In addition to the mitigation measures, basic environmental programs were proposed to control and monitor the identified impacts in the four phases foreseen for the project (design, construction, deactivation of works and operation).

On the other hand, it was identified that the positive impacts are related to the socioeconomic environment and they are fundamentally related to the increase in direct and indirect employment, the increase in tax collection and the dynamism of the local economy, in the construction and operation phases of the pulp mill.

Thus, it should be noted that the positive impacts are extremely relevant in the social context for the municipalities of Concepción, Loreto, Belén and Horqueta, and they will be important milestones in the development of these cities. And according to the social perception study, it was possible to verify that for the community of Piquete Cue and houses located near the DAA, besides the existing micro-territories located on the access roads to the mill area, as well as in the municipalities of Loreto, Belén and Horqueta, the arrival of any company can provide development and better living conditions in its department, is considered a positive attitude.

Finally, according to the analyses carried out during this Environmental and Social Impact Assessment, it can be stated that no environmental impact identified, in the opinion of the team that developed this ESIA, would threaten the environmental feasibility of the company's implementation. And the identified environmental aspects of greater vulnerability are susceptible to mitigation, which requires that environmental control measures must be considered in the executive project and be implemented successfully.

For this reason, the PARACEL pulp mill and its associated infrastructure that will produce bleached pulp for paper can be implemented in the region studied, since it is a sustainable company and viable from the economic, social, environmental, technical and legal points of view, which will contribute to the social and economic growth of the region, the department of Concepción and Paraguay country as a whole.

ANNEX I

RECORD OF PUBLIC CONSULTATIONS AND STAKEHOLDER ENGAGEMENTS

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
1.	July 3, 2019	Preliminary visits to authorities	Paracel	MADES technical team	In-person	Project presentation
2.	Oct 4, 2019	Preliminary visits to authorities	Paracel	Head of Police Department - Concepcion	In-person	Project presentation
3.	Nov 13, 2019	Preliminary visits to authorities	Paracel	Head of Concepcion Port	In-person	Project presentation
4.	Multiple site visits November 2019-March 2020	Field Visit to Indigenous Communities (Indigenous Report)	Paracel	Mbya Guaraní, Pai Tavyterá and Comunidad de Redención communities (Concepción, Cerro Apu'ua, Cerro Sarambi)	In-person	Multiple engagement events detailed in the Indigenous Report with these IP located near Concepcion. Each community was engaged with in separate meetings at least once.
5.	Dec 11, 2019	Preliminary visits to authorities	Paracel	Head of Municipality of Loreto	In-Person	Project presentation
6.	Dec 12, 2019	Preliminary visits to authorities	Paracel	Secretary General of Concepcion county	In-Person	Project presentation
7.	Dec 13, 2019	Preliminary visits to authorities	Paracel	Head of Communications – Municipality of Concepcion	In-Person	Project presentation
8.	Dec 13, 2019	Preliminary visits to authorities	Paracel	Secretary General Municipality of Horqueta	In-Person	Project presentation
9.	Dec 13, 2019	Preliminary visits to authorities	Paracel	Head of Municipality of Belen	In-Person	Project presentation
10.	Dec 16, 2019	Preliminary visits to authorities	Paracel	MOPC, technical team	In-Person	Project presentation
11.	Dec 16-18, 2019	Preliminary visits to local stakeholders	Paracel's social consultant	8 local stakeholders	In-Person	Each stakeholder was engaged with separately.

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
12.	Jan 13, 2020	Preliminary visits to local stakeholders	Paracel's social consultant	Head of Communications – Municipality of Concepcion	In-Person	
13.	Jan 14-15, 2020	Field Visit for Pöyry PEIS	Paracel's social consultant	Residents of Piquete Cue	In-person	Information collected from 13 households
14.	Jan 16, 2020	Field Visit for Pöyry PEIS	Paracel's social consultant	Residents of Belen	In-person	Information collected from 28 personal interviews
15.	Jan 17, 2020	Field Visit for Pöyry PEIS	Paracel's social consultant	Residents of Horqueta	In-person	Information collected from 30 personal interviews
16.	Jan 20, 2020	Field Visit for Pöyry PEIS	Paracel's social consultant	Residents of Loreto	In-person	Information collected from 30 personal interviews
17.	Jan 20-24 and 27-30, 2020	Field Visit for Pöyry PEIS	Paracel's social consultant	Residents of Concepcion city, Horqueta, C. San Ramon, C. San Luis, C. San Antonio, C. Primavera, Costa Pucu, Jhugua Gonzalez, Jhugua Zarzo, Co'ê Porâ, Curuzu Ñu, Laguna Plato, Mbocayaty, Pirity Mongelós, Colonia Cnel. Mongelós, Paso Itá, Colonia R.L. Petit, Saladillo.	In-person	Information collected from 44 group interviews. Each group was engaged with separately.
18.	Jan 21-27, 2020	Field Visit for Pöyry ESIA	Paracel's social consultant	Residents of Concepcion	In-person	Information collected from 62 personal interviews.
19.	Jan 22-24 and 29-30, 2020	Field Visit for Pöyry ESIA	Paracel's social consultant	Institutional representatives of Concepcion, Horqueta, Loreto and Belen	In-person	Information collected from 20 personal interviews.
20.	Jan 23, 2020	Workshop	Paracel	Local stakeholders (see folder 19.12.7)	In-person	Workshop with stakeholders
21.	Jan 25 2020	Field Visit for Pöyry ESIA	Paracel's social consultant	Institutional representatives of Colonia R.L.Petit	In-person	23 attendees

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
22.	Jan 25 2020	Field Visit for Pöyry ESIA	Paracel's social consultant	Institutional representatives of Costa Pucu	In-person	10 attendees
23.	Feb 6, 2020	Field Visit for Pöyry ESIA	Paracel's social consultant	Social and women organizations representatives of Belen	In-person	14 attendees
24.	Feb 8, 2020	Field Visit for Pöyry ESIA	Paracel's social consultant	Institutional representatives of Loreto	In-person	12 attendees
25.	Feb 8, 2020	Field Visit for Pöyry ESIA	Paracel's social consultant	Institutional representatives of Horqueta	In-person	9 attendees
26.	Feb 11, 2020	Preliminary visits to authorities	Paracel	ANDE technical team	In-Person	Project presentation
27.	Feb 12, 2020	Preliminary visits to authorities	Paracel	INDI	In-person	
28.	Feb 20, 2020	Preliminary visits to authorities	Paracel	Minister of Labor	In-Person	Project presentation
29.	Apr 14, 2020	Preliminary coordination meeting	Paracel	ANDE technical team	In-Person	
30.	May 4, 2020	Preliminary coordination meeting	Paracel	ANDE technical team	Zoom	
31.	June 22 – July 27, 2020	Information exchange weekly meeting prior ESIA submittal	Paracel	MADES technical team	Zoom	Pöyry ESIA presentation
32.	July 24, 2020	Field visit for plantations ESIA	Paracel's social consultant	Local health authorities	In-person	
33.	Aug 13, 2020	Preliminary visits to authorities	Paracel's social consultant	Head - Municipality of Sgto. J.F.Lopez (Puentesiño)	In-person	Project presentation
34.	Aug 17, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Loreto: Virgen del Camino, Hugua Po'i	In-person	Project presentation. Personal interviews

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
35.	Aug 18, 2020	Preliminary visits to authorities	Paracel's social consultant	Head – Municipality of Paso Barreto	In-person	Project presentation
36.	Aug 18, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Loreto: Hugua Po'i	In-person	Project presentation. Personal interviews
37.	Aug 19, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Loreto: Jhugua Guazú, Laguna Cristo Rey	In-person	Project presentation. Personal interviews
38.	Aug 19, 2020	Preliminary visits to authorities	Paracel	Director of SNPP - Concepcion	In-Person	Project presentation
39.	Aug 19, 2020	Preliminary visits to authorities	Paracel	Gov authorities - Concepcion	In-Person	Project presentation
40.	Aug 20, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Paso Barreto: Isla Hermosa Loreto: Laguna Cristo Rey	In-person	Project presentation. Personal interviews
41.	Aug 21, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Horqueta: Paso Mbutu	In-person	Project presentation. Personal interviews
42.	Aug 27, 2020	Coordination meeting	Paracel	Association of industrialists and merchants of Concepcion	Zoom	
43.	Aug 28, 2020	Visits to stakeholders	Paracel	UIP	Zoom	Project presentation
44.	Sep 8, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Sgto. J.F.Lopez (Puentesiño)	In-person	Project presentation. Personal interviews
45.	Sep 8-9, 2020	2-day Virtual Meeting	Paracel	Potential Suppliers	Zoom	Recording of meetings available on YouTube
46.	Sep 9, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Sgto. J.F.Lopez (Puentesiño)	In-person	Project presentation. 2 group meetings
47.	Sep 11, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Paso Barreto	In-person	Project presentation. Personal interviews

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
48.	Sep 12-14, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Loreto: Anderí, Hugua Po'i, Virgen del Camino Paso Barreto	In-person	Project presentation. Personal interviews
49.	Sep 15, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Horqueta: Paso Mbutu, Estibe de Plata	In-person	Project presentation. Group meeting
50.	Sep 16-17, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Arroyito – Horqueta: Calle 15 Loreto: Santísima Trinidad	In-person	Project presentation. Personal interviews
51.	Sep 17, 2020	Coordination meeting	Paracel	ANDE technical team	Zoom	
52.	Sep 18, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Paso Barreto	In-person	Project presentation. Group meeting
53.	Sep 19-21, 2020	Field visit for plantations ESIA	Paracel's social consultant	Several stakeholders in Paso Barreto: Colonia Jorge Sebastián Miranda Bella Vista: Ayala Cue Horqueta: Domínguez Nigó	In-person	Project presentation. Personal interviews
54.	Sep 22, 2020	Coordination meeting	Paracel	ANDE technical team	Zoom	
55.	Sep 25, 2020	Coordination meeting	Paracel	ANDE technical team	Zoom	
56.	Sep 30, 2020	Virtual Meeting	Paracel	Civil Organizations	Zoom	Recording of meeting available on Google Drive
57.	Sep 30, 2020	Virtual Meeting	Paracel	Unions	Zoom	Recording of meeting available on Google Drive
58.	Oct 1, 2020	Virtual Meeting	Paracel	Environmental NGOs	Zoom	Recording of meeting available on Google Drive
59.	Oct 1, 2020	Virtual Meeting	Paracel	Universities	Zoom	Recording of meeting available on Google Drive

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
60.	Oct 6, 2020	Virtual Meeting	Paracel	Media	Zoom	Recording of meeting available on Google Drive
61.	Oct 6, 2020	Virtual Meeting	Paracel	Government Authorities	Zoom	Recording of meeting available on Google Drive
62.	Oct 7, 2020	Open Virtual Meeting	Paracel	Nationwide Public	Zoom	Recordings available on YouTube
63.	Oct 8, 2020	Project presentation to local authorities	Paracel	Head of Environmet – Municipality of Horqueta	In-person	
64.	Oct 8, 2020	Project presentation to local authorities	Paracel	Head – Municipality of Arroyito	In-person	
65.	Oct 8, 2020	Project presentation to local authorities	Paracel	Secretary General - Municipality Sgto. J.F.Lopez (Puentesiño)	In-person	
66.	Oct 8, 2020	Project presentation to local authorities	Paracel	Secretary General - Municipality Belén	In-person	
67.	Oct 9, 2020	Project presentation to local authorities	Paracel	Risk Management Director - Municipality Concepción	In-person	
68.	Oct 9, 2020	Project presentation to local authorities	Paracel	Head – Municipality of Loreto	In-person	
69.	Oct 9, 2020	Project presentation to local authorities	Paracel	Secretary General - Municipality San Alfredo	In-person	
70.	Oct 9, 2020	Project presentation to local authorities	Paracel	Authorities – Municipality of Paso Barreto	In-person	
71.	Oct 20, 2020	Visits to stakeholders	Paracel	Parish Priest of Puentesiño	In-person	

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
72.	Oct 20, 2020	Mill site visit	Paracel	Potential suppliers	In-person	
73.	Oct 20, 2020	Project Presentation	Paracel	Residents of Arroyito	In-person	Recordings available on YouTube.
74.	Oct 20, 2020	Coordination meetings	Fundación Natán	INDI		
75.	Oct 21, 2020	Project Presentation	Paracel	Residents of Paso Barreto	In-person	Recordings available on YouTube.
76.	Oct 21, 2020	Project Presentation	Paracel	Residents of Loreto	In-person	Recordings available on YouTube.
77.	Oct 22, 2020	Project Presentation	Paracel	Residents of Belén	In-person	Recordings available on YouTube.
78.	Oct 22, 2020	Project Presentation	Paracel	Residents of Concepción City	In-person	Recordings available on YouTube.
79.	Oct 23, 2020	Project Presentation	Paracel	Residents of Horqueta	In-person	Recordings available on YouTube.
80.	Oct 27, 2020	Mill site visit	Paracel	Potencial suppliers	In-person	Recordings available on YouTube.
81.	Oct 27, 2020	Coordination meetings	Fundación Natán	INDI		
82.	Week of November 9, 2020	Field Visit to Concepción	ERM's Paraguay Consultant	Concepción (Laguna Plato, Callejón San Ramón, Universidad Nacional de Concepción, Asociación de Comerciantes de Concepción, Municipalidad de Concepción, Villa Redención, Calaberita, Sawhomayaha IP Community, as well as individuals).	In-person	Interview format. Minutes available.
83.	Nov 4, 2020	Field Visit to IP	Fundación Natán	Heads (Caciques) of Indigenous Communities	In-person	Report provides photographic evidence of engagement and signed consents.
84.	Nov 5, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Redencion	In-person	Report provides photographic evidence of engagement and signed consents.
85.	Nov 6, 2020	Coordination meetings	Fundación Natán	Local Gov. authorities		

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
86.	Nov 6, 2020	Coordination meetings	Fundación Natán	Local Stakeholders		
87.	Nov 10, 2020	Mill site visit	Paracel	Potential suppliers	In-person	
88.	Nov 10, 2020	Open Virtual Meeting	Paracel	Nationwide Public	Zoom	Recordings available on YouTube
89.	Nov 10, 2020	Visits to stakeholders	Paracel	Dean of the Faculty of Exact Sciences and their Technologies of the UNC	In-person	
90.	Nov 11, 2020	Visits to stakeholders	Paracel	Vice-dean of the Faculty of Agricultural Sciences of the UNC	In-person	
91.	Nov 11, 2020	Visits to stakeholders	Paracel	ACIC (Association of industrialists and merchants of Concepcion)	In-person	
92.	Nov 11, 2020	Coordination meetings	Fundación Natán	Local Gov. authorities		
93.	Nov 11, 2020	Coordination meetings	Fundación Natán	County Gov. authorities		
94.	Nov 11, 2020	Coordination meetings	Fundación Natán	Local stakeholders		
95.	Nov 12, 2020	Field Visit to IP	Fundación Natán	Indigehous Community of Takuarita	In-person	Repart provides photographic evidence of engagement and signed consents.
96.	Nov 24, 2020	Field Visit to IP	Fundación Natán	Indigehous Community of Takuarendyju	In-person	Repart provides photographic evidence of engagement and signed consents.
97.	Nov 24-25, 2020	Field Visit to IP	Fundación Natán	Indigehous Community of Vy'a Renda	In-person	Repart provides photographic evidence of engagement and signed consents.
98.	Nov 24, 2020	Visits to stakeholders	Paracel	FEPAMA	Zoom	Project presentation
99.	Nov 26, 2020	Field Visit to IP	Fundación Natán	Indigehous Community of Takuarita	In-person	Repart provides photographic evidence of engagement and signed consents.

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
100.	Nov 27-28, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Redencion	In-person	Report provides photographic evidence of engagement and signed consents.
101.	Nov 27, 2020	Coordination meetings	Fundacion Natan	Local Gov. authorities		
102.	Week of Dec 7, 2020	Field Visit to IP in Plantation Areas	ERM's Paraguay Consultant	Two Mbya Guaraní communities and three Pai Tavyterá communities in Vy'a renda, Takuarendyju, Tacuarita and Cerro Akangue.	In-person	Interview format. Minutes available.
103.	Dec 8, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Takuarendyju	In-person	Report provides photographic evidence of engagement and signed consents.
104.	Dec 8, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Vy'a Renda	In-person	Report provides photographic evidence of engagement and signed consents.
105.	Dec 9, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Jeguahaty	In-person	Report provides photographic evidence of engagement and signed consents.
106.	Dec 9, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Sati	In-person	Report provides photographic evidence of engagement and signed consents.
107.	Dec 9, 2020	Forestry site visit	Paracel	Potential Suppliers	In-person	
108.	Dec 10, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Cerro Akangue	In-person	Report provides photographic evidence of engagement and signed consents.
109.	Dec 10, 2020	Public Consultation	Paracel	Nationwide Public	Zoom and In-person	In-person and online event with over 100 attendees.
110.	Dec 10-11, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Redencion	In-person	Report provides photographic evidence of engagement and signed consents.

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
111.	Dec 12, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Mberyvo Jaguaraymi	In-person	Report provides photographic evidence of engagement and signed consents.
112.	Dec 12-13, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Apyka Jegua	In-person	Report provides photographic evidence of engagement and signed consents.
113.	Dec 13, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Sati	In-person	Report provides photographic evidence of engagement and signed consents.
114.	Dec 13, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Guyra ñe´engatu amba	In-person	Report provides photographic evidence of engagement and signed consents.
115.	Dec 14-15, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Yvyty rovi cerro po´i	In-person	Report provides photographic evidence of engagement and signed consents.
116.	Dec 15, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Apyka Jegua	In-person	Report provides photographic evidence of engagement and signed consents.
117.	Dec 15, 2020	Coordination meeting	Paracel	DINAC	Zoom	Project presentation
118.	Dec 16, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Sati	In-person	Report provides photographic evidence of engagement and signed consents.
119.	Dec 16, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Guyra ñe´engatu amba	In-person	Report provides photographic evidence of engagement and signed consents.
120.	Dec 17, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Vy'a Renda	In-person	Report provides photographic evidence of engagement and signed consents.
121.	Dec 17, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Jeguahaty	In-person	Report provides photographic evidence of engagement and signed consents.

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
122.	Dec 17, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Mberyvo Jaguaraymi	In-person	Report provides photographic evidence of engagement and signed consents.
123.	Dec 17, 2020	Forestry site visit	Paracel	BNF	In-person	
124.	Dec 17, 2020	Visits to authorities	Paracel	IPS	Zoom	Project presentation
125.	Dec 18, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Redencion	In-person	Report provides photographic evidence of engagement and signed consents.
126.	Dec 18, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Takuarendyju	In-person	Report provides photographic evidence of engagement and signed consents.
127.	Dec 18, 2020	Field Visit to IP	Fundación Natán	Indigenous Community of Takuarita	In-person	Report provides photographic evidence of engagement and signed consents.
128.	Dec 21, 2020	Project follow-up monthly meeting	Paracel	Voluntary members of the committee	Zoom	First meeting
129.	Dec 22, 2020	Coordination weekly meeting	Paracel	MTESS	Zoom	
130.	Dec 30, 2020	Coordination weekly meeting	Paracel	MTESS	Zoom	
131.	Jan 5, 2021	Visits to authorities	Paracel	Traffic National Agency	Zoom	Project presentation
132.	Jan 7, 2021	Visits to stakeholders	Paracel	ACIC (Association of industrialists and merchants of Concepcion)	Virtual	
133.	Continuous	WhatsApp Channel	Paracel	Nationwide Public	WhatsApp	Over 110 community members are part of a dedicated WhatsApp channel to ask questions about the Project

No.	Date	Type of Engagement	Organizer	Stakeholders Engaged	Venue	Comments
	Continuous	Email	Paracel	Nationwide Public	N/A	Paracel receives CVs and inquiries from people interested in applying for a position, and keeps a log of emails and responses on an Excel spreadsheet that has been shared with ERM for review. To date, Paracel has received 369 emails to date (Jan 7).
	Continuous	Social Media	Paracel	Nationwide Public	N/A	Paracel has dedicated YouTube, Facebook, Twitter and Instagram accounts as part of their Communication and Disclosure Strategy
	Continuous	Media Appearances	Paracel	Nationwide Public	N/A	Paracel representatives have spoken on TV programs and on the radio. Articles about Paracel have also been printed.

Pöyry Tecnologia Ltda.
Av. Alfredo Egídio de Souza Aranha, 100
Bloco B - 7° andar
04726-170 São Paulo - SP
BRASIL
Tel. +55 11 3472 6955
Fax +55 11 3472 6980
E-mail: forest.br@poyry.com

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

Date 04.08.2020

Reference # 109001759-003-0000-E-1501

Page 1

Pulp Mill, River Port, Transmission Line and Electrical Substation in Concepción – Paraguay

VOLUME IV - COMPLEMENTARY ENVIRONMENTAL STUDIES

Content 14 COMPLEMENTARY ENVIRONMENTAL STUDIES

Annexes
I Atmospheric Dispersion Study
II Water Dispersion Study
III Preliminary Risk Analysis Study
IV Sound Pressure Level Modeling
V Self Depuration Study

Distribution
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Orig.	15/07/20 – bvv	15/07/20 – msh	15/07/20 – hfw	15/07/20 – hfw	For information
Rev.	Date/Author	Date/Verified	Date/Aproved	Date/Authorized	Observation
a	31/05/21 – bvv	31/05/21 – hbo	31/05/21 – hfw	31/05/21 – hfw	For information
b	31/07/21 – bvv	31/07/21 – hbo	31/07/21 – hfw	31/07/21 – hfw	For information

CONTENT

14 COMPLEMENTARY ENVIRONMENTAL STUDIES 3

FIGURE LIST

No table of figures entries found.

TABLE LIST

No table of figures entries found.

14 COMPLEMENTARY ENVIRONMENTAL STUDIES

This volume presents the complementary environmental studies of the Environmental and Social Impact Assessment (ESIA) regarding the implementation of the PARACEL pulp mill in Concepción, Paraguay.

Therefore, in this Volume, the following are presented as attachments:

- Atmospheric Dispersion Study;
- Water Dispersion Study;
- Preliminary Risk Analysis Study;
- Sound Pressure Level Modeling (PARACEL will meet noise IFC Guidelines);
- Self Depuration Study.

ANNEX I

ATMOSPHERIC DISPERSION STUDY

CataVento Ambientale Meteorologia e Meio Ambiente presents

ATMOSPHERIC DISPERSION STUDY

PARACEL – CONCEPCIÓN – PARAGUAY

MAY - 2020

PRESENTATION

Prepared by ***CataVento Ambientale Meteorologia e Meio Ambiente***

With the expectation that the activities presented in this document are satisfactory to the proposed objectives, we reiterate our expressions of consideration.

Rio Grande, May 10, 2020

SUMMARY

1. Introduction

2. Methodology

2.1 Models Description

2.1.1. AERMOD model
2.2.2. AERMET model
2.2.3. WRFmodel
2.2.4. MMIFmodel

2.2. Meteorological data

2.3. Surface Characteristics

2.4 Air Quality Standards

2.5 Emission Parameters

3. Results

3.1. Meteorology and Climatology

3.2. Evaluation of the WRF Model

3.3. Atmospheric Boundary Layer

3.4. Pollutant Dispersion

4. Conclusions

5. Bibliography

ANNEX A - Tables containing the maximum concentration values for pollutants CO, TRS, NO_2, PM_{10} and SO_2

1. INTRODUCTION

This technical report presents the atmospheric dispersion results of the following pollutants: carbon monoxide (CO), total reduced sulfur (TRS), nitrogen dioxide (NO_2), particulate matter (PM_{10}) and sulfur dioxide (SO_2), emitted by PARACEL pulp mill, with a capacity of 1.5 million tons per year of bleached pulp for paper or 900 thousand tons per year of dissolving pulp. PARACEL pulp mill and its emission sources will be installed near the city of Concepción, in Paraguay, at the coordinates 23.241050° S and 57.490110° W (7429711 S; 449862 O UTM). Concepción city is the capital of Concepción department and is located on the left side of Paraguay river, 400 km north of Asunción.

It should be noted that the PARACEL pulp mill, despite being designed to produce 1,500,000 t/year, will be able to produce up to 1,800,000 t/year of bleached pulp as a consequence of higher overall plant efficiency, as well as greater equipment performance without the need to increase the built area or include new additional equipment. Likewise, it will not be necessary to make any modification to the main environmental control equipment, nor any loss in its performance, which can guarantee the same liquid effluent and atmospheric emissions considered in this EIAp/RIMA. Therefore, it can be said that in the event of increasing pulp production up to 1,800,000 t/year, there will be no changes in the environmental impacts identified and evaluated in this EIAp/RIMA.

Simulations of atmospheric dispersion of CO, TRS, NO_2, PM_{10}, and SO_2 are performed using the Aerial Model Dispersion (AERMOD), developed and available by the United States Environmental Protection Agency (EPA). The surface and altitude meteorological data were obtained from a numerical simulation with the WRF mesoscale meteorological model, the MMIF software and the AERMET processor. The meteorological data series covers the period from 01/01/2018 to 01/01/2020, two years of simulated data.

2. METHODOLOGY

2.1 Models Description

Atmospheric dispersion modeling is performed using the AERMET-AERMOD model system, fed with meteorological data simulated by the WRF mesoscale model. The interface between the FRM model and the AERMET-AERMOD model system is done using the MMIF model. Descriptions of the models used for the study are presented in this section.

2.1.1. Modelo AERMOD

AERMOD was developed by the United States Environmental Protection Agency (EPA, 2004a, 2008a). AERMOD is a stationary Gaussian model used to calculate the concentrations associated with industrial sources; the model is an improvement of the ISCST3 (SourceComplex-Short Term3). AERMOD can be applied on complex terrain and under realistic conditions of turbulence of the atmospheric boundary layer (ATC). The model assumes the Gaussian distribution in all directions under any atmospheric condition. However, can treat vertical distribution as non-Gaussian under convective (unstable) conditions. The model is also composed of algorithms to simulate dispersion in light wind conditions and to consider the effect of buildings on the dispersion of pollutants (building downwash).

To run simulations with the AERMOD model, information from two data sets is needed: emission sources and meteorology. Emitting source data includes coordinates, emission rates, exit pollutant temperature, and exit pollutant velocity. The meteorological data set must contain the pressure, wind direction and speed, air temperature, precipitation and the solar radiation, as well as some specific parameters of CLA (microscale parameters). The simulation domain topography can also be reported in several resolutions.

The dispersion processing and concentration calculation by the AERMOD model is performed from a name list file (aermod.inp), in which the appropriate commands are listed and read by the model. Meteorological and micro meteorological information is delivered to the model through files for surface conditions (surface.sfc) and for altitude conditions (profile.pfl). If the pollutant emissions are variable in time, it is possible to create emission files for each pollutant and transfer the information to the model using the HOUREMISS.

2.1.2. Modelo AERMET

The AERMET processor (EPA, 2004b) organizes the meteorological data and estimates the CLA parameters necessary for the dispersion calculations with the AERMOD model. Thus, the AERMET was designed to perform the calculations in three stages. The first stage extracts the data and performs data quality control. The second stage combines the available data for 24 hour periods and writes this data to an intermediate file. The third and last stage reads the data generated in the second stage and calculates the CLA parameters necessary for the AERMOD model [CLA height, friction velocity (u *), convection velocity scale (w *), heat flux sensitive, Obukhov length (L)].

AERMET can extract altitude data in two formats: TD-6201 and *Forecast Systems Laboratory* (FSL). For surface data, the AERMET processor can extract hourly data in the following formats: : Tarjeta Deck 144 (CD-144), Solar and Meteorological Surface Observation Network (SAMSON), Hourly Surface Meteorological Observations (HUSWO), Integrated Surface Hours Database (ISHD) and TD-3280. AERMET may also receive data in a non-standard format to include weather information for a specific site (on-site station). In on-site mode, the AERMET model accepts data in ASCII format and structured by the user. The on-site station format works well for simulations using data from weather stations installed in locations outside of the United States and Canada, where files can be accessed by the user in the formats mentioned.

2.1.3. Modelo WRF

Numerical climate simulations, designed to obtain altitude information, are performed using the Weather Research and Forecasting (WRF) model. The WRF is a mesoscale computerized weather forecasting system designed for both operational service and research needs. The model is fully compressible and can be integrated in non-hydrostatic mode.

The WRF calculates the components of wind speed, potential temperature, geopotential, surface pressure field, and various physical quantities. It also allows other variables to be generated, such as turbulent kinetic energy and ratios for mixing water vapor, rain/snow, and cloud water/ice. Physics model also calculates non-local turbulence for CLA and determine long and short wave radiation in various spectral bands.

The simulation period with the WRF model (the last two consecutive years) allows the study to be carried out taking into account all the meteorological conditions that influence the transport and diffusion of pollutants in the region, including diurnal and seasonal variations. The model is used in a configuration with nested grids centered on the company coordinates. The physical parameters, used in the WRF simulation, include

CLA, surface, cumulus, cloud microphysics, and radiation parameterization. The characteristics of the simulation domains and the model configuration options are presented in Table 1.

Table 1 - Characteristics of the simulation domains and configuration options of the WRF model.

Domain	External Network	Intermediary Network	Internal network
Horizontal network	30 points	30 points	30 points
Network space	27 km	9 km	3 km
Simulation Period	01/01/2018 a 01/01/2020		
Coordinates central point of the networks	23,241050° S e 57,490110° O 7429711 S; 449862 O m UTM		
Initial and contour conditions of meteorology	GFS (0,25º)		
Vertical levels	30 layers		
Spin-up period	15 days (since December, 15 (2017))		
CLA settings	Yonsei University (YSU)		
Surface settings	Monin-Obukhov Similarity Theory (MM5 MRF PBL).		
Cumulus settings	Betts-Miller-Janjic		
Cloud microphysics settings	WSM 3-class scheme (Hong et al., 2004)		
Radiation settings	RRTM		

2.1.4. MMIF Model

After performing numerical simulations with the WRF model, a data conversion to the AERMET and AERMOD models is necessary. To perform, the software provided by the US EPA, called “Mesoscale Model Interface Program” - MMIF (EPA, 2016) is used. The MMIF converts the results of the meteorological forecast models (WRF, MM5, ...) to the AERMET-AERMOD model system (Cimorelli et al., 2005).

With MMIF it is possible to extract the necessary surface and altitude data for the AERMET module and finally generate the files with the necessary data and in the specific format to feed the AERMOD dispersion model. MMIF creates three files, which are read by the AERMET model: a file that contains surface and altitude meteorological information (in situ), a file that contains altitude information only (ascending), and a file that contains information with characteristics of surface (roughness length, albedo and Bowen ratio).

AERMET uses this information to generate new files with the surface conditions (surface.sfc) and the altitude conditions (profile.pfl), which will be read by the AERMOD dispersion model.

2.2. Meteorological data

In this study, altitude and surface characteristics data are extracted from the results generated by the WRF model. This procedure was adopted due to the unavailability of primary (observed) meteorological data that could be used in the AERMOD dispersion model. The closest official and approved meteorological station is located at Teniente Coronel Carmelo Peralta Airport (USAF: 861340 / ICAO: SGCO), about 21 km southeast of the pulp mill (coordinates 23,442 ° S and 57,427 ° W (7407484.94 S ; 456383.89 O m UTM, altitude: 77 m). However, the airport station does not provide hourly meteorological data (1-hour averages) necessary to AERMOD.

Therefore, because the AERMOD model requires hourly meteorological data, and the Teniente Coronel Carmelo Peralta airport station or other official station close to the project does not have it, the AERMOD model was executed with meteorological data generated by numerical simulation by WRF model. This procedure is considered acceptable and the data from that station was used only for climatology and for the evaluation of the WRF weather model, which is presented in Section 3.2.

The files with surface and altitude information are generated from numerical simulations with the WRF model and are subsequently processed by the MMIF software. The MMIF model generates an altitude file in the format of the Forecast Systems Laboratory (FSL) and an on-site file with surface data. The files generated by the MMIF are communicated to the AERMET model to generate the “surface.sfc” and “profile.pfl” files, which serve as input for the AERMOD model. Both surface and altitude information are obtained from the center point of the grid, which coincides with the location of the company's emission sources. The surface and altitude data series, taken from the WRF model, covers the period from January 1, 2018 to January 1, 2020.

2.3. Surface Characteristics

To use the AERMET model to process meteorological data for the AERMOD model, it is necessary to determine the appropriate values for three surface characteristics:

roughness length, albedo, and Bowen coefficient. The length of the roughness is related to the height of the obstacles that the wind runoff will find in the simulation domain; in principle, it is the height at which the average wind speed is zero, considering a logarithmic wind profile. Roughness length is a parameter that directly influences wind shear near the surface and is important in determining the intensity of mechanical turbulence (generated by wind friction at the surface) and also stability in CLA. Albedo is the fraction of incident solar radiation reflected from the surface into space. The Bowen coefficient is the relationship between the sensible heat flux and the latent heat flux. Along with albedo and other meteorological variables; in this way, the Bowen ratio is used to determine the turbulence parameters of CLA under convection conditions (positive sensible heat flow at the surface).

The roughness length, albedo, and Bowen ratio are calculated from the region's ground cover information based on files from the United States Geological Survey (USGS). This information was obtained directly from the FRM model, extracted by the MMIF software. In the WRF model, land cover is based on data monitored by the AVHRR satellite with 24 categories and 1 km resolution. The surface characteristics are calculated and written in a format to be used in the third stage of AERMET. The topographic information, used to study the dispersion, is obtained from the SRTM-NASA database ("Shuttle Radar Topography Mission - NASA"), with a fidelity of 90 m.

2.4. Air Quality Standards

The maximum concentrations evaluation of CO, NO_2, MP_{10} and SO_2, calculated by the AERMOD model, are compared with the air quality standards established by the General Directorate of Air of the Ministry of the Environment (extinct SEAM), through SEAM Resolution 259/15. In the case of H_2S, the limits of perception of odors given by the World Health Organization (WHO, 2003) (11 µg / m^3) are used for the evaluation of air quality. The air quality standards established by SEAM Resolution 259/15 are shown in Table 2.

Table 2 – Air quality standards established by SEAM Resolution 259/15.

Pollutant	Annual average	24 h average	8 h average	1 h average
Particulate Material – $MP_{2,5}$	15 $\mu g/m^3$	30 $\mu g/m^3$		
Particulate Material – MP_{10}		150 $\mu g/m^3$		
Ozone – O_3			120 $\mu g/m^3$	
Nitrogen dioxide – NO_2	40 $\mu g/m^3$			200 $\mu g/m^3$
Sulfur dioxide – SO_2		20 $\mu g/m^3$		
Carbon monoxide - CO			10 mg/m^3	

2.5. Emission Standards

The pulp mill will have four emission sources (chimneys): Recovery Boiler, Lime Kiln 1, Lime Kiln 2 and Biomass Boiler. Emission rates and conditions are presented in Table 3.

Table 3 – Emission rates and conditions

Pollutant	Unit	Recovery boiler	Lime Kiln 1	Lime Kiln 2	Biomass boiler
MP	g/s	8.0	0.6	0.6	1.9
TRS (as H_2S)	g/s	1.8	0.3	0.3	-
SOx	g/s	16.4	2.7	2.7	5.7
NOx	g/s	63.9	10.8	10.8	12.2
CO	g/s	109.5	4.1	4.1	11.4
Flow	Nm^3/s @ 8% O_2	365	27	27	38
Temperature	°C	140	300	300	155
Moisture	%	23.7	23.0	23.0	24.0
Oxygen content	%	2.2	6.0	6.0	3.1
Flow (actual conditions)	m^3/s	500	64	64	57
Velocity	m/s	20.0	20.0	20.0	20.0
Chimney diameter	m	5.64	2.02	2.02	1,90
Chimney height	m	140	140	140	140
Coordinates	m	449867 E 7429710 S	449862 E 7429706 S	449856 E 7429711 S	449862 E 7429716 S

3. RESULTS

3.1. Meteorology and Climatology

Air pollutants dispersion of a region, in addition to the pollutants characteristics and emission sources, depends on the weather conditions and their interactions with the geographical environment. Emission characteristics generally include the type of pollutant, outlet temperature, release rate, emission rate, height, and dimensions of the source.

The analysis of meteorological phenomena and their interactions with geographical aspects represents the most complex part of the air dispersion study. The geographical aspects interfere in the meteorological fields, modifying the radiation balance, generating circulations, humidity flows, turbulence, etc. Therefore, the geographical characteristics of the study region, such as latitude, maritime and the presence of water bodies (lakes, lagoons, etc.), the relief and the predominant land cover, can have a great influence on the resulting circulation. Sea / land, lake / land, valley / mountain breezes and urban / rural circulations are examples of circulations generated due to geographic characteristics.

The pulp mill and its emission sources will be installed in the vicinity of the city of Concepción, in Paraguay, coordinates 23.241050 ° S and 57.490110 ° W (7429711 S; 449862 O m UTM). Concepción is the Capital of the Department of Concepción and is located on the left bank of the Paraguay River, about 400 km north of Asunción. The area where the emission sources will be installed is a predominantly rural region and the topography has altitudes that reach 180 m at sea level (Figure 1).

Paraguay's climate can be classified into three types according to the Köppen-Geiger Classification (Figure 2): 1) humid subtropical (Cfa), with hot summers (temperatures exceed 22 ºC in summer) and with more than 30 mm of rain in the driest month; 2) tropical savanna (Aw), with dry winter, rainy season in summer and average temperature of the coldest month above 18 ºC; 3) hot semi-arid (BSh), characterized by low rainfall, intense solar radiation and high average temperatures (around 27 ºC). For the Concepción region, where the pulp mill is located, the Köppen-Geiger classification indicates a tropical savanna (Aw) climate.

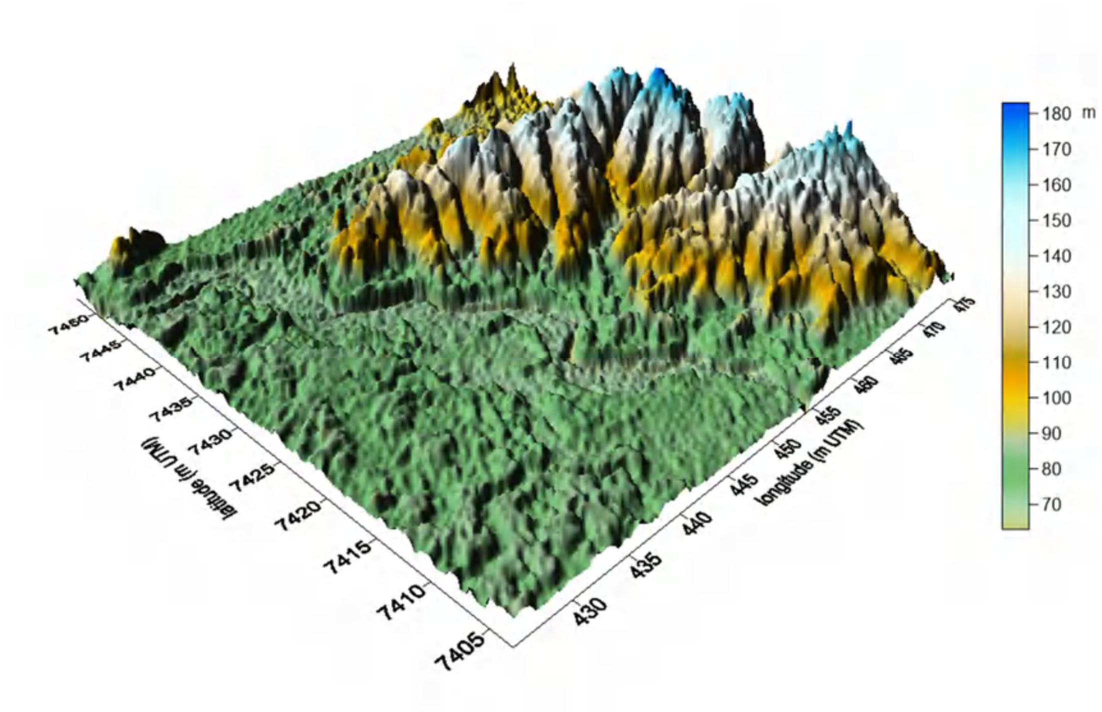


Figure 1 –Three-dimensional orographic map of the study area (2,500 km^2). Source: Generated with SRTM-NASA data (“Shuttle Radar Topography Mission - NASA”) with 90 m of definition.

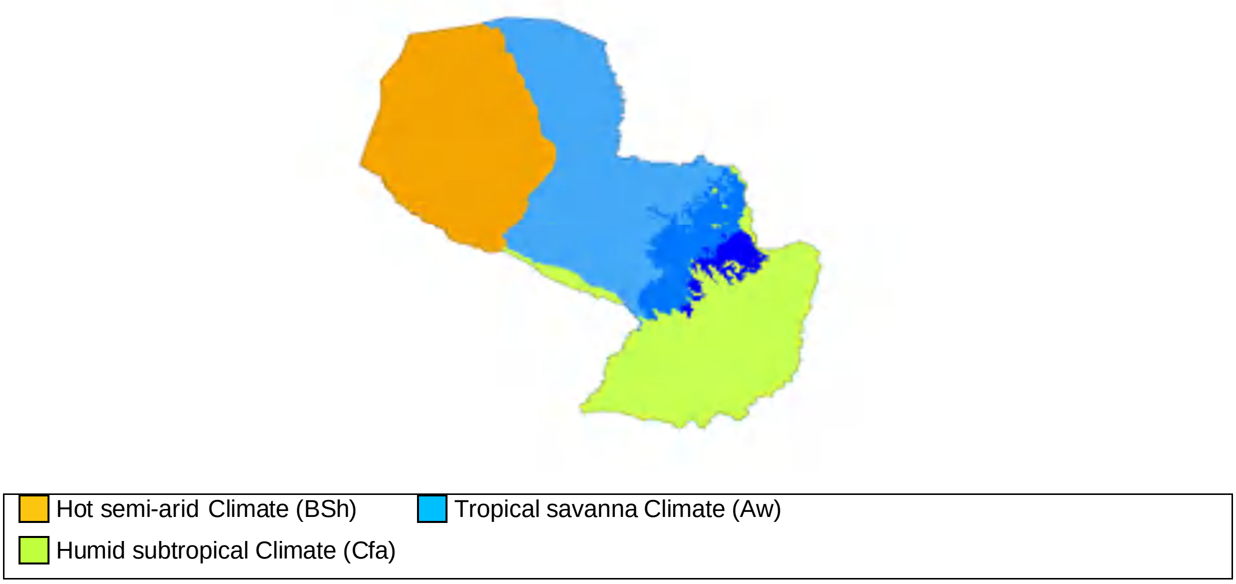


Figure 2 – Second climatic classification of Paraguay Köppen-Geiger (Source: https://es.wikipedia.org/wiki/Clima_de_Paraguay).

The data used for the climate study were obtained from the Integrated Surface Database (DSI), which can be consulted on the website of the National Oceanic and Atmospheric Agency (NOAA). The Integrated Surface Database (ISD) consists of global synoptic and temporal observations compiled from various sources in a single ASCII format. DSI integrates data from more than 100 original sources, including various data formats.

The closest approved station is at Teniente Coronel Carmelo Peralta Airport (USAF: 861340 / ICAO: SGCO), about 21 km southeast of the development (coordinates 23,442 ° S and 57,427 ° W (7407484.94 S; 456383.89 O m UTM, altitude: 77 m) Due to the proximity and completeness of the data, the station can be considered representative for climatological analysis.

For the analysis, 10 years of observed data (from 01/01/2010 to 12/31/2019) of atmospheric pressure (hPa), air temperature (°C), relative humidity (%), wind speed (m/s) and wind direction (degrees) are considered. This series of data allows the composition of the provisional Climatic Norms, which are averages of short periods based on observations that extend over a minimum period of 10 years. Figures 3 to 6 show the evolution over time of the monthly averages observed at the Lieutenant Colonel Carmelo Peralta station.

The atmospheric pressure ranged from 1,001.5 to 1,007.5 hPa, presenting a provisional climatological average of 1,003.9 hPa for the period from 2010 to 2019 (Figure 3). The monthly average temperature varied between 15.5˚C and 29.6˚C, while the provisional climatological average for the period from 2010 to 2019 was 24.3˚C (Figure 4).

The air temperature is defined by the effect of continentality and topographic homogeneity, presenting a wide range. In summer, being a tropical region, maximum temperatures can exceed 30°C, and in winter frost phenomena can be registered as a consequence of cold fronts. The monthly relative humidity varied between 51.4% and 85.5%, with a provisional climatological average for the period of 70.9% (Figure 5). Relative humidity varies considerably in the company region depending on the variability of rainfall in the region. The average monthly wind speed varied between 1.8 and 4.9 m/s, while the provisional climatological average for the period from 2010 to 2019 was 3.2 m/s (Figure 6). The wind rose shows the predominance of winds from the south, followed by those from the northeast and east, and with a less important southeast component, as shown in Figure 7.

The data used is satisfactory for the provisional climatic and meteorological analysis of the region, in which the pulp mill will be located. In summary, the average atmospheric pressure of the region is 1,003.9 hPa, the average air temperature is 24.3˚C, the relative humidity found is 70.9%, the average wind speed is 3.2 m/s with predominance of the north and south directions. The series of variables analyzed reproduce well the climatological behavior of the region of interest.

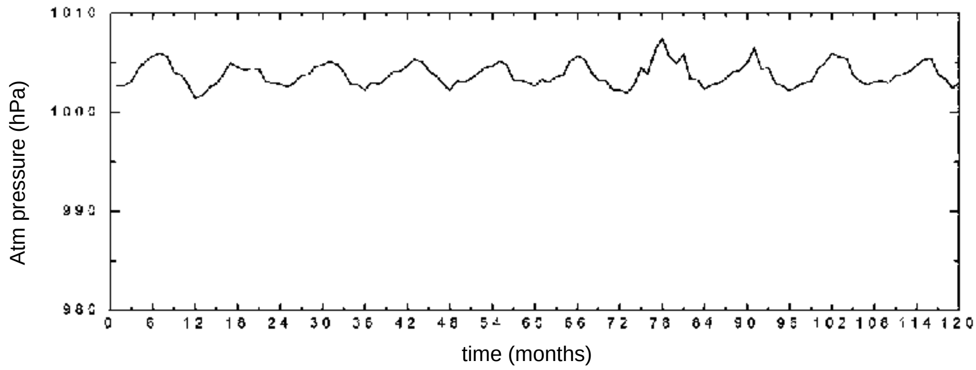


Figure 3 – Average monthly atmospheric pressure observed at the Teniente Coronel Carmelo Peralta Airport station (USAF: 861340 / ICAO: SGCO) in the period from 01/01/2010 to 12/31/2019.

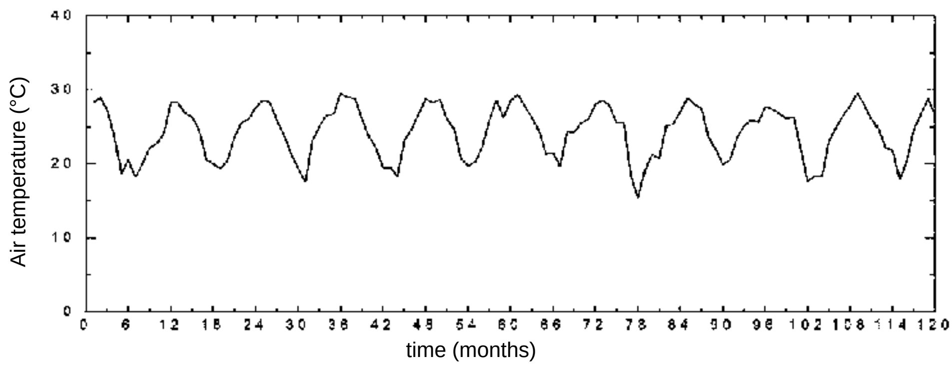


Figure 4 – Average monthly air temperature observed at the Teniente Coronel Carmelo Peralta

Airport station (USAF: 861340 / ICAO: SGCO) in the period 01/01/2010 to 12/31/2019.

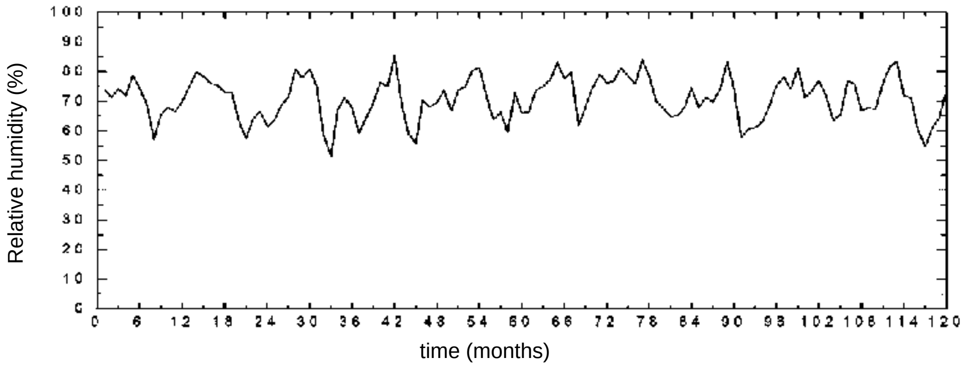


Figure 5 – Monthly average relative humidity observed at the Teniente Coronel Carmelo Peralta Airport station (USAF: 861340 / ICAO: SGCO) in the period from 01/01/2010 to 12/31/2019.

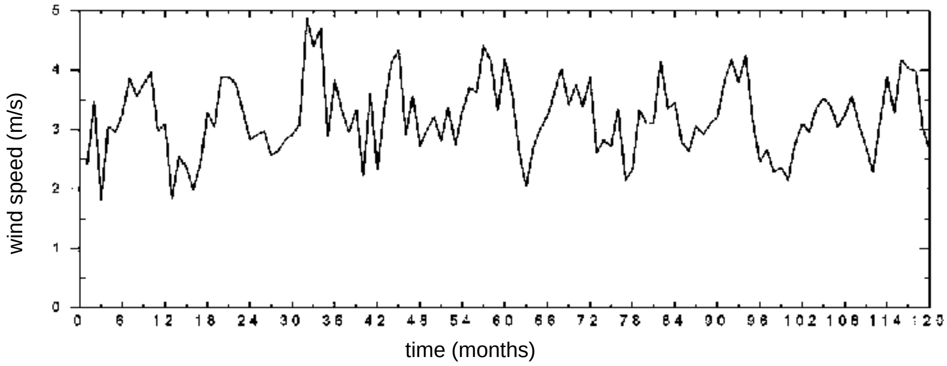


Figure 6 – Average monthly wind speed observed at the Teniente Coronel Carmelo Peralta Airport station (USAF: 861340 / ICAO: SGCO) in the period 01/01/2010 to 12/31/2019.

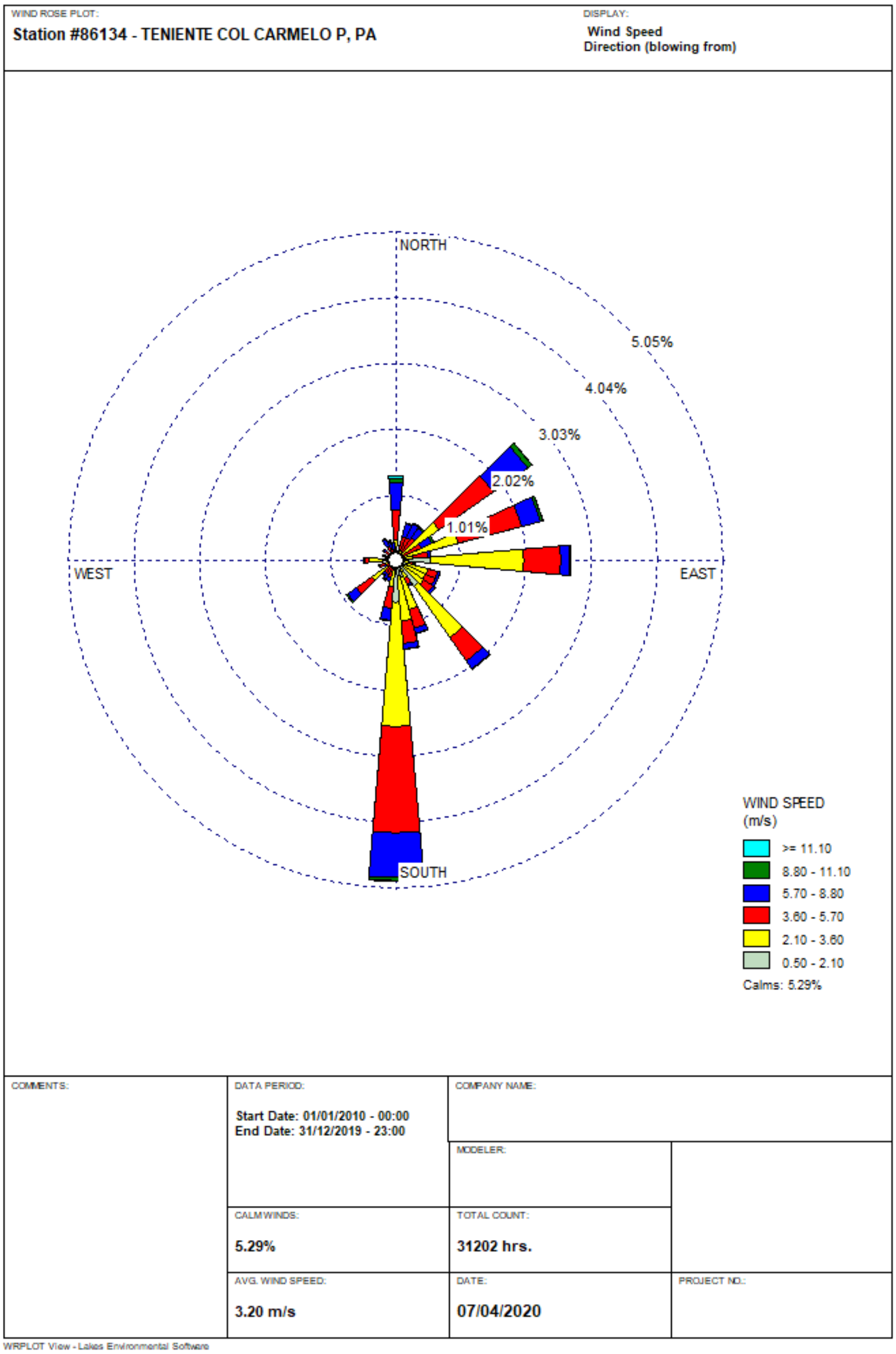


Figure 7 – Wind rose generated from data observed at the Teniente Coronel Carmelo Peralta Airport station (USAF: 861340 / ICAO: SGCO) in the period from 01/01/2010 to 12/31/2019.

3.2. WRF Model Evaluation

As previously described, the meteorological data used as input parameters in the AERMOD model is derived from the meteorological simulation with the WRF mesoscale model. Therefore, an evaluation of the results is required to check the quality of the simulation. For this evaluation, a direct comparison is made with the data measured by the nearest approved meteorological station, that is, the Teniente Coronel Carmelo Peralta Airport station (USAF: 861340 / ICAO: SGCO).

Figures 8 to 11 show the comparison between the data simulated by the FRM model and those observed at the airport station for the monthly averages of air temperature, atmospheric pressure, relative humidity and wind speed since 01/01/2018 until 12/31/2019. The data simulated by the WRF model was taken from the large point referring to the station coordinates. Regarding air temperature, a very good response is observed from the WRF model to simulate the variable, both the evolution over the months and the maximum and minimum values. Regarding atmospheric pressure, the model follows the evolution over time relatively well, but overestimates the maximum values and underestimates the minimum values. For relative humidity, again the model simulates the evolution of the variable over time well, but it does not follow the decrease in humidity at the end of 2019. Regarding wind speed, the model data show a very evolution similar to observed data, but overestimate observation throughout the period. The variables simulated by the FRM model reasonably well reproduce the weather behavior of the pulp mill region.

Figures 12 and 13 show, respectively, the wind roses obtained from the airport station data and the data simulated by the WRF model at the station location. In a direct comparison, it can be seen that the simulated wind rose presents a configuration similar to the observed wind rose, with predominant components from the south and northeast. The model reproduces the frequencies and intensities of the prevailing winds from the south well, but does not reproduce the winds from the northeast with the same quality. Regarding the average wind intensity for the period, the simulated result (3.94 m/s) is relatively close to the observed value (3.10 m/s). The result of the model, for the direction and speed of the wind, reproduces well the weather behavior in the region of the future pulp mill.

In general terms, the results generated by the FRM model for meteorological variables reproduce well the evolution over time of the observed data, but do not reproduce the maximum and minimum values during the period in the same way. It is important to note that the data series of the Teniente Coronel Carmelo Peralta airport station has countless times without registration (missing data). Throughout the series monitored at the station, the data presents records with a frequency of 3 hours, in most of the period, while the simulated data series has a frequency of 1 hour; the difference in the frequency of the records certainly causes a negative impact on the evaluation of the model. In addition, direct comparison at a specific point in the model grid is hampered by some aspects, such as the resolution of the model grid, the resolution of land cover and topography information, and the influence of obstacles (vegetation, buildings, ...) around the station, which are hardly considered by the model due to the resolution of the simulation matrix.

As an example, the difference in frequency in observing meteorological data can be perceived by comparing the model simulated wind rose with the comparative rose observed at the location of the Silvio Pettirossi International Airport Station, near Asunción. The station of that airport records meteorological data every hour, that is, on a frequency equal to the outputs of the WRF model. Figures 14 and 15 show the comparison of observation and simulation, from which the similarity of the two results can be verified.

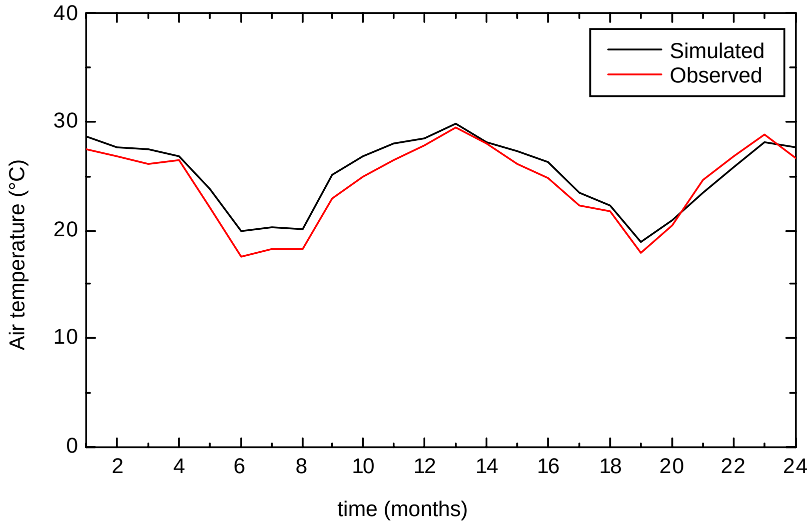


Figure 8 – Comparison between the monthly average air temperature simulated by the WRF and observed at the Teniente Coronel Carmelo Peralta Airport station (USAF: 861340 / ICAO: SGCO) from 01/01/2018 to 12/31/2019.

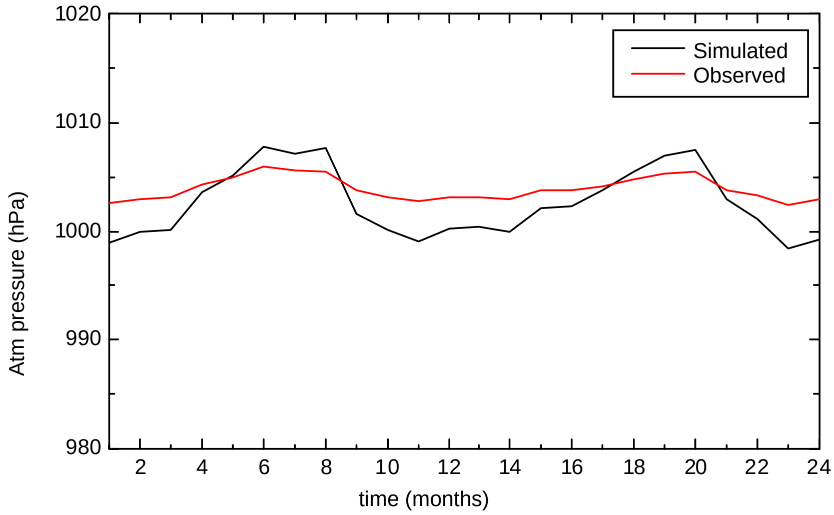


Figure 9 – Comparison between the average monthly atmospheric pressure simulated by the WRF and that observed at the Teniente Coronel Carmelo Peralta airport station (USAF: 861340 / ICAO: SGCO) from 01/01/2018 to 12/31/2019.

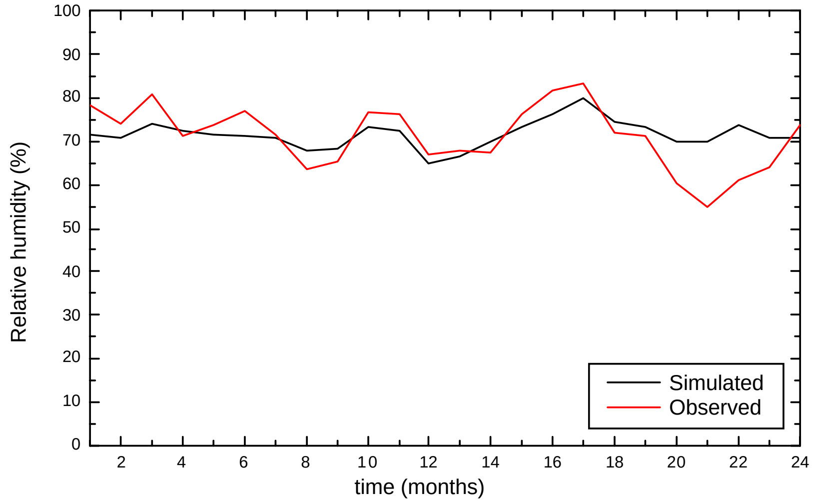


Figure 10 – Comparison between the monthly relative humidity simulated by the WRF and that observed at the Teniente Coronel Carmelo Peralta airport station (USAF: 861340 / ICAO: SGCO) from 01/01/2018 to 12/31/2019.

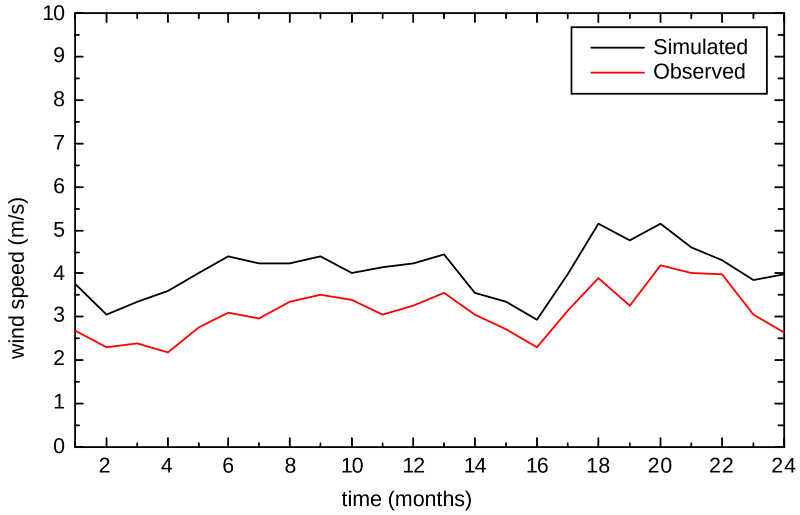


Figure 11 – Comparison between the average monthly wind speed simulated by the WRF and that observed at the Teniente Coronel Carmelo Peralta airport station (USAF: 861340 / ICAO: SGCO) from 01/01/2018 to 12/31/2019.

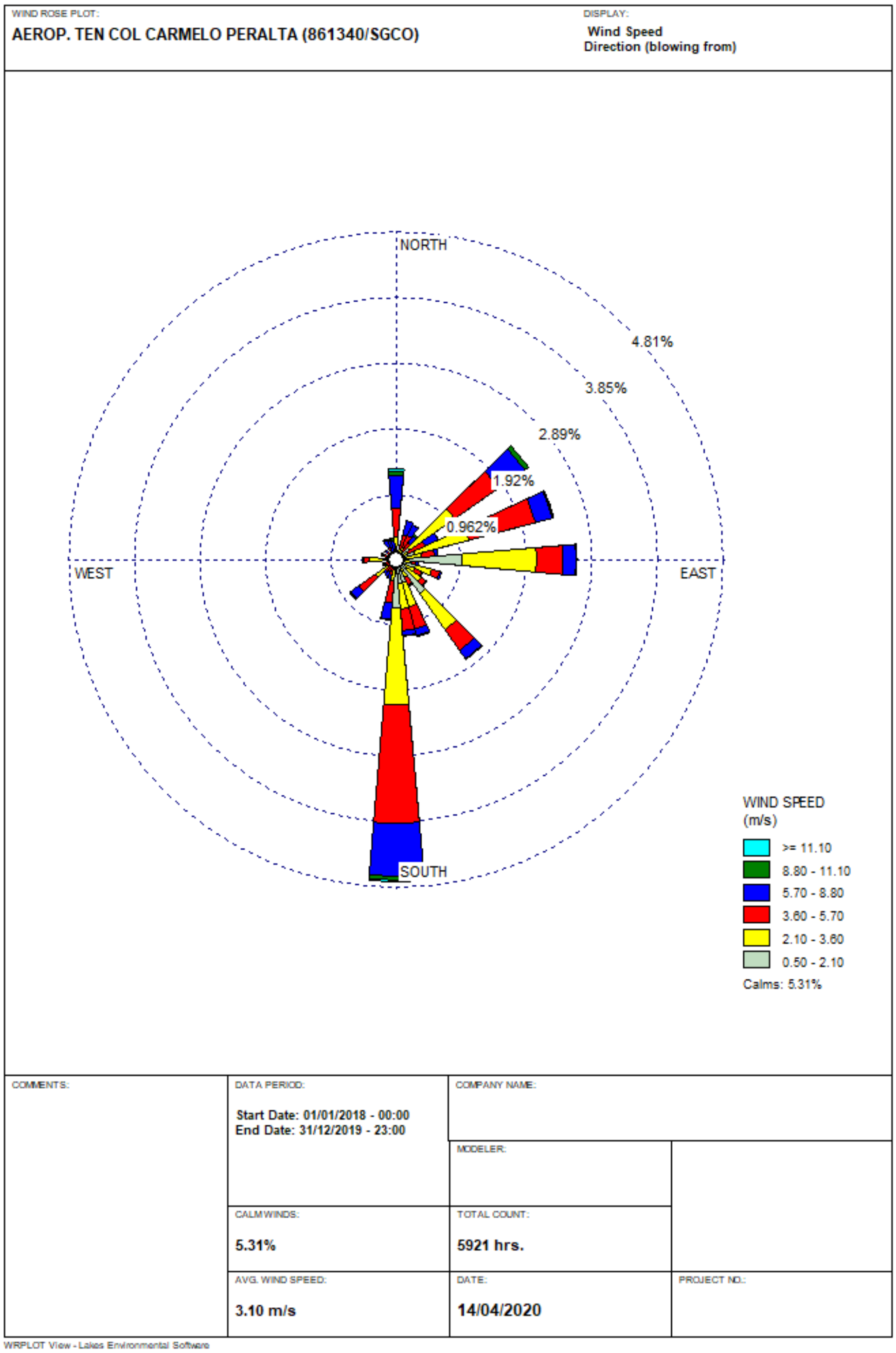


Figure 12 – Wind rose generated by data observed at the Teniente Coronel Carmelo Peralta airport station (USAF: 861340 / ICAO: SGCO) from 01/01/2018 to 12/31/2019.

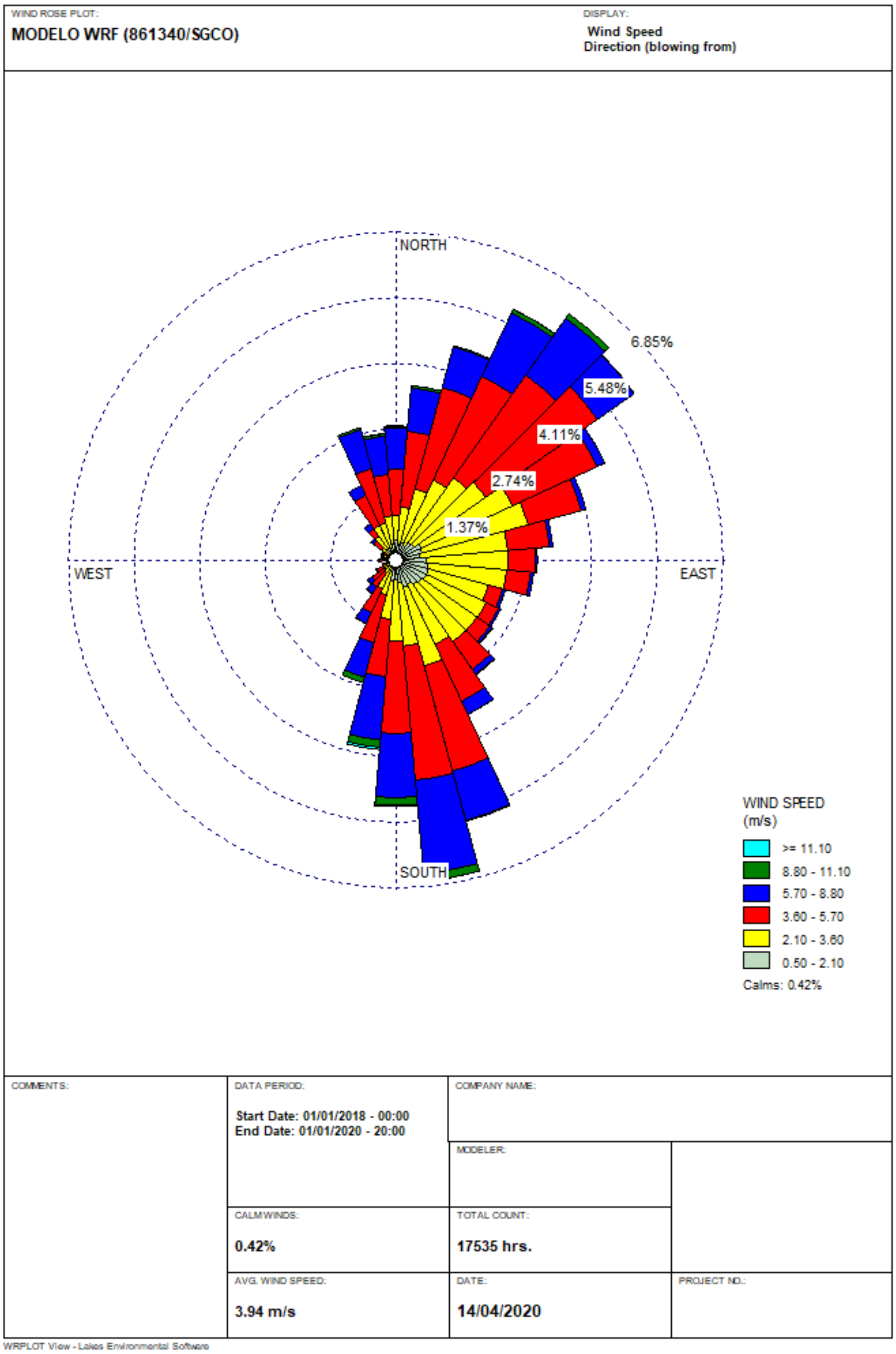


Figure 13 – Wind rose generated from data simulated by the WRF model at the coordinates of Teniente Coronel Carmelo Peralta Airport (USAF: 861340 / ICAO: SGCO) from 01/01/2018 to 01/01/2020.

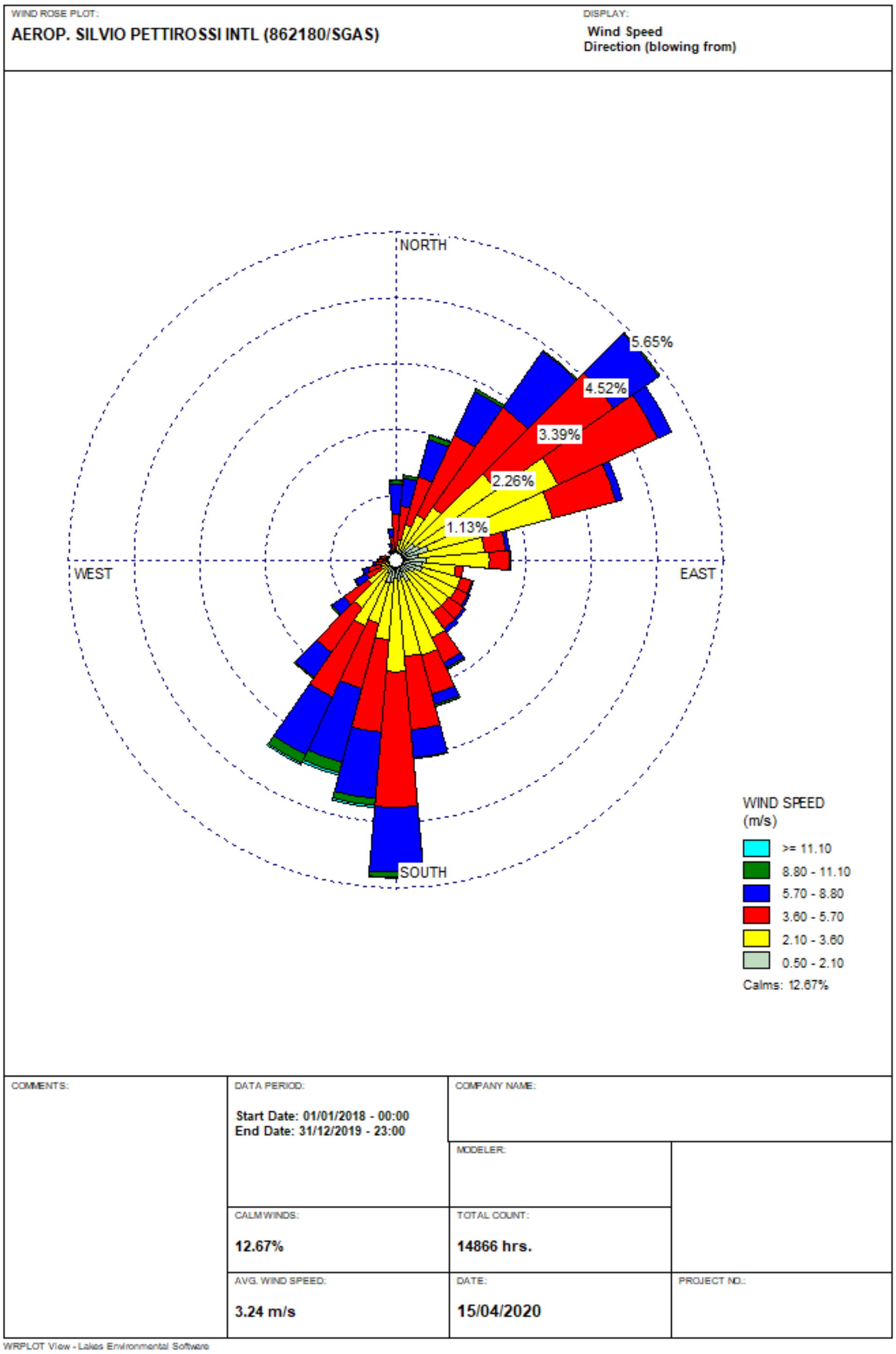


Figure 14 – Wind rose generated from data observed at the Silvio Pettirossi International Airport station (USAF: 862180 / ICAO: SGAS) from 01/01/2018 to 12/31/2019.

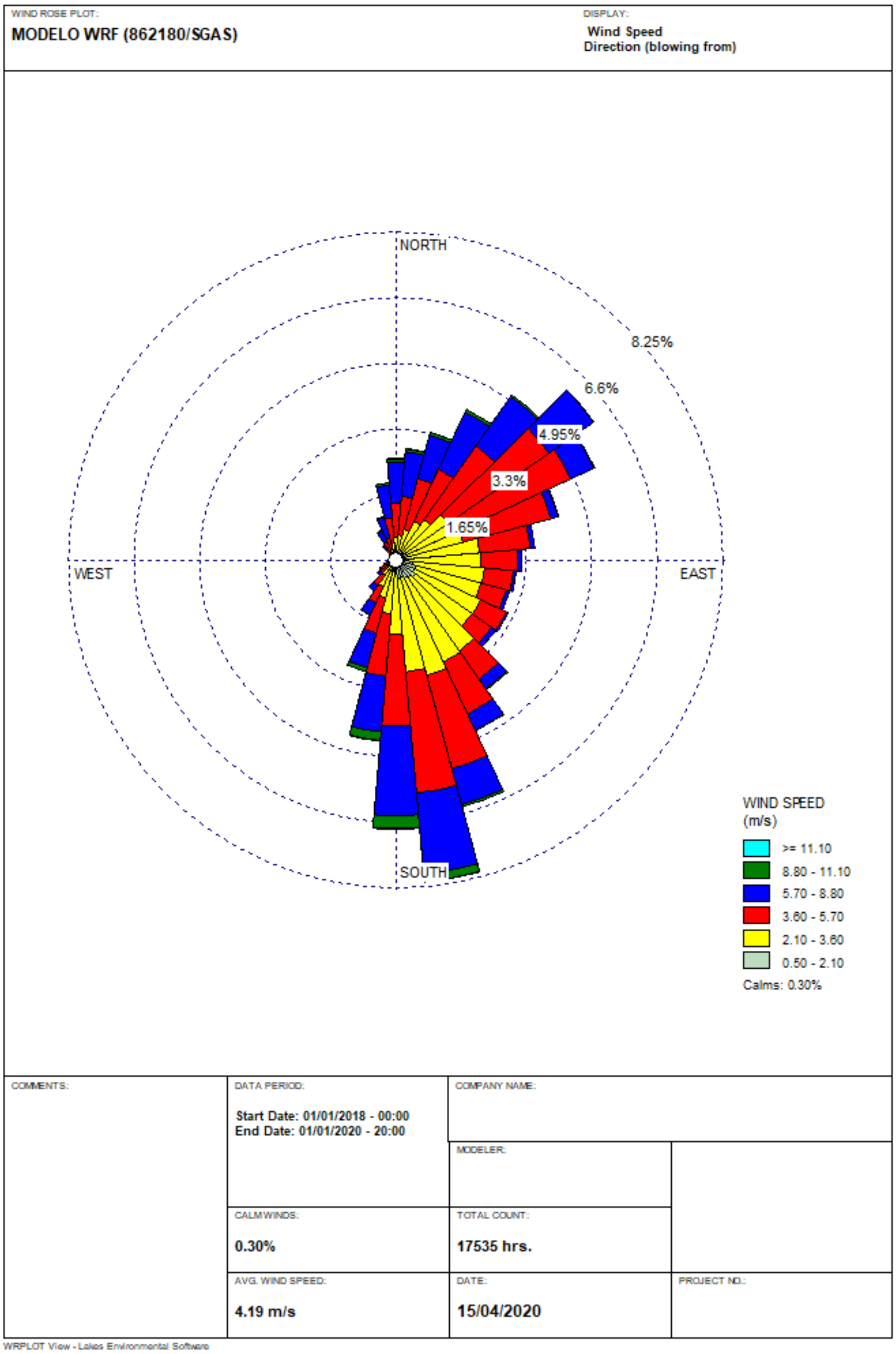


Figure 15 – Wind rose generated from data simulated by the WRF model at the coordinates of the Silvio Pettirossi International Airport station (USAF: 862180 / ICAO: SGAS) from 01/01/2018 to 01/01/2020.

To quantitatively analyze the differences between simulation and observation, Table 4 presents the statistical analysis result of the variables evaluated in Figures 8 to 13. The statistical indices considered are RMSE (Root-Mean-Square Error), BIAS and MAPE (Mean Absolute Percentage Error) (Carvalho et al., 2002; Wilks, 2011):

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(P_i - O_i)^2}$$

$$BIAS = \frac{1}{n}\sum_{i=1}^{n}(P_i - O_i)$$

$$MAPE = \left(\frac{1}{n}\sum_{i=1}^{n}\left|\frac{(P_i - O_i)}{O_i}\right|\right) \times 100$$

where P represents the predicted (simulated) value, O represents the observed value and n indicates the number of data.

Root Square Error (RMSE) is a measure of difference between the values predicted by the model and the observed values of the environment being simulated. These individual differences are also called residuals, and the RMSE serves to aggregate them into a single statistical value. BIAS represents the tendency of simulated values to underestimate or overestimate the observed values of the meteorological variables. MAPE is a precision statistical measure of a simulated result; It measures the precision as a percentage and can be considered as the average absolute percentage error in each period of time. The closer the RMSE value is to zero, the better the prediction. The closer the BIAS is to zero, the better the prediction. MAPE values below 10% average high precision, between 10% and 20% is considered good precision and between 20% and 50% the result is reasonable.

According to the statistical values presented in Table 4, it can be concluded that the simulation result with the WRF model is very good. Relatively low values are observed for the statistical parameters RMSE and BIAS, which shows the degree of quality of the numerical simulation. There is a clear tendency for simulated values to overestimate the measured values of almost all meteorological variables, with the exception of atmospheric pressure. It is also observed that ASM remained below 10% for most of the variables, with one exception for wind speed. This last result indicates a high precision of the model in the simulation of the climatic conditions in the region of interest.

Table 4 – Statistical parameters calculated from the comparison between monthly averages simulated by WRF and observed at the Teniente Carmelo Peralta Airport station (USAF: 861340 / ICAO: SGCO) in the period from 01/01/2018 to 12/31/2019.

Parameters	**RMSE**	**BIAS**	**MAPE**
Air temperature	1,323 ^{o}C	0,940 ^{o}C	5,175 %
Atmospheric pressure	2,447 hPa	-1,339 hPa	0,218 %
Humidity	5,761 %	0,348 %	6,815 %
Wind speed	0,998 m/s	0,948 m/s	31,875 %
Wind direction	13,109 degrees	4,757 degrees	9,399 %

3.3. Atmospheric Boundary Layer (CLA)

The Atmospheric Boundary Layer (CLA) is the lowest layer of the atmosphere and is directly influenced by the presence of the Earth's surface. Turbulence is the characteristic phenomenon of this layer, which plays a fundamental role in the evolution of the CLA height and the diffusion of pollutants emitted near the surface. CLA is, therefore, the volume enclosed by the turbulent diffusion process and its height acts as a vertical limit for the transport of pollutants emitted on the surface. CLA evolves in such a way that it is thicker during the day than at night.

The turbulence in the CLA can be of thermal origin, where the convection process is generated from the incidence of solar radiation on the surface during the day, and of mechanical origin, where small turbulent vortices are generated from friction. of the wind on the surface during the day or night. During the day the turbulence has its origin in the competition between the thermal force and the mechanical force, and during the night only the mechanical force is active. Thermal turbulence is more effective for the diffusion of pollutants, since large convection vortices act more effectively to make the concentration field homogeneous.

Therefore, to evaluate the evolution of the CLA height, it is necessary to consider the meteorological variables of wind speed and air temperature. Figure 16 shows the temporal evolution of the heights of the convective and mechanical CLA, between 01/01/2018 and 01/01/2020. The CLA is observed to be higher during the warmer periods of the year, so there is a strong correlation between the evolution of air temperature and the evolution of the height of convective CLA. Specifically, the amplitude of the height of the convective CLA is much greater than the amplitude of the mechanical CLA, showing differences that reach 1,100 m. This result is related to the variability of air temperature and solar radiation throughout the year.

The evolution of the mechanical CLA is correlated with the evolution of the wind speed. The higher the wind intensity, the higher the values of friction velocity (u *) and Obukhov length (L), which generates an increase in the diffusion of pollutants due to mechanical turbulence; (L) represents, in addition to a stability parameter, the height in the CLA up to where the effect of mechanical turbulence is most effective. According to the results, the average height of convective CLA is 1,267 m while the height of mechanical CLA is 523 m.

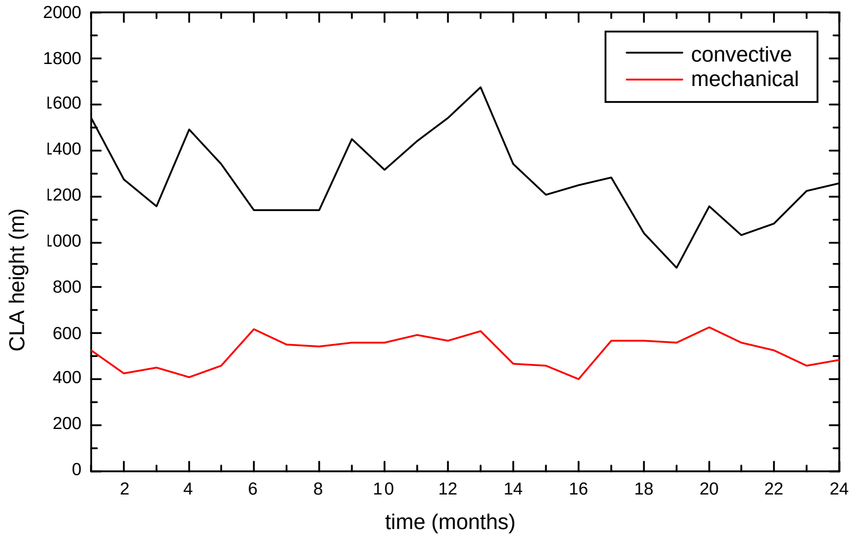


Figure 16 – Temporal evolution (monthly average) of the height of the CLA calculated by AERMET for the pulp mill site in the period between 01/01/2018 and 01/01/2020.

3.4. Pollutant Dispersion

Pollutants dispersion simulations of CO, TRS, NO_2, PM_{10}, and $SO_2$are performed using the dispersion model known as the AERMIC model (AERMOD), which was developed by the United States Environmental Protection Agency (US - EPA) . The meteorological data used as input parameters in the AERMOD model is derived from the meteorological simulation with the WRF mesoscale model. The meteorological data series covers the period from 01/01/2018 to 01/01/2020. This period of time allows the dispersion study, considering all the meteorological conditions that influence the transport and diffusion of pollutants in the region.

The information on emission sources (emission rates and release conditions) presented in Table 3 (see section 2.5) is used to enter data into the AERMOD dispersion model. The simulation domain covers an area of 2,500 km^2 (50 km x 50 km), with a horizontal resolution of 0.25 km. This domain has been configured using three criteria. The first criterion refers to the determination of the World Meteorological Organization (WMO), which indicates that the surface data are representative of a region within a radius of up to 25 km, under homogeneous meteorological conditions. The second criterion takes into account the fact that the AERMOD is a stationary model, that is, that during a determined period of time the value of any meteorological variable at the station location is the same for the entire simulation domain. Thus, the use of a domain over 50 km x 50 km in a non-stationary meteorological region would lead to incorrect weather conditions. The third criterion is related to the fact that, in an initial analysis, the concentration peaks occur at a much shorter distance of 25 km. This ensures that the highest concentrations occur within the simulation domain with a good safety margin.

The topography information is obtained from the SRTM-NASA (Shuttle Radar Topography Mission - NASA) database, with a resolution of 90 m. The surface characteristics (roughness length, albedo and Bowen ratio) are generated by the AERSURFACE model from the files of the United States Geological Survey (USGS) - National Land Cover Data 1992 (NLCD92). The effect of lowering buildings has been considered, since there are constructions near the sources, so that the plume of pollutants can be modified due to the mechanical turbulence caused by obstacles.

Figures 17 to 26 show the maximum surface concentration fields of the pollutants CO, TRS, NO_2, PM_{10} and SO_2 simulated by AERMOD. The maximum concentration is obtained by averaging 1 hour, 8 hours, 24 hours or annually at each point in the grid, depending on the contaminant and its respective air quality standard (see section 2.4). In the sequence, the highest concentration values are determined at each point on the grid to generate the fields presented in the Figures. Considering the time intervals of the averages, the concentration fields of 1h, 8h and 24h are maximum values representative of the short-term averages, while the annual concentration fields are maximum values representative of the long-term averages.

Initially, it is possible to observe the low values of the simulated concentrations of the company's emissions. The maximum concentration values for CO, NO_2, PM_{10} and SO_2 are below the air quality standards established by SEAM Resolution 259/15 (Table 2). Maximum TRS concentration values are well below the WHO (2003) odor perception limit of 11 $\mu g/m^3$. The maximum concentration peaks of all pollutants occur north and south-southwest of the emission sources. Table 4 presents a summary of the simulation results, which highlights the values of the peaks of maximum average concentration and the distances at which they occur from the emission sources.

Figure 27 shows where the three highest concentrations occur relative to the point of emission. Table 5 shows the maximum concentration values in 15 discrete receivers in the region of interest. The choice of receivers took into account people's circulation locations near emission sources and preferred wind directions. Figure 28 presents a map with the location of the 15 discrete receivers in relation to the company. The complete lists with the highest concentrations of CO, TRS, NO_2, PM_{10} and SO_2 are found in Annex A of this technical report.

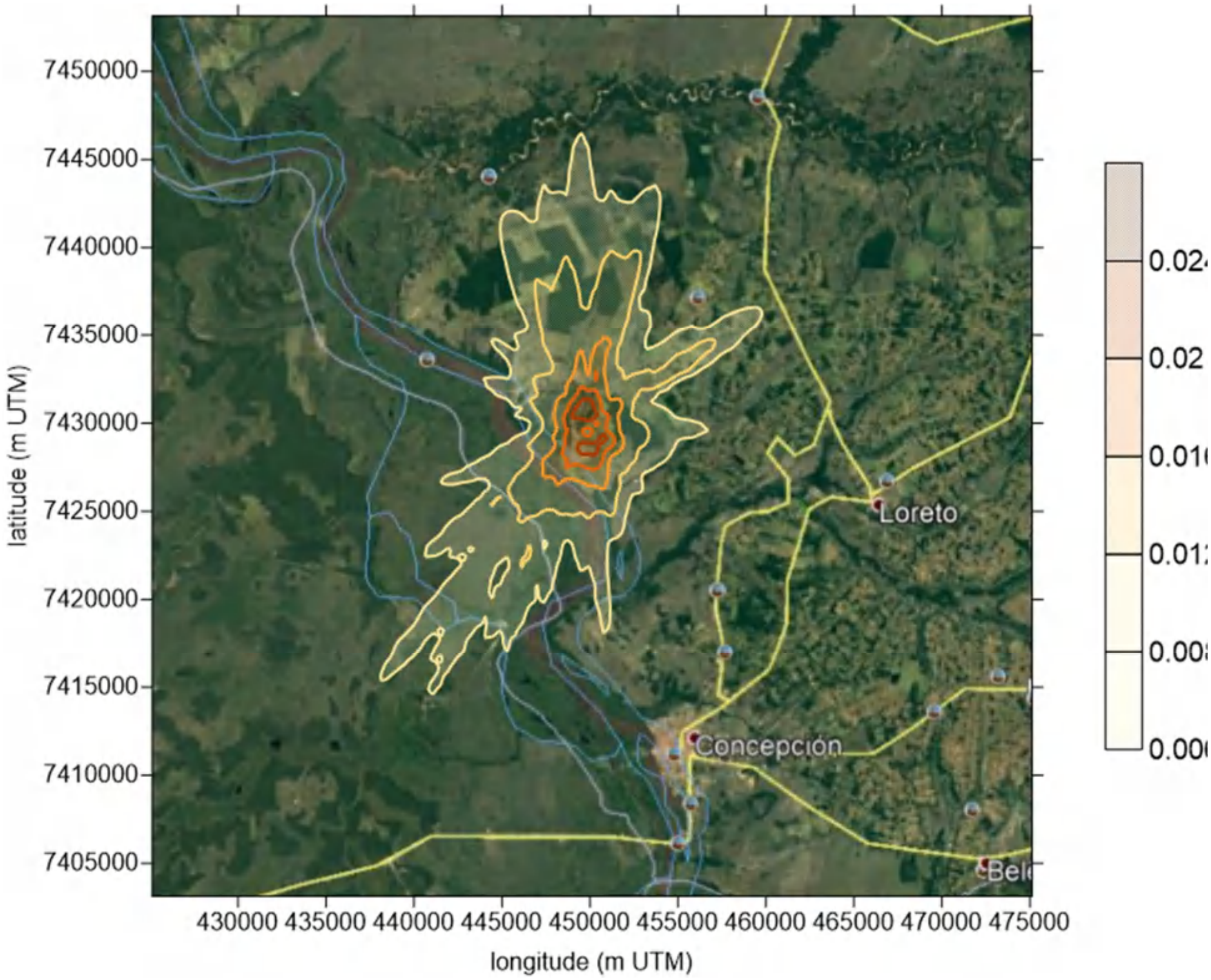


Figure 17 – Maximum average concentration of 8 hours for CO (scale in mg.m^{-3}). Maximum peak concentration of 0.02490 mg.m^{-3} at position 7430625 S and 449875 O (m UTM) on 04/02/2019 at 4 p.m.

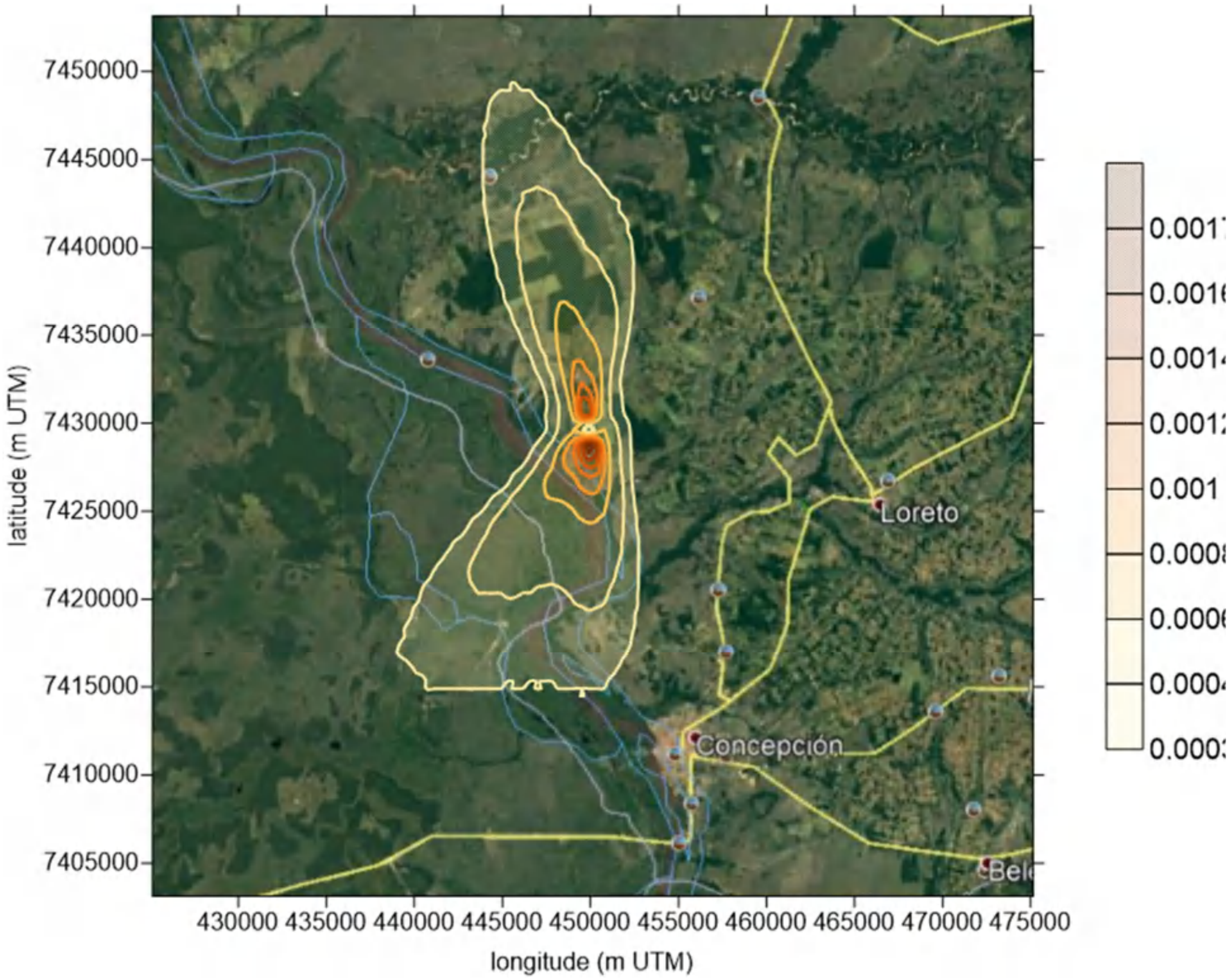


Figure 18 – Annual average maximum CO concentration (scale in $mg.m^{-3}$). Maximum peak concentration of 0.00174 $mg.m^{-3}$ at position 7428625 S and 449875 O (m UTM).

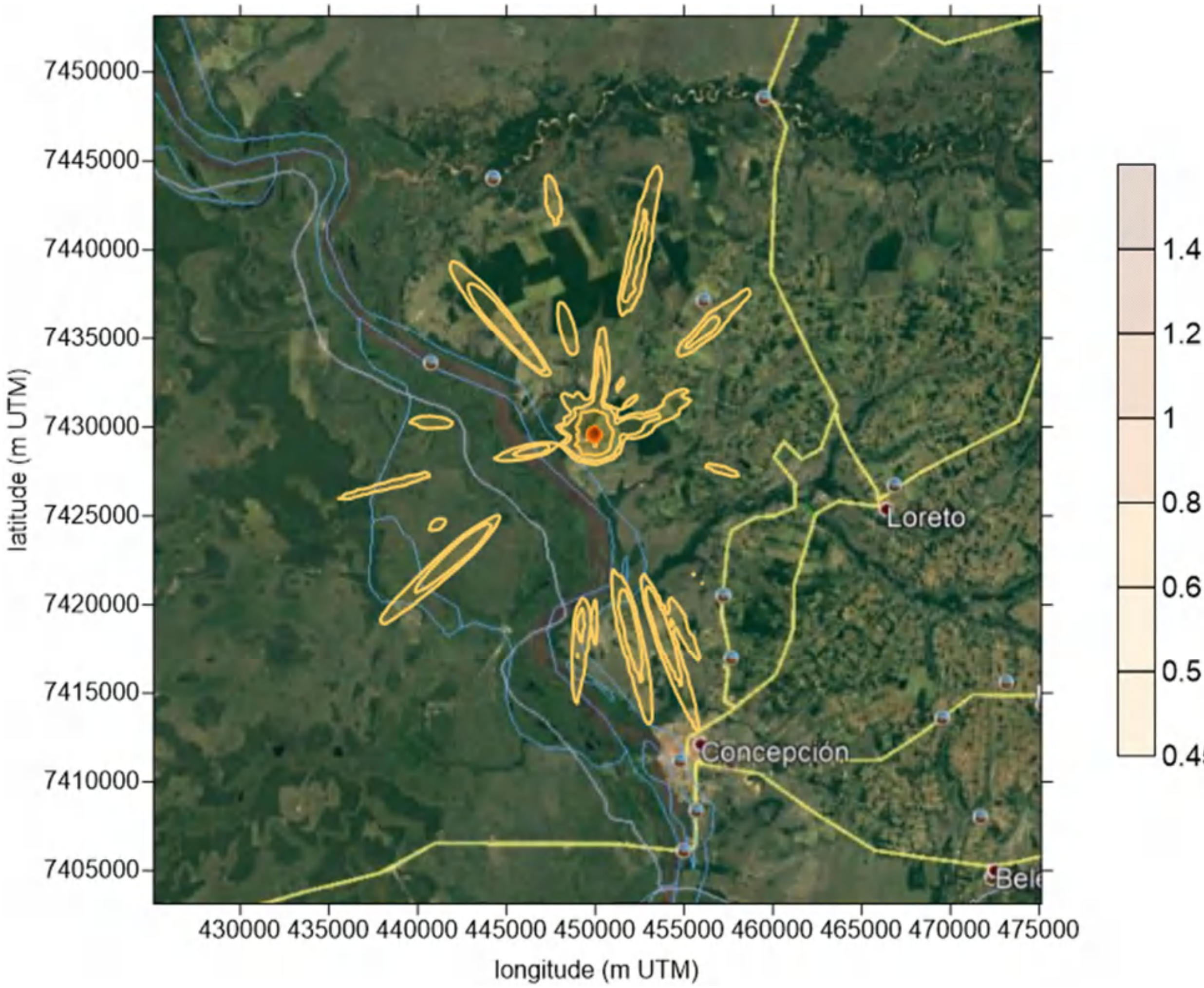


Figure 19 – Maximum average concentration of 1 hour for TRS (scale in µg.m^{-3}). Maximum peak concentration of 1,49240 µg.m^{-3} at position 7429875 S and 449875 O (m UTM) on 02/24/2018 at 12 h.

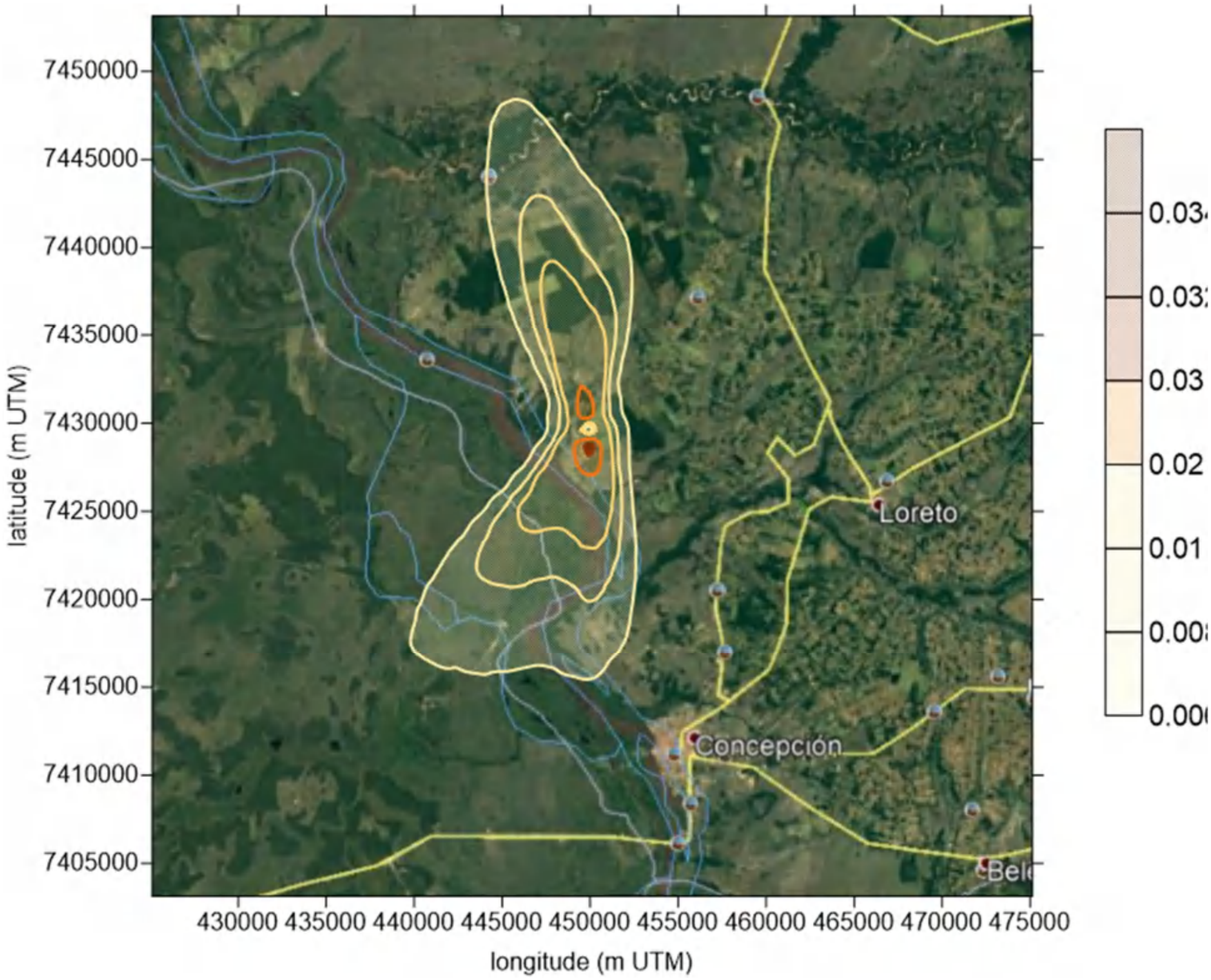


Figure 20 – Maximum annual average concentration for TRS (scale in µg.m^{-3}). Maximum peak concentration of 0.03424 µg.m^{-3} at position 7428625 S and 449875 O (m UTM).

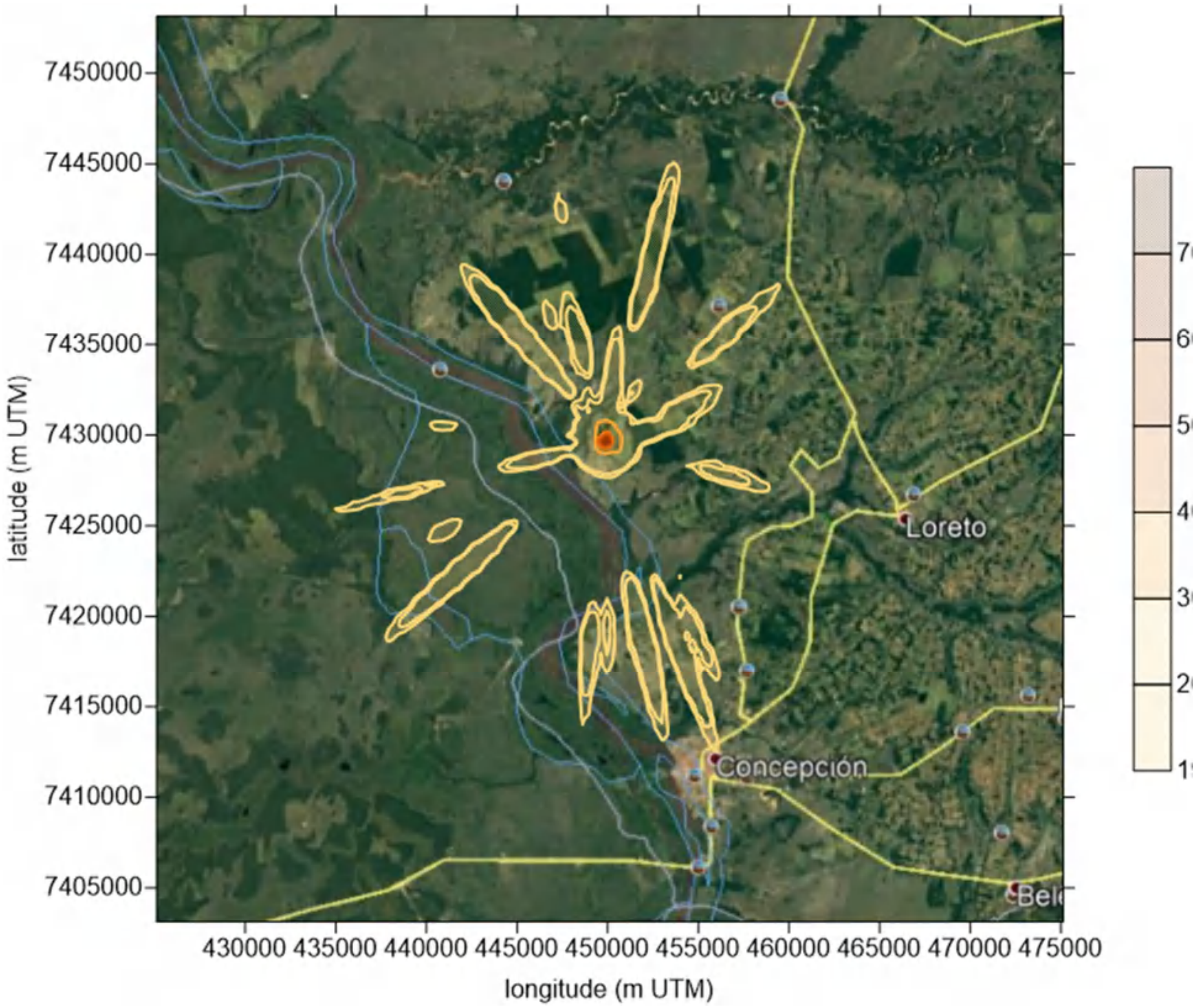


Figure 21 – Maximum average concentration of 1 hour for NO_2 (scale in µg.m^{-3}). Maximum peak concentration of 74.81947 µg.m^{-3} at position 7429875 S and 449875 O (m UTM) on 02/24/2018 at 12 h.

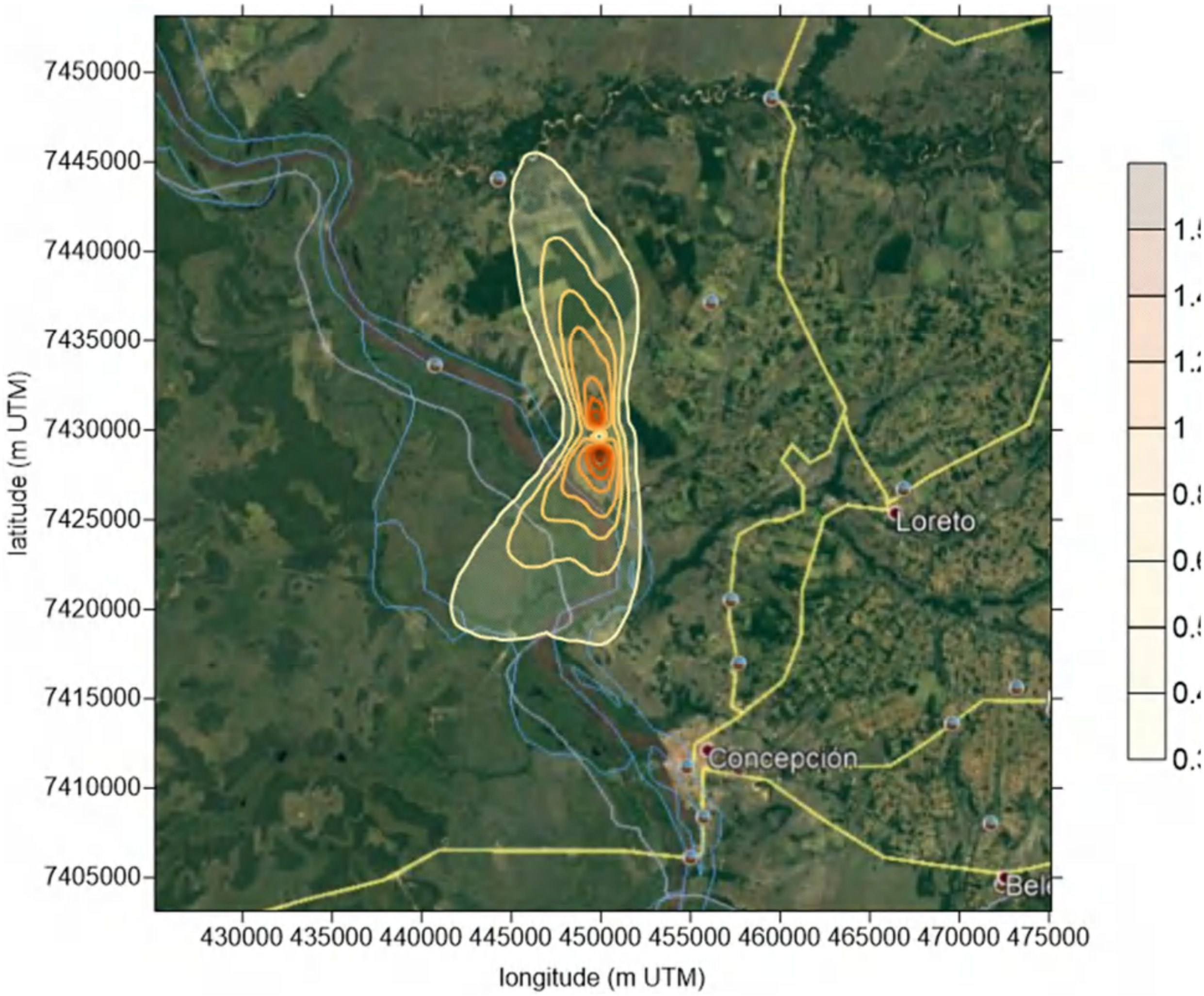


Figure 22 – Maximum annual average NO_2 concentration (scale in µg.m^{-3}). Maximum peak concentration of 1.57742 µg.m^{-3} at position 7428625 S and 449875 O (m UTM).

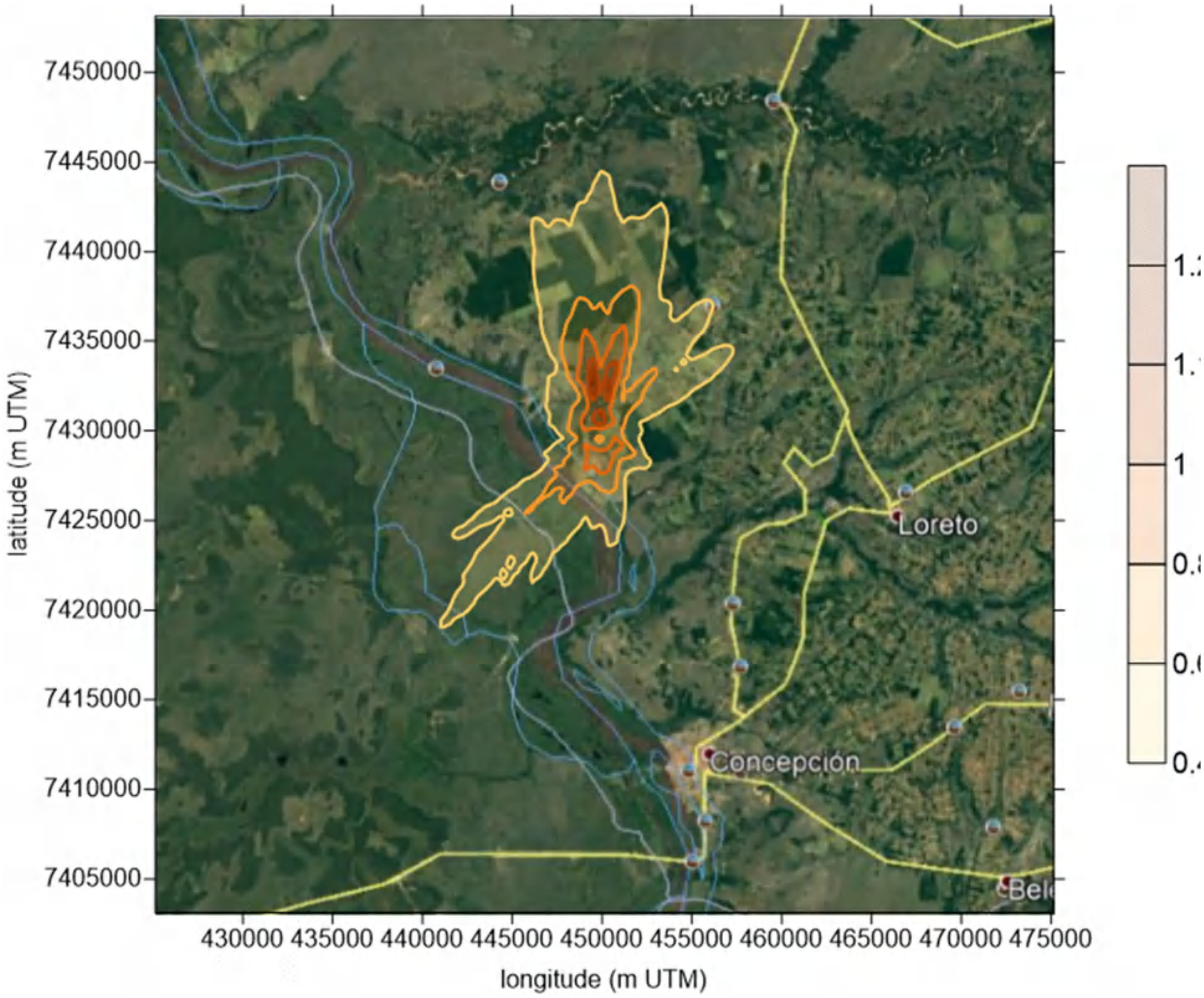


Figure 23 – 24-hour average maximum concentration for PM_{10} (scale in $\mu g.m^{-3}$). Maximum peak concentration of 1.23890 $\mu g.m^{-3}$ at position 7432125 S and 450 125 O (m UTM) on 08/02/2019.

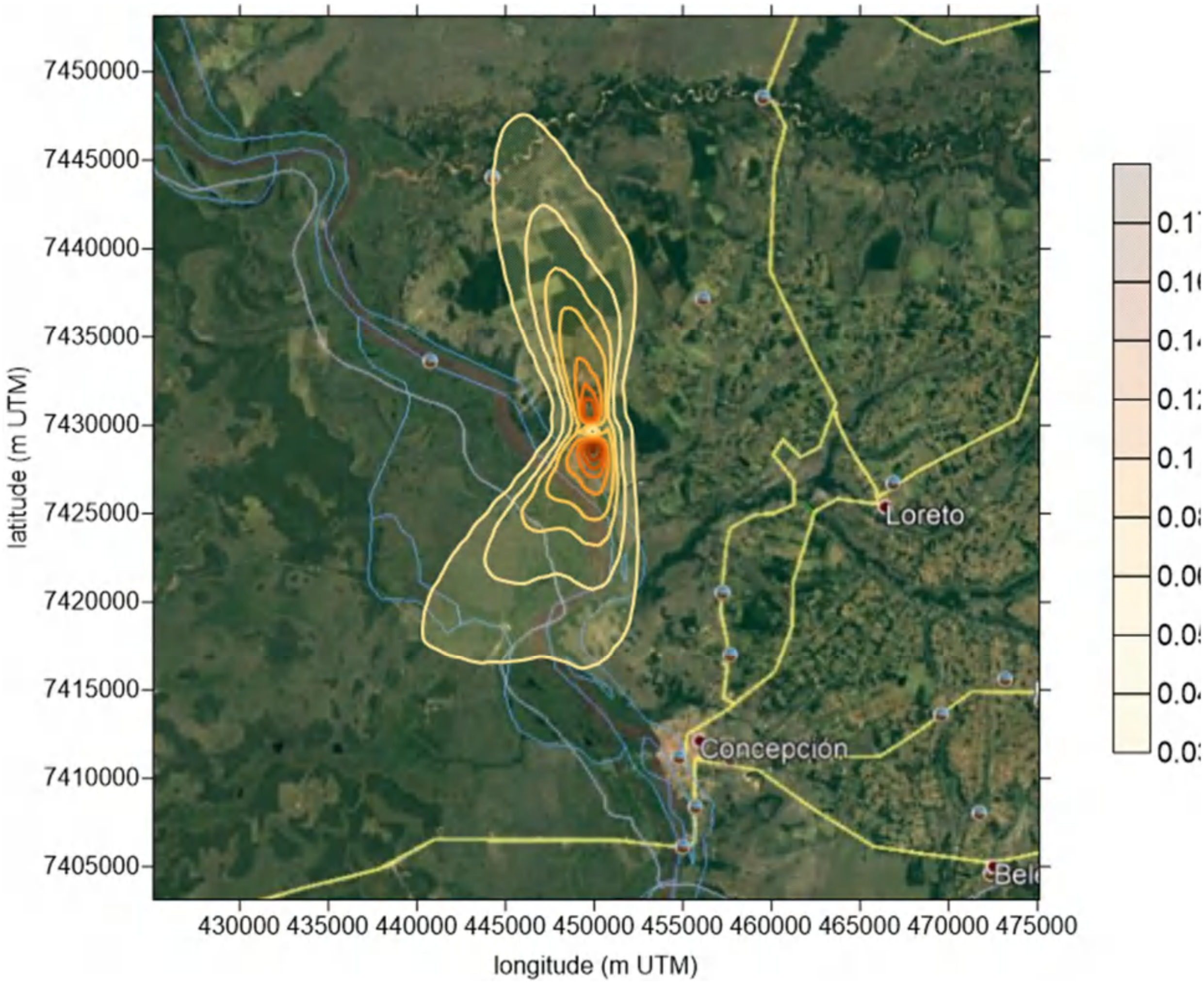


Figure 24 – Maximum annual average concentration for PM_{10} (scale in µg.m^{-3}). Maximum peak concentration of 0.17252 µg.m^{-3} at position 7428625 S and 449875 O (m UTM).

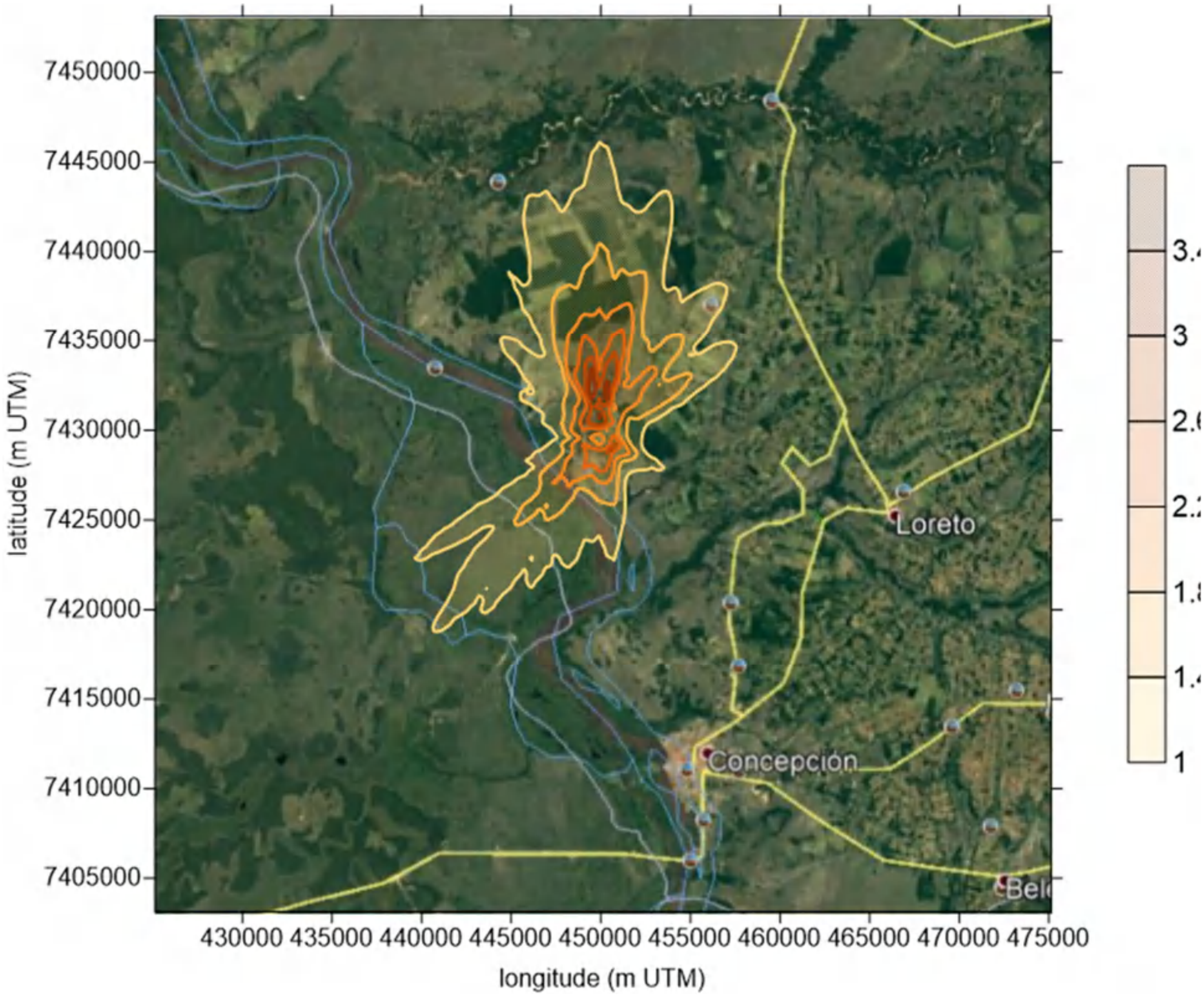


Figure 25 – Maximum 24-hour average concentration for SO_2 (scale in $\mu g.m^{-3}$). Peak concentration peak of 3.45833 $\mu g.m^{-}3$ at position 7432125 S e 449625 O (m UTM) on 08/13/2019.

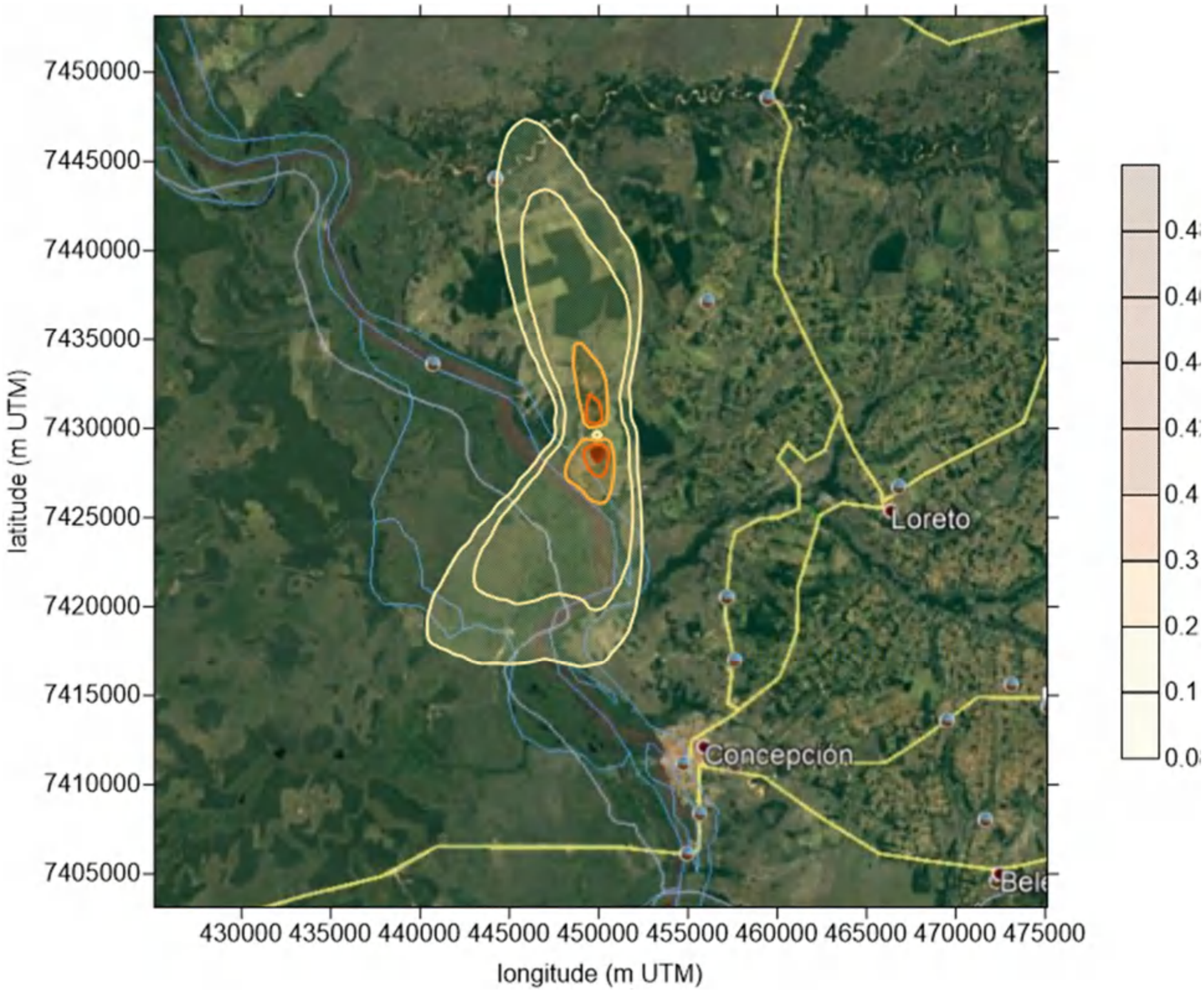
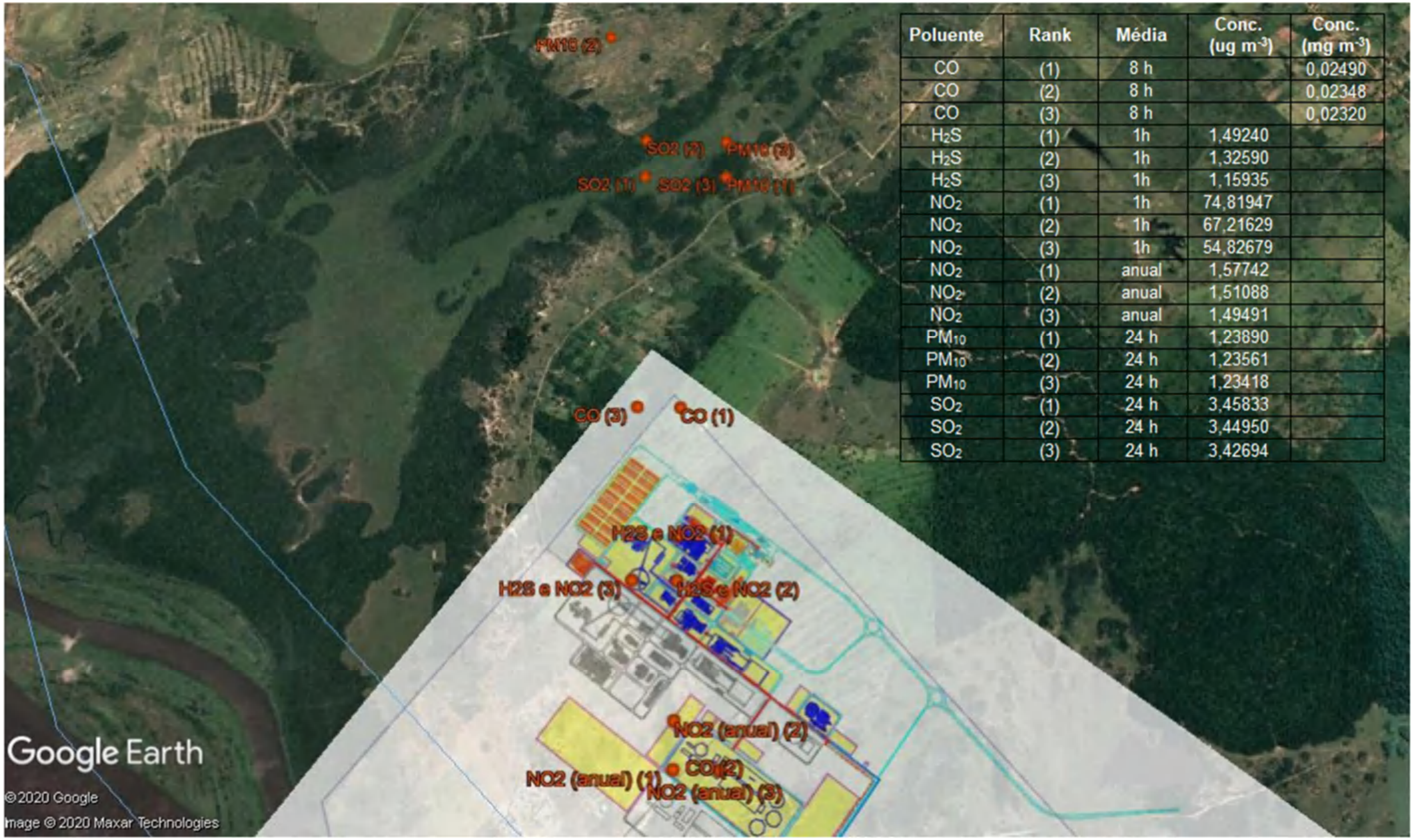


Figure 26 – Maximum annual average concentration for SO_2 (scale in µg.m^{-3}). Maximum peak concentration of 0.47616 µg.m^{-3} at position 7428625 S and 449875 O (m UTM).

Table 5 - Maximum values of the maximum average concentrations, location and altitude.

Pollutant	Average	Conc. ($\mu g\ m^{-3}$)	Conc. ($mg\ m^{-3}$)	Air Quality Standard SEAM Resolution No. 259/15	Location (m UTM)	Altitude (m)
CO	8 h		0.02490	10 mg/m^3	7430625 S; 449875 O	105
CO	annual		0.00174	-	7428625 S; 449875 O	81
H_2S	1h	1.49240		-	7429875 S; 449875 O	93
H_2S	annual	0.03424		-	7428625 S; 449875 O	81
NO_2	1h	74.81947		200 $\mu g/m^3$	7429875 S; 449875 O	93
NO_2	annual	1.57742		40 $\mu g/m^3$	7428625 S; 449875 O	81
PM_{10}	24 h	1.23890		150 $\mu g/m^3$	7432125 S; 450125 O	84
PM_{10}	annual	0.17252		-	7428625 S; 449875 O	81
SO_2	24 h	3.45833		20 $\mu g/m^3$	7432125 S; 449625 O	86
SO_2	annual	0.47616		-	7428625 S; 449875 O	81



Poluente	Rank	Média	Conc. (ug m⁻³)	Conc. (mg m⁻³)
CO	(1)	8 h		0,02490
CO	(2)	8 h		0,02348
CO	(3)	8 h		0,02320
H_2S	(1)	1h	1,49240	
H_2S	(2)	1h	1,32590	
H_2S	(3)	1h	1,15935	
NO_2	(1)	1h	74,81947	
NO_2	(2)	1h	67,21629	
NO_2	(3)	1h	54,82679	
NO_2	(1)	anual	1,57742	
NO_2	(2)	anual	1,51088	
NO_2	(3)	anual	1,49491	
PM_{10}	(1)	24 h	1,23890	
PM_{10}	(2)	24 h	1,23561	
PM_{10}	(3)	24 h	1,23418	
SO_2	(1)	24 h	3,45833	
SO_2	(2)	24 h	3,44950	
SO_2	(3)	24 h	3,42694	

Figure 27 – Location of the highest concentrations around the pulp mill.

Table 6 – Average maximum concentrations of CO, TRS, NO_2, PM_{10} and SO_2 pollutants in 15 discrete receivers.

Receivers	Latitud (m UTM)	Longitud (m UTM)	Distance (m)	CO (8h) (mg m^{-3})	TRS (1h) ($\mu g\ m^{-3}$)	NO_2 (1h) ($\mu g\ m^{-3}$)	NO_2 (annual) ($\mu g\ m^{-3}$)	PM_{10} (24h) ($\mu g\ m^{-3}$)	SO_2 (24h) ($\mu g\ m^{-3}$)
1PC	7430391.91	449116.83	990	0.02278	0.62720	28.57480	0.62879	1.00221	2.74160
8PC	7431394.05	449676.03	1700	0.01943	0.52123	22.82475	1.18136	0.96854	2.76283
13PC	7432140.83	450453.38	2500	0.01438	0.56375	24.12785	0.66171	0.94413	2.93071
25SC	7432559.04	446004.90	4800	0.00646	0.39077	14.82095	0.20657	0.35561	1.00411
23SM	7425994.00	453141.00	4800	0.00579	0.27218	12.06002	0.20551	0.22369	0.58613
26SD	7434628.66	450930.24	5200	0.01216	0.43091	18.62207	0.46721	0.94560	2.58933
40LP - Centro	7433012.58	454114.85	5470	0.00840	0.35621	15.13918	0.14720	0.46553	1.29691
21PY	7429985.53	455552.36	5700	0.00628	0.33315	13.56784	0.12158	0.23911	0.67922
30SR - Centro	7427494.70	455813.98	6300	0.00490	0.39714	18.27058	0.11276	0.22911	0.62055
AR3	7434430.00	457299.00	8800	0.00748	0.32489	14.45117	0.09836	0.39442	1.02888
50RP - Centro	7436905.19	455528.15	9300	0.00555	0.28749	10.76636	0.11624	0.41794	1.16889
60KP - Centro	7420669.84	457392.36	11700	0.00317	0.33599	15.96352	0.10143	0.13293	0.34587
27HA	7417523.92	454028.61	13000	0.00476	0.55114	24.16594	0.18062	0.20875	0.55525
AR2	7426022.00	466753.00	17300	0.00276	0.27709	10.38484	0.05060	0.07745	0.20585
AR1	7410810.00	454572.00	19500	0.00287	0.32137	13.34266	0.14436	0.18067	0.47359
Standard Air Quality Resolution SEAM no 259/15				**10 mg/m^3**	**-**	**200 $\mu g/m^3$**	**40 $\mu g/m^3$**	**150 $\mu g/m^3$**	**20 $\mu g/m^3$**

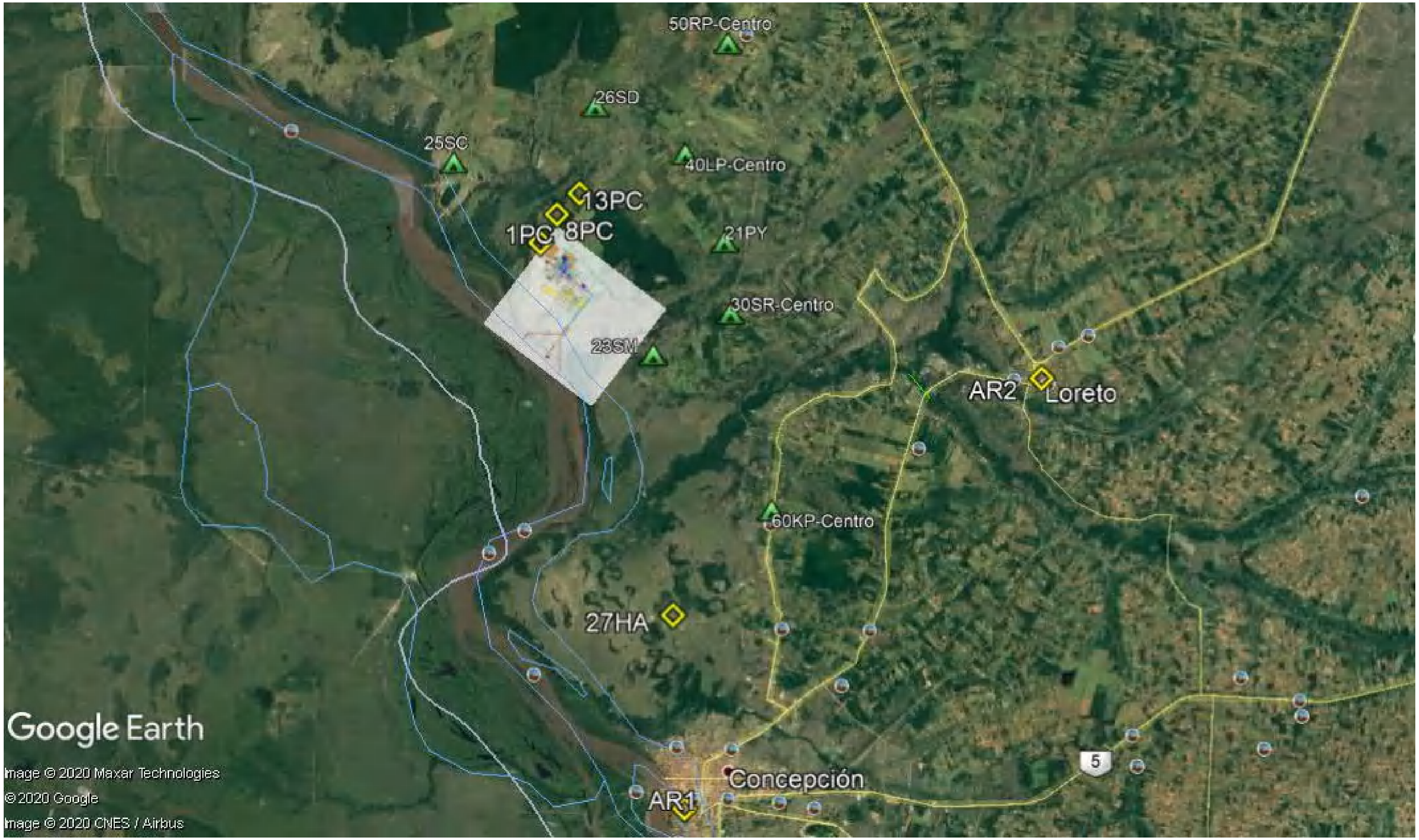


Figure 27 – Location of the 15 discrete receivers around the pulp mill.

4. CONCLUSIONS

This technical report presented the air dispersion study results of carbon monoxide (CO), total reduced sulfur (TRS), nitrogen dioxide (NO_2), particulate matter (MP10) and sulfur dioxide (SO_2) emitted by the future PARACEL pulp mill sources. The pulp mill and its emission sources will be installed near the city of Concepción, in Paraguay, at the coordinates 23.241050 ° S and 57.490110 ° W. Dispersion simulations were carried out with the WRF-MMIF-AERMET-AERMOD model system, so that the surface and altitude data are derived from numerical simulation with the WRF weather model.

The study revealed that there is a good correlation between the analyzed meteorological and climatological conditions and the pollutant plume behavior. Pollutant concentrations at the surface depend mainly on meteorological conditions and the transport of pollutants is under the influence of macro, meso and microscale conditions. According to the meteorological data and the dispersion study results, the directions of the south and northeast winds defined the concentration peaks location.

Finally, the atmospheric dispersion simulations generated low concentration values of the pollutants CO, TRS, NO_2, PM_{10} and SO_2. The maximum concentration values are below the air quality standards established by the Paraguayan regulations for CO, NO_2, PM_{10} and SO_2 and the odor perception limit indicated by the World Health Organization for TRS (Total Reduced Sulfur). Specifically, the maximum concentrations of PM_{10} are even below the air quality standards for $PM_{2.5}$, considering both the daily average (24 h) and the annual average. The maximum concentration peaks of all pollutants occur near the pulp mill, at distances between 165 and 2,428 m. The pollutant concentrations in discrete receivers, chosen to complement the air quality assessment in the area of interest, are below air quality standards.

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Rio Grande, July 15, 2020.

TECHNICAL RESPONSIBILITY:

Dr. Jonas Carvalho
Meteorologist - Technical Manager
CREA: RS122364

Dra. Natalia Pereira
Meteorologist - Technical Manager
CREA RS148325

ANNEX A

TABLES CONTAINING THE VALUES OF THE MAXIMUM CONCENTRATIONS OF CONTAMINANTS CO, TRS, NO_2, PM_{10} AND SO_2

Table A1 – 50 highest concentrations of CO (8h) generated by the AERMOD model.

*** THE MAXIMUM 50 8-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): CALDREC , FRNCAL1 , FRNCAL2 , CALDBIO ,

** CONC OF CO IN MILLIGRAMS/M**3 **

RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR)	OF TYPE
1.	0.02490	(19020416) AT	(449875.00, 7430625.00)	DC	26.	0.02171	(18120216) AT	(449875.00, 7430875.00)	DC
2.	0.02348	(19022316) AT	(450125.00, 7428625.00)	DC	27.	0.02167	(19110116) AT	(449375.00, 7428875.00)	DC
3.	0.02320	(19022716) AT	(449625.00, 7430625.00)	DC	28.	0.02167	(18120116) AT	(449625.00, 7430875.00)	DC
4.	0.02319	(18022116) AT	(449875.00, 7430625.00)	DC	29.	0.02166	(18120716) AT	(449625.00, 7431125.00)	DC
5.	0.02316	(19020416) AT	(449875.00, 7430875.00)	DC	30.	0.02157	(19022316) AT	(450125.00, 7428375.00)	DC
6.	0.02310	(18111916) AT	(449375.00, 7430375.00)	DC	31.	0.02150	(18010316) AT	(449875.00, 7430625.00)	DC
7.	0.02307	(18031016) AT	(450125.00, 7428625.00)	DC	32.	0.02148	(18120216) AT	(449875.00, 7431125.00)	DC
8.	0.02300	(19021616) AT	(450125.00, 7430625.00)	DC	33.	0.02147	(18111216) AT	(449625.00, 7428375.00)	DC
9.	0.02279	(18021316) AT	(449625.00, 7430625.00)	DC	34.	0.02146	(19022416) AT	(450125.00, 7428625.00)	DC
10.	0.02278	(18112516) AT	(449125.00, 7430375.00)	DC	35.	0.02143	(19022416) AT	(450125.00, 7428375.00)	DC
11.	0.02275	(18010716) AT	(449375.00, 7430875.00)	DC	36.	0.02141	(19011016) AT	(450125.00, 7428625.00)	DC
12.	0.02262	(18021316) AT	(449625.00, 7430875.00)	DC	37.	0.02139	(18031016) AT	(450125.00, 7428375.00)	DC
13.	0.02248	(18011416) AT	(450875.00, 7429125.00)	DC	38.	0.02136	(19022316) AT	(450125.00, 7428875.00)	DC
14.	0.02244	(18120716) AT	(449625.00, 7430875.00)	DC	39.	0.02134	(19111516) AT	(449875.00, 7430625.00)	DC
15.	0.02236	(19123116) AT	(450875.00, 7429375.00)	DC	40.	0.02132	(18012316) AT	(450125.00, 7428375.00)	DC
16.	0.02220	(19112816) AT	(449875.00, 7430625.00)	DC	41.	0.02131	(19092216) AT	(449375.00, 7430875.00)	DC
17.	0.02219	(18110216) AT	(449875.00, 7428625.00)	DC	42.	0.02130	(19121716) AT	(449625.00, 7431125.00)	DC
18.	0.02214	(19022716) AT	(449625.00, 7430875.00)	DC	43.	0.02128	(19122416) AT	(449625.00, 7428875.00)	DC
19.	0.02211	(18111916) AT	(449125.00, 7430625.00)	DC	44.	0.02128	(19011716) AT	(450125.00, 7428375.00)	DC
20.	0.02202	(19112316) AT	(449625.00, 7430625.00)	DC	45.	0.02121	(19011516) AT	(450125.00, 7428625.00)	DC
21.	0.02200	(19112316) AT	(449625.00, 7430875.00)	DC	46.	0.02120	(19012816) AT	(449375.00, 7428375.00)	DC
22.	0.02184	(19112816) AT	(449875.00, 7430875.00)	DC	47.	0.02118	(19011416) AT	(450125.00, 7428625.00)	DC
23.	0.02180	(19123116) AT	(450625.00, 7429375.00)	DC	48.	0.02116	(19010216) AT	(450125.00, 7428375.00)	DC
24.	0.02180	(18020916) AT	(450125.00, 7428875.00)	DC	49.	0.02115	(19011716) AT	(450125.00, 7428625.00)	DC
25.	0.02175	(19121716) AT	(449625.00, 7430875.00)	DC	50.	0.02114	(18012316) AT	(450125.00, 7428625.00)	DC

Table A2 – 10 highest concentrations of CO (annual average) generated by the AERMOD model.

*** THE SUMMARY OF MAXIMUM ANNUAL RESULTS AVERAGED OVER 2 YEARS ***

** CONC OF CO IN MILLIGRAMS/M**3 **

GROUP ID		AVERAGE CONC		RECEPTOR (XR,	YR,	ZELEV,	ZHILL,	ZFLAG)	NETWORK OF TYPE GRID-ID
ALL	1ST HIGHEST VALUE IS	0.00174	AT (	449875.00,	7428625.00,	81.00,	0.00,	0.00)	DC
	2ND HIGHEST VALUE IS	0.00168	AT (	449875.00,	7428375.00,	81.00,	0.00,	0.00)	DC
	3RD HIGHEST VALUE IS	0.00166	AT (	450125.00,	7428625.00,	81.00,	0.00,	0.00)	DC
	4TH HIGHEST VALUE IS	0.00163	AT (	450125.00,	7428375.00,	81.00,	0.00,	0.00)	DC
	5TH HIGHEST VALUE IS	0.00162	AT (	449875.00,	7428875.00,	82.00,	0.00,	0.00)	DC
	6TH HIGHEST VALUE IS	0.00154	AT (	449875.00,	7428125.00,	79.00,	0.00,	0.00)	DC
	7TH HIGHEST VALUE IS	0.00153	AT (	450125.00,	7428875.00,	83.00,	0.00,	0.00)	DC
	8TH HIGHEST VALUE IS	0.00152	AT (	450125.00,	7428125.00,	81.00,	0.00,	0.00)	DC
	9TH HIGHEST VALUE IS	0.00150	AT (	449625.00,	7428625.00,	84.00,	0.00,	0.00)	DC
	10TH HIGHEST VALUE IS	0.00148	AT (	449625.00,	7428375.00,	84.00,	0.00,	0.00)	DC

Table A3 – 50 highest concentrations of Total Reduced Sulfur (average 1h) generated by the AERMOD model.

```
                    *** THE MAXIMUM   50   1-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL      ***
                                                     INCLUDING SOURCE(S):     CALDREC     , FRNCAL1     , FRNCAL2     ,

                                                        ** CONC OF H2S      IN MICROGRAMS/M**3                          **

   RANK         CONC    (YYMMDDHH) AT      RECEPTOR (XR,YR) OF TYPE    RANK         CONC    (YYMMDDHH) AT      RECEPTOR (XR,YR) OF
                                                                  TYPE
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                                                                  -
    1.       1.49240 (18022412) AT ( 449875.00, 7429875.00)  DC       26.       0.95623 (19112116) AT ( 449625.00, 7429625.00)  DC
    2.       1.32590 (18022412) AT ( 449875.00, 7429625.00)  DC       27.       0.95053 (18022412) AT ( 450125.00, 7429875.00)  DC
    3.       1.15935 (18022412) AT ( 449625.00, 7429625.00)  DC       28.       0.93719 (19041513) AT ( 450125.00, 7429875.00)  DC
    4.       1.15461 (18022413) AT ( 449625.00, 7429625.00)  DC       29.       0.93359 (19112116) AT ( 450125.00, 7429625.00)  DC
    5.       1.11782 (18022413) AT ( 449875.00, 7429875.00)  DC       30.       0.92228 (18030615) AT ( 449625.00, 7429625.00)  DC
    6.       1.11480 (18022413) AT ( 450125.00, 7429625.00)  DC       31.       0.91922 (19112413) AT ( 449875.00, 7429375.00)  DC
    7.       1.08065 (18022413) AT ( 449625.00, 7429875.00)  DC       32.       0.91141 (19112116) AT ( 449625.00, 7429875.00)  DC
    8.       1.07207 (18022412) AT ( 450125.00, 7429625.00)  DC       33.       0.89467 (18030615) AT ( 450125.00, 7429625.00)  DC
    9.       1.06082 (19041513) AT ( 449625.00, 7429625.00)  DC       34.       0.88188 (19041513) AT ( 449875.00, 7429375.00)  DC
   10.       1.05446 (19041513) AT ( 449875.00, 7429875.00)  DC       35.       0.87378 (19041413) AT ( 450125.00, 7429625.00)  DC
   11.       1.03435 (19020212) AT ( 450125.00, 7429625.00)  DC       36.       0.87225 (19041413) AT ( 449625.00, 7429875.00)  DC
   12.       1.03141 (18022413) AT ( 450125.00, 7429875.00)  DC       37.       0.87110 (19112116) AT ( 450125.00, 7429875.00)  DC
   13.       1.02779 (19020212) AT ( 449625.00, 7429875.00)  DC       38.       0.87029 (18022412) AT ( 449875.00, 7429375.00)  DC
   14.       1.02063 (18022412) AT ( 449625.00, 7429875.00)  DC       39.       0.86099 (19041413) AT ( 450125.00, 7429875.00)  DC
   15.       1.01692 (18030615) AT ( 449875.00, 7429875.00)  DC       40.       0.85734 (19041413) AT ( 449625.00, 7429625.00)  DC
   16.       1.01338 (19020212) AT ( 450125.00, 7429875.00)  DC       41.       0.84552 (19112116) AT ( 449875.00, 7429875.00)  DC
   17.       1.01315 (19041513) AT ( 450125.00, 7429625.00)  DC       42.       0.84398 (18012515) AT ( 449875.00, 7429875.00)  DC
   18.       1.01244 (19020212) AT ( 449625.00, 7429625.00)  DC       43.       0.83527 (19020213) AT ( 449625.00, 7429625.00)  DC
   19.       0.98591 (19112413) AT ( 450125.00, 7429625.00)  DC       44.       0.83479 (19020212) AT ( 449625.00, 7429375.00)  DC
   20.       0.98333 (19041513) AT ( 449625.00, 7429875.00)  DC       45.       0.83306 (19020212) AT ( 449875.00, 7430125.00)  DC
   21.       0.97344 (19112413) AT ( 449625.00, 7429875.00)  DC       46.       0.82900 (19020213) AT ( 450125.00, 7429625.00)  DC
   22.       0.97186 (19112413) AT ( 449625.00, 7429625.00)  DC       47.       0.82698 (19041413) AT ( 449875.00, 7429375.00)  DC
   23.       0.96746 (19020212) AT ( 449875.00, 7429375.00)  DC       48.       0.81520 (18030615) AT ( 449625.00, 7429875.00)  DC
   24.       0.95960 (18022413) AT ( 449875.00, 7429375.00)  DC       49.       0.81099 (19112116) AT ( 449875.00, 7429375.00)  DC
   25.       0.95712 (19112413) AT ( 450125.00, 7429875.00)  DC       50.       0.81064 (19020212) AT ( 450125.00, 7429375.00)  DC
```

Table A4 – 10 highest concentrations of Total Reduced Sulfur (annual average) generated by the AERMOD model.

```
                              *** THE SUMMARY OF MAXIMUM ANNUAL RESULTS AVERAGED OVER   2 YEARS ***


                                          ** CONC OF H2S      IN MICROGRAMS/M**3 **

                                                                                                           NETWORK
GROUP ID                         AVERAGE CONC                RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
                                                          -

    ALL      1ST HIGHEST VALUE IS       0.03424 AT (  449875.00,  7428625.00,    81.00,     0.00,    0.00)  DC
             2ND HIGHEST VALUE IS       0.03276 AT (  449875.00,  7428375.00,    81.00,     0.00,    0.00)  DC
             3RD HIGHEST VALUE IS       0.03260 AT (  450125.00,  7428625.00,    81.00,     0.00,    0.00)  DC
             4TH HIGHEST VALUE IS       0.03206 AT (  449875.00,  7428875.00,    82.00,     0.00,    0.00)  DC
             5TH HIGHEST VALUE IS       0.03170 AT (  450125.00,  7428375.00,    81.00,     0.00,    0.00)  DC
             6TH HIGHEST VALUE IS       0.03010 AT (  450125.00,  7428875.00,    83.00,     0.00,    0.00)  DC
             7TH HIGHEST VALUE IS       0.02998 AT (  449875.00,  7428125.00,    79.00,     0.00,    0.00)  DC
             8TH HIGHEST VALUE IS       0.02949 AT (  450125.00,  7428125.00,    81.00,     0.00,    0.00)  DC
             9TH HIGHEST VALUE IS       0.02946 AT (  449625.00,  7428625.00,    84.00,     0.00,    0.00)  DC
            10TH HIGHEST VALUE IS       0.02900 AT (  449625.00,  7428375.00,    84.00,     0.00,    0.00)  DC
```

Table A5 – 50 highest concentrations of NO_2 (average 1h) generated by the AERMOD model.

*** THE MAXIMUM 50 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): CALDREC , FRNCAL1 , FRNCAL2 , CALDBIO ,

** CONC OF NOX IN MICROGRAMS/M**3 **

RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR)	OF TYPE
1.	74.81947	(18022412) AT	(449875.00, 7429875.00)	DC	26.	43.85058	(19112413) AT	(449625.00, 7429625.00)	DC
2.	67.21629	(18022412) AT	(449875.00, 7429625.00)	DC	27.	43.66804	(19112413) AT	(449625.00, 7429875.00)	DC
3.	54.82679	(18022412) AT	(449625.00, 7429625.00)	DC	28.	43.29349	(18030615) AT	(450125.00, 7429625.00)	DC
4.	52.82401	(18022413) AT	(449875.00, 7429875.00)	DC	29.	43.25166	(19112116) AT	(449625.00, 7429875.00)	DC
5.	52.79425	(18022413) AT	(449625.00, 7429625.00)	DC	30.	43.06829	(19041513) AT	(450125.00, 7429875.00)	DC
6.	52.28682	(18030615) AT	(449875.00, 7429875.00)	DC	31.	42.75139	(19112413) AT	(450125.00, 7429875.00)	DC
7.	51.05697	(19041513) AT	(449875.00, 7429875.00)	DC	32.	42.58570	(18022413) AT	(449875.00, 7429375.00)	DC
8.	50.49182	(18022413) AT	(450125.00, 7429625.00)	DC	33.	41.98974	(19020212) AT	(449875.00, 7429375.00)	DC
9.	50.13500	(18022412) AT	(450125.00, 7429625.00)	DC	34.	41.19899	(19112116) AT	(450125.00, 7429875.00)	DC
10.	49.50687	(19041513) AT	(449625.00, 7429625.00)	DC	35.	40.58434	(19112413) AT	(449875.00, 7429375.00)	DC
11.	48.99142	(18022413) AT	(449625.00, 7429875.00)	DC	36.	40.53243	(19112116) AT	(449875.00, 7429875.00)	DC
12.	47.89336	(18022412) AT	(449625.00, 7429875.00)	DC	37.	40.09942	(18030615) AT	(449625.00, 7429875.00)	DC
13.	46.90867	(19041513) AT	(450125.00, 7429625.00)	DC	38.	39.94520	(19041413) AT	(450125.00, 7429625.00)	DC
14.	46.39094	(18022413) AT	(450125.00, 7429875.00)	DC	39.	39.85186	(19041513) AT	(449875.00, 7429375.00)	DC
15.	45.57274	(19041513) AT	(449625.00, 7429875.00)	DC	40.	39.76865	(18022412) AT	(449875.00, 7429375.00)	DC
16.	45.53535	(19112116) AT	(449625.00, 7429625.00)	DC	41.	39.75791	(19041413) AT	(449625.00, 7429875.00)	DC
17.	45.50227	(19020212) AT	(450125.00, 7429625.00)	DC	42.	39.53131	(19041413) AT	(449625.00, 7429625.00)	DC
18.	45.28503	(18030615) AT	(449625.00, 7429625.00)	DC	43.	39.10913	(19020213) AT	(449625.00, 7429625.00)	DC
19.	45.15472	(19020212) AT	(449625.00, 7429875.00)	DC	44.	38.98442	(19041413) AT	(450125.00, 7429875.00)	DC
20.	44.84967	(18012515) AT	(449875.00, 7429875.00)	DC	45.	38.57790	(19020213) AT	(450125.00, 7429625.00)	DC
21.	44.67380	(19020212) AT	(449625.00, 7429625.00)	DC	46.	37.98624	(19112116) AT	(449875.00, 7429375.00)	DC
22.	44.35921	(19020212) AT	(450125.00, 7429875.00)	DC	47.	37.73857	(19020213) AT	(449625.00, 7429875.00)	DC
23.	44.26685	(19112413) AT	(450125.00, 7429625.00)	DC	48.	37.01162	(19041413) AT	(449875.00, 7429375.00)	DC
24.	44.25133	(19112116) AT	(450125.00, 7429625.00)	DC	49.	36.51162	(18030615) AT	(450125.00, 7429875.00)	DC
25.	44.18416	(18022412) AT	(450125.00, 7429875.00)	DC	50.	36.33225	(19020213) AT	(450125.00, 7429875.00)	DC

Table A6 – 10 highest concentrations of NO_2 (annual average) generated by the AERMOD model.

*** THE SUMMARY OF MAXIMUM ANNUAL RESULTS AVERAGED OVER 2 YEARS ***

** CONC OF NOX IN MICROGRAMS/M**3 **

GROUP ID		AVERAGE CONC		RECEPTOR (XR,	YR,	ZELEV,	ZHILL,	ZFLAG)	OF TYPE	NETWORK GRID-ID
ALL	1ST HIGHEST VALUE IS	1.57742	AT (	449875.00,	7428625.00,	81.00,	0.00,	0.00)	DC	
	2ND HIGHEST VALUE IS	1.51088	AT (	449875.00,	7428875.00,	82.00,	0.00,	0.00)	DC	
	3RD HIGHEST VALUE IS	1.49491	AT (	450125.00,	7428625.00,	81.00,	0.00,	0.00)	DC	
	4TH HIGHEST VALUE IS	1.49017	AT (	449875.00,	7428375.00,	81.00,	0.00,	0.00)	DC	
	5TH HIGHEST VALUE IS	1.43693	AT (	450125.00,	7428375.00,	81.00,	0.00,	0.00)	DC	
	6TH HIGHEST VALUE IS	1.40948	AT (	450125.00,	7428875.00,	83.00,	0.00,	0.00)	DC	
	7TH HIGHEST VALUE IS	1.38774	AT (	449625.00,	7430625.00,	104.00,	0.00,	0.00)	DC	
	8TH HIGHEST VALUE IS	1.36688	AT (	449625.00,	7430875.00,	103.00,	0.00,	0.00)	DC	
	9TH HIGHEST VALUE IS	1.35961	AT (	449625.00,	7428625.00,	84.00,	0.00,	0.00)	DC	
	10TH HIGHEST VALUE IS	1.35616	AT (	449875.00,	7428125.00,	79.00,	0.00,	0.00)	DC	

Table A7 – 50 highest concentrations of PM_{10} (average 24h) generated by the AERMOD model.

*** THE MAXIMUM 50 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): CALDREC , FRNCAL1 , FRNCAL2 , CALDBIO ,

** CONC OF PM10 IN MICROGRAMS/M**3 **

RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR)	OF TYPE
1.	1.23890	19080224) AT	(450125.00, 7432125.00)	DC	26.	1.06653	19081324) AT	(449125.00, 7433875.00)	DC
2.	1.23561	19081324) AT	(449375.00, 7433125.00)	DC	27.	1.06633	19081324) AT	(449625.00, 7433375.00)	DC
3.	1.23418	19080224) AT	(450125.00, 7432375.00)	DC	28.	1.06514	19080224) AT	(450375.00, 7432875.00)	DC
4.	1.22371	19081324) AT	(449625.00, 7432375.00)	DC	29.	1.06144	19081324) AT	(449625.00, 7431625.00)	DC
5.	1.22183	19081324) AT	(449375.00, 7432625.00)	DC	30.	1.05845	19080224) AT	(450375.00, 7432625.00)	DC
6.	1.22049	19081324) AT	(449375.00, 7432875.00)	DC	31.	1.05619	19080224) AT	(450125.00, 7433375.00)	DC
7.	1.21874	19081324) AT	(449375.00, 7433375.00)	DC	32.	1.05493	19080224) AT	(450375.00, 7433125.00)	DC
8.	1.21416	19080224) AT	(450125.00, 7431875.00)	DC	33.	1.05078	19081324) AT	(449125.00, 7433375.00)	DC
9.	1.20598	19081324) AT	(449625.00, 7432125.00)	DC	34.	1.04975	18082024) AT	(450625.00, 7433125.00)	DC
10.	1.20486	19080224) AT	(450125.00, 7432625.00)	DC	35.	1.04455	18011424) AT	(450875.00, 7429125.00)	DC
11.	1.19638	19081324) AT	(449625.00, 7432625.00)	DC	36.	1.04363	19081324) AT	(449125.00, 7434125.00)	DC
12.	1.18226	19081324) AT	(449375.00, 7433625.00)	DC	37.	1.03720	18082024) AT	(450625.00, 7433375.00)	DC
13.	1.17451	19081324) AT	(449375.00, 7432375.00)	DC	38.	1.03661	18022124) AT	(449875.00, 7430625.00)	DC
14.	1.16956	19020424) AT	(449875.00, 7430625.00)	DC	39.	1.03603	19022324) AT	(450125.00, 7428625.00)	DC
15.	1.15599	19081324) AT	(449625.00, 7431875.00)	DC	40.	1.03504	18021324) AT	(449625.00, 7430875.00)	DC
16.	1.15082	19080224) AT	(450125.00, 7432875.00)	DC	41.	1.03312	19022724) AT	(449625.00, 7430625.00)	DC
17.	1.13852	19080224) AT	(450125.00, 7431625.00)	DC	42.	1.03145	19080224) AT	(450375.00, 7433375.00)	DC
18.	1.13490	19081324) AT	(449625.00, 7432875.00)	DC	43.	1.02975	18082024) AT	(450625.00, 7432875.00)	DC
19.	1.12516	19081324) AT	(449375.00, 7433875.00)	DC	44.	1.02913	18021324) AT	(449625.00, 7430625.00)	DC
20.	1.11293	19081324) AT	(449625.00, 7433125.00)	DC	45.	1.02599	18111924) AT	(449375.00, 7430375.00)	DC
21.	1.11120	19020424) AT	(449875.00, 7430875.00)	DC	46.	1.02533	18082024) AT	(450625.00, 7433625.00)	DC
22.	1.09877	19080224) AT	(450125.00, 7433125.00)	DC	47.	1.02061	18120724) AT	(449625.00, 7430875.00)	DC
23.	1.07352	19081324) AT	(449125.00, 7433625.00)	DC	48.	1.01639	19021624) AT	(450125.00, 7430625.00)	DC
24.	1.07134	19081324) AT	(449375.00, 7432125.00)	DC	49.	1.01607	18082024) AT	(450875.00, 7433875.00)	DC
25.	1.06690	19081324) AT	(449375.00, 7434125.00)	DC	50.	1.01591	19080224) AT	(450375.00, 7432375.00)	DC

Table A8 – 10 highest concentrations of PM_{10} (annual average) generated by the AERMOD model.

*** THE SUMMARY OF MAXIMUM ANNUAL RESULTS AVERAGED OVER 2 YEARS ***

** CONC OF PM10 IN MICROGRAMS/M**3 **

GROUP ID		AVERAGE CONC	RECEPTOR (XR,	YR,	ZELEV,	ZHILL,	ZFLAG)	OF TYPE	NETWORK GRID-ID
ALL	1ST HIGHEST VALUE IS	0.17252 AT (	449875.00,	7428625.00,	81.00,	0.00,	0.00)	DC	
	2ND HIGHEST VALUE IS	0.16465 AT (	449875.00,	7428875.00,	82.00,	0.00,	0.00)	DC	
	3RD HIGHEST VALUE IS	0.16382 AT (	450125.00,	7428625.00,	81.00,	0.00,	0.00)	DC	
	4TH HIGHEST VALUE IS	0.16359 AT (	449875.00,	7428375.00,	81.00,	0.00,	0.00)	DC	
	5TH HIGHEST VALUE IS	0.15801 AT (	450125.00,	7428375.00,	81.00,	0.00,	0.00)	DC	
	6TH HIGHEST VALUE IS	0.15394 AT (	450125.00,	7428875.00,	83.00,	0.00,	0.00)	DC	
	7TH HIGHEST VALUE IS	0.15045 AT (	449625.00,	7430625.00,	104.00,	0.00,	0.00)	DC	
	8TH HIGHEST VALUE IS	0.14933 AT (	449875.00,	7428125.00,	79.00,	0.00,	0.00)	DC	
	9TH HIGHEST VALUE IS	0.14863 AT (	449625.00,	7430875.00,	103.00,	0.00,	0.00)	DC	
	10TH HIGHEST VALUE IS	0.14856 AT (	449625.00,	7428625.00,	84.00,	0.00,	0.00)	DC	

Table A9 – 50 highest concentrations of SO_2 (average 24h) generated by the AERMOD model.

*** THE MAXIMUM 50 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): CALDREC , FRNCAL1 , FRNCAL2 , CALDBIO ,

** CONC OF SO2 IN MICROGRAMS/M**3 **

RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR)	OF TYPE
1.	3.45833	19081324) AT	(449625.00, 7432125.00)	DC	26.	2.98840	18082024) AT	(450625.00, 7433375.00)	DC
2.	3.44950	19081324) AT	(449625.00, 7432375.00)	DC	27.	2.98190	19081324) AT	(449375.00, 7433875.00)	DC
3.	3.42694	19080224) AT	(450125.00, 7432125.00)	DC	28.	2.95414	18082024) AT	(450375.00, 7432375.00)	DC
4.	3.41879	19080224) AT	(450125.00, 7431875.00)	DC	29.	2.93071	18082024) AT	(450375.00, 7432125.00)	DC
5.	3.39701	19081324) AT	(449375.00, 7432625.00)	DC	30.	2.91591	18082024) AT	(450625.00, 7433625.00)	DC
6.	3.38252	19081324) AT	(449625.00, 7431875.00)	DC	31.	2.91376	19080224) AT	(450125.00, 7433125.00)	DC
7.	3.36691	19080224) AT	(450125.00, 7432375.00)	DC	32.	2.90844	18021324) AT	(449625.00, 7430625.00)	DC
8.	3.35245	19081324) AT	(449375.00, 7433125.00)	DC	33.	2.90197	18082024) AT	(450375.00, 7432625.00)	DC
9.	3.34993	19081324) AT	(449375.00, 7432875.00)	DC	34.	2.89373	18082024) AT	(450375.00, 7431875.00)	DC
10.	3.32468	19081324) AT	(449625.00, 7432625.00)	DC	35.	2.88112	18111924) AT	(449375.00, 7430375.00)	DC
11.	3.31887	19081324) AT	(449375.00, 7432375.00)	DC	36.	2.87846	19091224) AT	(450375.00, 7432625.00)	DC
12.	3.28238	19080224) AT	(450125.00, 7431625.00)	DC	37.	2.87316	19081324) AT	(449625.00, 7433375.00)	DC
13.	3.27520	19081324) AT	(449375.00, 7433375.00)	DC	38.	2.87202	18021324) AT	(449625.00, 7430875.00)	DC
14.	3.25008	19080224) AT	(450125.00, 7432625.00)	DC	39.	2.87150	19112824) AT	(449875.00, 7430625.00)	DC
15.	3.23796	19020424) AT	(449875.00, 7430625.00)	DC	40.	2.86986	18011424) AT	(450875.00, 7429125.00)	DC
16.	3.17601	19081324) AT	(449625.00, 7431625.00)	DC	41.	2.86623	19081324) AT	(449125.00, 7433625.00)	DC
17.	3.15205	19081324) AT	(449375.00, 7433625.00)	DC	42.	2.86531	19022724) AT	(449625.00, 7430625.00)	DC
18.	3.11826	19081324) AT	(449625.00, 7432875.00)	DC	43.	2.86493	19091224) AT	(450375.00, 7432875.00)	DC
19.	3.08807	19081324) AT	(449375.00, 7432125.00)	DC	44.	2.85597	18082024) AT	(450875.00, 7433875.00)	DC
20.	3.07608	19080224) AT	(450125.00, 7432875.00)	DC	45.	2.84777	19080224) AT	(450375.00, 7432625.00)	DC
21.	3.06616	18082024) AT	(450625.00, 7433125.00)	DC	46.	2.84312	18022124) AT	(449875.00, 7430625.00)	DC
22.	3.05650	18082024) AT	(450625.00, 7432875.00)	DC	47.	2.84253	18082024) AT	(450875.00, 7433625.00)	DC
23.	3.02686	19020424) AT	(449875.00, 7430875.00)	DC	48.	2.83980	19080224) AT	(450375.00, 7432875.00)	DC
24.	3.02491	19081324) AT	(449625.00, 7433125.00)	DC	49.	2.83093	19091224) AT	(450375.00, 7433125.00)	DC
25.	2.99504	18082024) AT	(450625.00, 7432625.00)	DC	50.	2.83064	19081324) AT	(449125.00, 7433375.00)	DC

Table A10 – 10 highest concentrations of SO_2 (annual average) generated by the AERMOD model.

*** THE SUMMARY OF MAXIMUM ANNUAL RESULTS AVERAGED OVER 2 YEARS ***

** CONC OF SO2 IN MICROGRAMS/M**3 **

GROUP ID		AVERAGE CONC	RECEPTOR (XR,	YR,	ZELEV,	ZHILL,	ZFLAG)	OF TYPE	NETWORK GRID-ID
ALL	1ST HIGHEST VALUE IS	0.47616 AT (	449875.00,	7428625.00,	81.00,	0.00,	0.00)	DC	
	2ND HIGHEST VALUE IS	0.46137 AT (	449875.00,	7428875.00,	82.00,	0.00,	0.00)	DC	
	3RD HIGHEST VALUE IS	0.45015 AT (	450125.00,	7428625.00,	81.00,	0.00,	0.00)	DC	
	4TH HIGHEST VALUE IS	0.44686 AT (	449875.00,	7428375.00,	81.00,	0.00,	0.00)	DC	
	5TH HIGHEST VALUE IS	0.43010 AT (	450125.00,	7428375.00,	81.00,	0.00,	0.00)	DC	
	6TH HIGHEST VALUE IS	0.42905 AT (	450125.00,	7428875.00,	83.00,	0.00,	0.00)	DC	
	7TH HIGHEST VALUE IS	0.42811 AT (	449625.00,	7430625.00,	104.00,	0.00,	0.00)	DC	
	8TH HIGHEST VALUE IS	0.41828 AT (	449625.00,	7430875.00,	103.00,	0.00,	0.00)	DC	
	9TH HIGHEST VALUE IS	0.41076 AT (	449625.00,	7428625.00,	84.00,	0.00,	0.00)	DC	
	10TH HIGHEST VALUE IS	0.40553 AT (	449875.00,	7428125.00,	79.00,	0.00,	0.00)	DC	

ANNEX II
WATER DISPERSION STUDY

Pöyry Tecnologia Ltda.
Av. Alfredo Egídio de Souza Aranha, 100
Bloco B - 5° andar
04726-170 São Paulo - SP
BRASIL
Tel. +55 11 3472 6955
Fax +55 11 3472 6980
E-mail: contato.br@poyry.com

ENVIROMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

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Page 1

Pulp Mill, Port, Transmission Line and Electrical Substation in Concepción - Paraguay

VOLUME IV – COMPLEMENTARY ENVIRONMENTAL STUDIES
Effluent Dispersion Study

Content

Content	1	INTRODUCTION
	2	GENERAL INFORMATION
	3	EFFLUENT DISPERSION MODEL
	4	MIXING ZONE MODELING
	5	CONCLUSIONS
	6	REFERENCES
Attachments	I	CORMIX Simulations

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SUMMARY

1 INTRODUCTION....5
2 GENERAL INFORMATION....6
2.1 General Description....6
2.2 Description of the Effluents Treatment Plant (ETP)....6
2.2.1 Generation sources y Characteristics of the Effluent Before Treatment....6
2.2.2 Effluent Treatment Plant (ETP)....8
2.2.3 Characteristics of Treated Effluents....11
2.3 Effluent Final Disposal....12
2.4 Paraguay River....13
2.4.1 Flow rates and Depths....14
2.4.2 Water Quality....14
3 EFFLUENT DISPERSION MODEL....14
3.1 Mixing Zone Concept....14
3.2 Cormix Model (Mixing Zone Simulation)....14
3.2.1 Hydrodynamic Mixing Processes....15
3.2.2 Type of Discharge....16
3.2.3 CORMIX Parameters....17
4 MIXING ZONE MODELING....17
4.1 Premises....17
4.2 Input Data....17
4.3 Results of Evaluated Scenarios....21
4.3.1 Scenario 1 (BOD, Minimum flow - $Q_{7,10}$)....21
4.3.2 Scenario 2 (BOD, Average flow - $Q_{average}$)....23
4.3.3 Scenario 3 (Color, Minimum flow - $Q_{7,10}$)....24
4.3.4 Scenario 4 (Color, Average flow - $Q_{average}$)....26
4.3.5 Scenario 5 (Total nitrogen, Minimum flow - $Q_{7,10}$)....27
4.3.6 Scenario 6 (Total nitrogen, Average flow - $Q_{average}$)....29
4.3.7 Scenario 7 (Total phosphorus, Minimum flow - $Q_{7,10}$)....30
4.3.8 Scenario 8 (Total phosphorus, Average flow - $Q_{average}$)....32
4.3.9 Scenario 9 (AOX, Minimum flow - $Q_{7,10}$)....33
4.3.10 Scenario 10 (AOX, Average flow - $Q_{average}$)....35
5 CONCLUSIONS....36
6 REFERENCES....38

LIST OF FIGURES

Figure 1 – Location of effluent discharge. Source: *Google Earth* (2020). 12
Figure 2 – Vision of the Paraguay River. Source: Pöyry Tecnologia (2019). 13
Figure 3 – Screen of CORMIX software. 15
Figure 4 – Exemple of special check valve (duckbill type). 16
Figure 5 – Discharge of effluent by diffusers. 17
Figure 6 – River Perspectives of the underwater emissary in the Paraguay River. 20
Figure 7 – Simulation of the BOD dispersion plume in 3 dimensions. 22
Figure 8 – Graphic of BOD concentration (mg/L) X distance (m). 22
Figure 9 – Simulation of the BOD dispersion plume in 3 dimensions. 23
Figure 10 – Graphic of BOD concentration (mg/L) X distance (m). 24
Figure 11 – Simulation of the color dispersion plume in 3 dimensions. 25
Figure 12 – Graphic of color concentration (mg/L) X distance (m). 25
Figure 13 – Simulation of the color dispersion plume in 3 dimensions. 26
Figure 14 – Graphic of color concentration (mg/L) X distance (m). 27
Figure 15 – Simulation of the nitrogen dispersion plume in 3 dimensions. 28
Figure 16 – Graphic of nitrogen concentration (mg/L) X distance (m). 28
Figure 17 – Simulation of the nitrogen dispersion plume in 3 dimensions. 29
Figure 18 – Graphic of nitrogen concentration (mg/L) X distance (m). 30
Figure 19 – Simulation of the phosphorus dispersion plume in 3 dimensions. 31
Figure 20 – Graphic of phosphorus concentration (mg/L) X distance (m). 31
Figure 21 – Simulation of the dispersion plume in 3 dimensions. 32
Figure 22 – Graphic of concentration (mg/L) X distance (m). 33
Figure 23 – Simulation of the AOX dispersion plume in 3 dimensions. 34
Figure 24 – Graphic of AOX concentration (mg/L) X distance (m). 34
Figure 25 – Simulation of the AOX dispersion plume in 3 dimensions. 35
Figure 26 – Graphic of AOX concentration (mg/L) X distance (m). 36

LIST OF TABLE

Table 1 – Characteristics of the effluent before treatment 7
Table 2 – Expected emissions from treated effluents....11
Table 3 – Environmental data 18
Table 4 – Treated effluent data 18
Table 5 – Subaquatic emissary data 18
Table 6 – Scenarios evaluated in the present study....21
Table 7 – Data used in the scenario 1....21
Table 8 – Scenario results 1 23
Table 9 – Data used in this scenario....23
Table 10 – Scenario results 2 24
Table 11 – Data used in this scenario....24
Table 12 – Scenario results 3 26
Table 13 – Data used in this scenario....26
Table 14 – Scenario results 4 27
Table 15 – Data used in this scenario....27
Table 16 – Scenario results 5 29
Table 17 – Data used in this scenario....29
Table 18 – Scenario results 6 30
Table 19 – Data used in this scenario....30
Table 20 – Scenario results 7 32
Table 21 – Data used in this scenario....32
Table 22 – Scenario results 8 33
Table 23 – Data used in this scenario....33
Table 24 – Scenario results 9 35
Table 25 – Data used in this scenario....35
Table 26 – Scenario results 10 36
Table 27 – Results of the CORMIX simulations 37

1 INTRODUCTION

This document consists of the Treated Effluent Dispersion Study from the future pulp mill of par, which will be discharged in Paraguay River.

In general, the most relevant issues facing contemporary society are the preservation of water resources. In Paraguay, the concern about this issue is evidenced, among others, in SEAM Resolution 222/2002 (water quality standards), SEAM Resolution 50/2006 (national water management), SEAM Resolution 255/2006 (classification of all waters in Paraguay in class 2) and Law 3239/2007 (water resources in Paraguay).

Among the control instruments foreseen in our legislation, we highlight the monitoring and diagnosis of the quality of water resources, especially rivers and estuaries. In this particular, water quality mathematical models can be useful tools.

These models consist of a set of equations that, solved, provide the space-time distribution of constituents that are transported in solution and in suspension by the water body. These equations, as a rule, are solved numerically, generating what is called a numerical simulation, and the model, once calibrated, allows to draw future and past scenarios according to the inputs that are prescribed. Thus, mixing zones, pollutant feather behavior and dispersion can be properly calculated and predicted by the simulation.

The mixing zone is defined as "*the region of the receiving body, estimated on the basis of theoretical models, extending from the point of discharge of the effluent, and delimited by the surface on which the mixing equilibrium between the physical and chemical parameters, as well as the biological equilibrium of the effluent and those of the receiving body, is achieved, being specific to each parameter*".

Therefore, this document presents the Treated Effluent Dispersion Study, aiming to know the zone of mixture of treated effluents from the project of the PARACEL mill in the Paraguay River.

In order to know the dispersion of the effluent from the project of the mentioned mill, simulations were carried out through the mathematical model CORMIX, developed by Cornell University in conjunction with the US Environmental Protection Agency (USEPA), mainly in terms of load (measured in BOD), color, total nitrogen, total phosphorus and AOX, the results of which are presented in this report.

This study is part of the EIAp/RIMA project of bleached pulp mill of PARACEL.

This Study is comprised by following chapters:

– Introduction
– Project Information
– Effluent Dispersion Model
– Mixing Zone Modeling
– Conclusions
– References

2 GENERAL INFORMATION

2.1 General Description

The main activity of the factory is the production of 1,500,000 t/year of bleached pulp or 900,000 t/year of dissolving pulp from PARACEL in Concepción, Paraguay.

For the production of bleached pulp, PARACEL's mill will use *kraft* process - a technology widely known by pulp producers, as well as by engineering, equipment and consulting service providers, with additional advantages to obtain high brightness patterns and fiber quality perfection required by market, associated with energy self-sufficiency capacity and environmental benefits when compared to any production processes.

The process chosen to bleach the pulp was the ECF (*Elemental Chlorine Free*), which does not use elemental chlorine in its process stages, avoiding significant emissions of organochlorines to the effluent.

The pulp mill will also be a source of clean energy, by using forest biomass and wood liquor, which are renewable natural resources. For information, it will be co-generated 220 MW in case of bleached pulp, and considering the plant will consume about 120 MW and there will be a surplus of 100 MW for sale; or in case of dissolving pulp process is chosen, it will be co-generated 240 MW and the mill will consume about 110 MW of electrical energy, with a surplus of 130 MW for sale.

The operational regime will be 24 hours a day, 7 days a week and 12 months a year. The effective production period will be approximately 354 days, considering the general annual maintenance stop for equipment.

The total labor force, considering own employees and third parties, necessary for the operation of the PARACEL pulp mill will be approximately 1,200 people.

This mill will use the best available techniques (BAT), as well as the best practices of environmental management (BPEM), in order to reduce, control and monitor air emissions, liquid effluents and solid waste generated.

It should be noted that PARACEL pulp mill, despite being designed to produce 1,500,000 t/year, it will be set to produce up to 1,800,000 t/year of bleached pulp as a result of greater overall plant efficiency, as well as higher equipment performance without the need to increase its constructed area or include new additional equipment. In addition, no modifications will be required to the main environmental control equipment, nor will there be any loss in performance, which can guarantee the same liquid effluent and atmospheric emissions considered in this Environmental Impact Assessment. Therefore, it can be said that in the event of an increase in pulp production to 1,800,000 t/year, there will be no changes in the environmental impacts identified and evaluated in this EIAp.

2.2 Description of the Effluents Treatment Plant (ETP)

2.2.1 Generation sources y Characteristics of the Effluent Before Treatment

Basically, the sources of liquid effluent generation that will correspond to the activities of the pulp process and other support activities are the following:

– Effluents from the wood preparation area;

- Effluents from the cooking and brown pulp depuration area;
- Alkaline and acid filtrates from bleaching plant;
- Drying machine effluents;
- Effluents from evaporation and recovery;
- Effluents from the causticizing and lime kiln area;
- Contaminated condensate;
- Sanitary effluents;
- Contaminated rainwater; and
- Miscellaneous (spills, leaks, cleaning of various areas, etc.).

The quantitative and qualitative characteristics expected from these effluents before treatment, which are the basis for sizing the liquid effluent treatment station, are shown in the table below.

Table 1 – Characteristics of the effluent before treatment

Parameters	Unit	Value
Flow	m³/h	5,700
pH	-	3.0 - 10.0
Temperature	°C	60 - 70
DBO	kg/d	84,000
	mg/L	600
COD	kg/d	193,000
	mg/L	1,400
TSS	kg/d	47,000
	mg/L	350
Colour	kg/d	96,000
	mg/L	750
AOX	kg/d	1,400
	mg/L	10
N_{total}	kg/d	2,000
	mg/L	15
$N_{ammoniacal}$	kg/d	700
	mg/L	5

Parameters	Unit	Value
P_{total}	kg/d	700
	mg/L	5

Source: Pöyry Tecnologia (2020).

2.2.2 Effluent Treatment Plant (ETP)

The pulp mill industrial liquid effluent will be measured for flow, temperature, pH and conductivity and, depending on the results, diverted to emergency lagoon. The other part of the treatment system description is below.

Specific effluent

Effluent from the chlorine dioxide plant, ash leaching and boiler make-up water plant will also be segregated from the main lines, as they have no organic load, requiring only pH control before release. The specific neutralized effluent will be added to the other treated effluent in the treated effluent tank for disposal in the Paraguay River.

Sanitary effluent

Sanitary effluent generated at the mill will be collected from the sanitary effluent network and sent to the ETP directly for biological treatment.

Summary of the Effluent Treatment System

PARACEL's effluent treatment system will basically consist of three stages: solids removal, organic load removal and final polishing. The main units of this system are listed and described below.

The main stages of the effluent treatment process are:

– Screening;
– Primary clarifier;
– Emergency lagoon;
– Neutralization;
– Cooling;
– Activated sludge - aeration tank;
– Secondary clarifier;
– Tertiary treatment;
– Emissary.

Screening

Effluent will be directed by gravity to a screening system to remove coarse materials. This system will have 2 sets composed of a mechanized screen and a manual screen, which will be used when the mechanized screen was subjected to maintenance.

Primary clarifier

After passing through a grid system and flow measurement, the effluent will be sent to two primary clarifiers with a diameter of 68 m to reduce the amount of suspended solids. These clarifiers will be equipped with a scraper to remove sedimentary solids and surface foam. The settled solids and the slag will be removed by pumps that will be sent to the primary sludge dewatering system. The clarified effluent will be sent to the neutralization system.

Primary sludge dewatering system

The primary sludge dewatering system will have a total capacity of 42 tDS/day. Each assembly will consist of a mechanical drum type or gravity type table thickener and a screw type dewatering press. The expected final consistency of the dewatered sludge is between 35 - 45%.

Emergency lagoon

In addition to the systems for preventing and collecting leaks and spills in each department of the mill, there will be a set of emergency lagoon at the effluent treatment plant. The purpose of these lagoons will be to receive all effluent with characteristics that are out of specification. Once discharged into the emergency lagoon, these effluents will be sent at the inlet to the neutralization tank so that no disturbance to the biological treatment is created.

Its operation will be controlled by on-line monitoring of pH, temperature and conductivity. When levels over the acceptable range occur, the valves will be closed and the effluent diverted to the emergency lagoon.

The total volume will be approximately 70,000 m^3 to receive the process effluents considered contaminated.

The lagoons will be constructed with a properly sealed bottom and sloped towards the drainage pumps.

Contaminated rain water

Rain water with the possibility of contamination will be sent to the contaminated rain water retention lagoon to avoid hydraulic overloading in the treatment plant due to high rainfall. Once discharged to the retention lagoon, the rain water will be treated and slowly diverted to the effluent treatment plant.

Effluent neutralization

The effluent clarified in the primary clarifiers will be sent to a neutralization tank. The purpose of this step will be to neutralize the effluent by adding caustic soda or sulfuric acid to maintain a pH between 6 and 8, making it suitable for biological treatment.

The neutralization tank will have a capacity of approximately 2,900 m^3 and will be equipped with mechanical agitators.

Effluent cooling

Because the neutralized effluent has a temperature considered high for biological treatment, the effluent must be cooled to a temperature that does not affect the performance of the biological treatment.

The effluent will be cooled through a cooling tower composed of six cells, which is sized for an inlet temperature of approximately 70°C and an outlet temperature of approximately 35°C.

Activated sludge

The biological treatment system adopted at PARACEL will be the activated sludge aerobic type. The activated sludge process is a proven technology and is commonly used in the pulp and paper industries worldwide.

The biological process requires sufficient concentrations of nitrogen and phosphorus in the effluent for optimum performance. The amounts required will be related to the amount of biodegradable organic matter, i.e. BOD (Biochemical Oxygen Demand) present in the untreated effluent.

Urea and phosphoric acid are considered sources of nitrogen and phosphorus and will be added, if necessary, before the effluent enters the selector tank. The amount required will depend on the amount present in the effluent (only the minimum amounts necessary should be added, to minimize discharges).

After dosing nutrients, the effluent will be sent to the selector tank, which will have a high oxygenation capacity and is intended to eliminate filamentous organisms. From this tank, the effluents will go to the aeration tank, where they will be submitted to the degradation of the organic matter present in a soluble and colloidal form through the activity of aerobic microorganisms. The injection of air into the system will be carried out through fine bubble diffusers that will be installed in the bottom of the aeration tank. These diffusers will supply the necessary oxygen for the development of bacteria and will promote the mixing of the liquid mass contained in the aeration tank, keeping the mixture in suspension.

The aeration tank (including the selector) will have a total volume of approximately 160,000 m^3 and the diffusers will be fed by blowers with a total capacity of approximately 130,000 Nm^3/h, one of which will be reserved for maintenance.

In the activated sludge process, the biological mass (sludge) to be physically separated from the liquid mass (clarified effluent) will be formed by three two clarifiers, each one with a diameter of 82 m.

The secondary (biological) sludge will be constantly removed from the bottom of the clarifiers by scrapers and directed by gravity to a sludge pit, from where it will be pumped to the selector tank, with its recirculation. The excess biological sludge will be sent to the secondary sludge dewatering system.

Secondary sludge dewatering system

The secondary sludge dewatering system will have an estimated total capacity of 30 tDS/day and will consist of mechanical type thickeners and centrifuges. The expected final consistency of the dewatered sludge is between 15 and 20%.

Tertiary treatment

After the biological treatment, the effluent will undergo a tertiary treatment to remove phosphorus, color and COD.

The tertiary treatment will be through a physical-chemical process with the application of aluminum sulfate and polymer in coagulation and flocculation tanks and then directed to the dissolved air flotation (DAF). The flotation system has the advantage of obtaining an approximately thickened sludge, which reaches a consistency of 2.0 to 3.0%. The tertiary sludge is supported by a dedicated dewatering system.

As an alternative to the physicochemical flotation system, tertiary treatment can be carried out by injecting ozone into the effluent. The ozone will be produced on site, through electric discharge in oxygen. In this alternative, the effluent will pass through a sealed contact tank, which will be hermetically sealed, where the ozone will be introduced through fine diffusers. The off gas can be reused and injected into the biological treatment aeration tank. After passing through the contact chamber, the effluent will be sent to the biological filters to retain the suspended solids.

The treated effluent will be discharged through emissaries and diffusers into the Paraguay River. It should be noted that the point of discharge will be located above the point of raw water intake for PARACEL pulp mill .

Tertiary sludge dewatering system

The tertiary sludge from flotation, where a consistency of 2.0 to 3.0% is expected, will be sent to a homogenization tank equipped with a mechanical agitator. This tank will also receive the sludge from the decanters of the Water Treatment Plant (WTP). From the homogenization tank, the mixed sludge (tertiary + WTP) will be pumped to centrifuges, where it will reach a final consistency of about 15%. It is planned to add polymer to the centrifuge inlets to increase dewatering efficiency.

2.2.3 Characteristics of Treated Effluents

The characteristics expected for treated industrial effluents are the following:

Table 2 – Expected emissions from treated effluents

Parameters	Unit	Value	IFC Guidelines*
Flow	m^3/h	5,700	-
	m^3/t	32.3	50 m^3/Adt
pH	-	6.0 - 8.0	6.0 – 9.0
Temperature	ºC	≤ 40	-
BOD	mg/L	25	-
	kg/day	3,200	-
	kg/t	0.76	1
COD	mg/L	150	-
	kg/day	20,500	-
	kg/t	4.8	20
Suspended solids	mg/L	40	
	kg/day	5,500	

Parameters	Unit	Value	IFC Guidelines*
	kg/t	1.3	1.5
Colour	kg/day	34,200	-
	mg/L	250	-
AOX	mg/L	3	-
	kg/day	400	-
	kg/t	0.25	0.09
N_{total}	mg/L	7	-
	kg/day	960	-
	kg/t	0.2	0.2
$N_{ammoniacal}$	kg/day	300	-
	mg/L	2	-
P_{total}	mg/L	1	-
	kg/day	150	-
	kg/t	0.03	0.03

Source: Pöyry Tecnologia (2020).

*Effluent Guidelines for pulp and paper facilities – bleached kraft pulp, integrated

2.3 Effluent Final Disposal

The treated effluent will be discharged into the Paraguay River through an underwater emissary, perpendicular to the left bank of the Paraguay River. The point of discharge of the treated effluent is located at the geographical coordinates UTM 448651 m E;7427135 m S (WGS 84), as shown in the following figure.

Figure 1 – Location of effluent discharge. Source: *Google Earth* (2020).

2.4 Paraguay River

Paraguay has a very important and extensive hydrographic network throughout its territory, in fact the Paraguay River separates and limits two natural regions with very different natural and socio-economic characteristics (MADES, 2020).

The Paraguay River Basin has an area of 1,095,000 km², which covers about 35% of the entire area of the Plata Basin, which is 3,100,000 km². One third of the Paraguay River Basin corresponds to Brazil (370,000 km²), another third to Paraguay (355,000 km²) and the rest is shared between Argentina (165,000 km²) and Bolivia (205,000 km²) (CIC, 2020).

The Paraguay River rises in the Chapada de Parecís (Brazil) and, after 2,550 km, flows into the Paraná River, at the level of the city of Resistencia (Argentina) (CIC, 2020). The city of Asunción, the capital of Paraguay, is located along the main course of the river (CIC, 2017).

The Paraguay River and all surface water resources in Paraguay are classified as a Class 2 river, according to SEAM Resolution 255/2006.

Its left bank tributaries are the Aquidaban, Jejui, Aguaray and Tebicuary rivers and its right bank tributaries are the Pilcomayo and Bermejo rivers (CIC, 2017).

Figure 2 – Vision of the Paraguay River. Source: Pöyry Tecnologia (2019).

The alluvial nature of the land on the banks, the enormous volume of solid material carried by the River Bermejo and the backwaters produced by the waters of the River Paraná, which cause irregularity in its river regime and transformations in its interannual variation, are its main characteristics (CIC, 2020).

2.4.1 Flow rates and Depths

The average ($Q_{average}$) and minimum ($Q_{7,10}$) flows of the Paraguay River were calculated from the data of the Concepción Hydrological Station (latitude: -57.43 / longitude: -23.44). The flows are shown below.

- Minimum flow ($Q_{7.10}$) = 1,093 m³/s
- Average flow ($Q_{average}$) = 2,179 m³/s

From the flow data, the respective mean ($Q_{average}$) and minimum ($Q_{7,10}$) flow depths of the Paraguay River were calculated, using the key curve Q=547.43+583.57H-26.18H2 (Source: DHI - Danish Hydrographic Institute). The depths are presented below.

- Depth (H) for minimum flow ($Q_{7,10}$) = 0.98 m
- Depth (H) for average flow ($Q_{average}$) = 3.28 m

2.4.2 Water Quality

Special consideration should be given to mining activity in the upper basin of the Paraguay River in Bolivia and Brazil. There are tin deposits in the form of cassiterite and acid drainage, the result of mining activity and its environmental liabilities, which contaminate rivers and groundwater (CIC, 2017).

Downstream, in Paraguay, the greatest loads of pollutants come from agricultural activity (crops and pastures) and, mainly, from discharges of domestic and industrial effluents in areas near large urban centers such as Concepción, Asunción and Pilar (CIC, 2017).

For the EIAp/RIMA, three (3) water quality monitoring campaigns were carried out on the Paraguay River at (2) two points, one above and one below the intake and discharge points of the future pulp mill.

3 EFFLUENT DISPERSION MODEL

3.1 Mixing Zone Concept

The mixing zone is defined as the region of the receiving body extending from the effluent discharge point and bounded by the surface at which the mixing equilibrium between the physical and chemical parameters is reached, as well as the biological balance of the effluent and the receiver body, being specific to each parameter.

Inside the mixing zone, the water quality level of the receiving body is lower compared to a point upstream of the effluent discharge. In this way, the water quality standards of the receiving body are applied outside the mixing zone, not inside the mixing zone.

3.2 Cormix Model (Mixing Zone Simulation)

The Cornell Mixing Zone Expert System (Cormix) is a system of computational models developed for the analysis, forecasting and planning of the discharge of effluents into different bodies of water. It was developed through the union between the EPA and Cornell University during the period 1985-1995.

It is a powerful analysis tool in the licensing process of industrial activities regarding the discharge of effluents in the receiving bodies. Although the system places great emphasis on predicting the geometry and dilution characteristics of the initial mixing zone, in order to verify the conformity of water quality with regulatory limits, the system also predicts the behavior of the discharge over longer distances.

CORMIX is composed of three subsystems: (a) CORMIX1, used for the analysis of single port discharges; (b) CORMIX2, for the analysis of multiple multiport diffuser discharges; and (c) CORMIX3, for the analysis of buoyant surface discharges.

Although the CORMIX methodology considers stationary environmental conditions, the system represents an adequate tool for predicting both qualitative features (flow classification, etc.) and quantitative aspects (dilution rates, plume trajectories, etc.) of the processes hydrodynamic mixtures resulting from different discharge configurations and in various types of water bodies, including small streams, large rivers, lakes, reservoirs, estuaries and coastal waters.

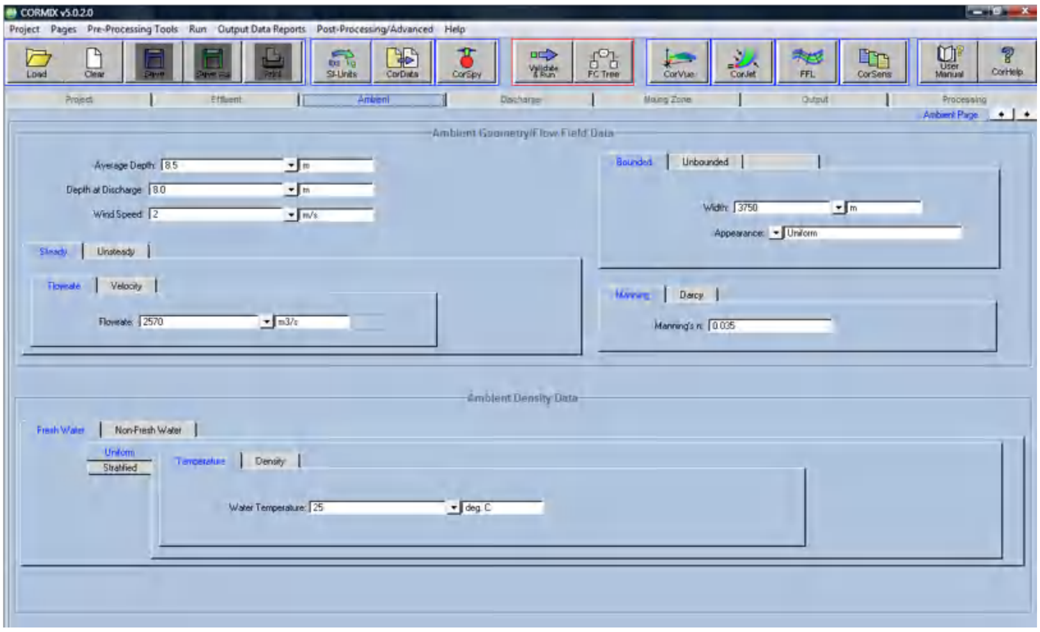

Figure 3 – Screen of CORMIX software.

3.2.1 Hydrodynamic Mixing Processes

The mixing behavior of any wastewater discharge is governed by the interaction of the ambient conditions of the receiving body and the discharge characteristics.

The modeling of the transport of an effluent plume comprises near-field and far-field modeling. The near field corresponds to the initial dilution zone, where the effects of the initial ejection velocity and the density difference between the effluent and the medium prevail. By far-field, it is understood the region where the effects of the local dynamics in the transport and dispersion of the plume predominate. In order to represent the behavior of the effluent plume, the process must be separated into modeling of the near-field and modeling of the far-field.

This report is limited to the study of near-field interactions, since the objective is to know the initial dilution zone.

3.2.2 Type of Discharge

The discharge of effluent from the Paraguay River will have the following design: 3 underwater branches (emissaries) with multipoint pens (3 diffusers each) below the surface of the water.

The emissary is intended for the launching of treated effluents in Paraguay River in a controlled and safe way through the underwater launch under conditions that prevent the formation of foams and promote dispersion in the most efficient way in the receiving body.

The complete system consists of: (a) one treated effluent well; (b) emissary of treated effluents to the margin of the Paraguay River, at the point of launch; (c) control valves; (d) emissary piping in the riverbed; (e) vertical risers with nozzles for underwater launching and dispersal in river waters.

The underwater pipelines will consist of 3 parallel lines (emissaries) of HDPE in the river bed, only 2 of which will be in operant mode and 1 will remain as a reserve. In certain locations favoring better dispersion in the river waters and homogenization of the mixture, there will be steel risers, which will conduct the treated effluent from buried pipelines approximately 50 cm above the river bed. The following figure gives an overview of the system.

At the end of each riser there will be a 90 ° turn to the horizontal. At the end of this curve, a special check valve (duckbill type) will be installed, allowing the discharge of effluent jets optimally, as well as prevent sand and foreign bodies from entering the system. The following figure shows details of the riser and check valve (duckbill type).

Figure 4 – Exemple of special check valve (duckbill type).

The treated effluent is discharged parallel to the flow of the river, remaining initially as cylindrical jets, and later as a single flat jet. The following figure illustrates this type of dilution.

For the present study, CORMIX 2 was used, which analyzes the discharges below the surface of the water, discharged by a subaquatic emissary with multiple diffusers.

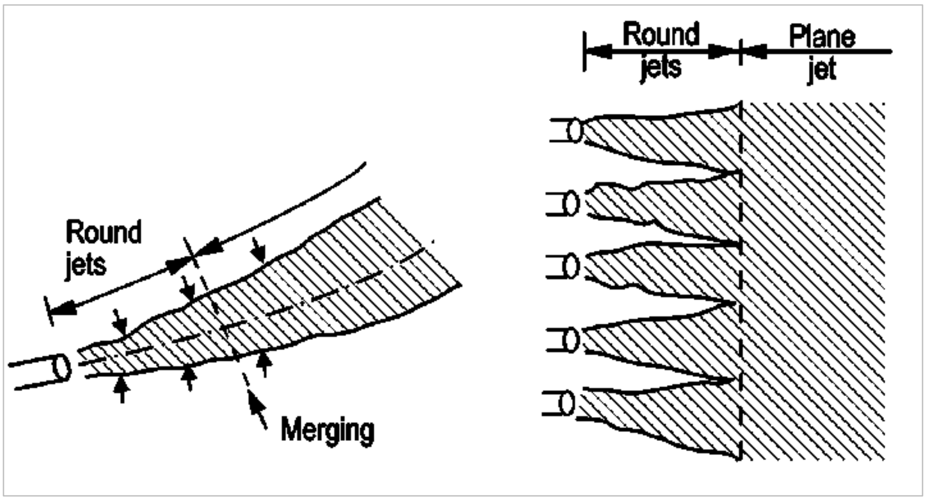

Figure 5 – Discharge of effluent by diffusers.

3.2.3 CORMIX Parameters

CORMIX allows you to work with three types of parameters:

- Conservative: the parameter does not undergo any decay process
- Non-conservative: the parameter suffers a decay of the first order
- High temperature discharge

In the present case it was adopted that the treated effluent of the mill is of the conservative type for BOD, that is, it was not considered a decay of the organic load by reaeration or biological degradation.

4 MIXING ZONE MODELING

4.1 Premises

The type of discharge of the treated effluents in the Paraguay River will be of the jet type of mixture by multiple multipoint diffuser discharges (submerged multiport diffuser discharges). Depending on the type of discharge, CORMIX 2 was used, that is, when an effluent is released through multiple multipoint discharges (diffusers).

4.2 Input Data

There are three types of input data that are required to use the CORMIX model: environmental data, effluent data, and disposal type information.

Environmental data consist of information on temperature, Manning coefficient, river depth, river flow, distance between river banks, among others.

Some physic-chemical properties of the treated effluent are included, such as: concentration of the parameters, flow rate and temperature.

The last set of input data of the model is composed of information about the type of discharge, characteristics of the diffuser, depth and discharge flow, etc.

In this study were used the data presented in the tables below.

Table 3 – Environmental data

Parameters	Unit	Value
Minimum flow ($Q_{7.10}$)	m^3/s	1,093
Average flow ($Q_{average}$)	m^3/s	2,179
Depth for minimum flow $Q_{7.10}$	m	0.98
Depth for average flow $Q_{average}$	m	3.28
River width	m	740
Water temperature	°C	29

Table 4 – Treated effluent data

Parameters	Unit	Value
Flow	m^3/h (m^3/s)	5,700 (1.58)
BOD	mg/L	25
Color	mg/L	250
Total nitrogen	mg/L	7
Total phosphorus	mg/L	1
AOX	mg/L	3
Effluent temperature	°C	38

Table 5 – Subaquatic emissary data

Parameters	Unit	Value
Type of discharge	-	CORMIX2
River bank	-	left side
Distance from river bank	m	205
Parallel lines (emissaries)	-	2 (operation) +1 (backup)
Line length	m	50

Parameters	Unit	Value
Duckbill per line (emissary)	-	10 (5 per line)
Duckbill height	m	0.20
Duckbill diameter	m	0.25

The following figure gives an overview of the underwater emissary.

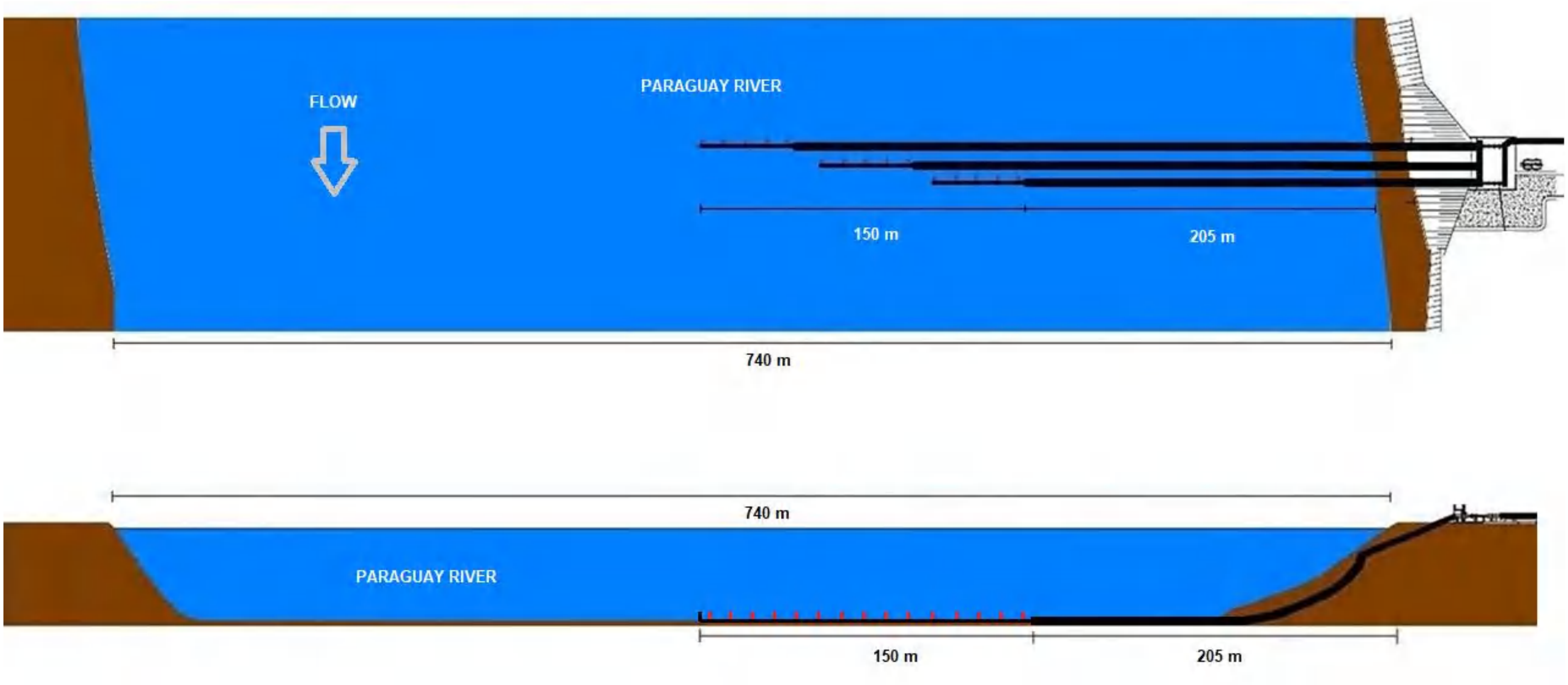

Figure 6 – River Perspectives of the underwater emissary in the Paraguay River.

The concentrations of BOD, colour, total nitrogen, total phosphorus and AOX of the effluent treated in this study are the maximum values, that is, the maximum planned for the pulp mill.

The mathematical model takes into account the BOD and the color, nitrogen, phosphorus and AOX concentrations of the Paraguay River in the initial situation as zero, that is, it does not consider the load of the river along the stretch of study, which varies according to the self-purification and the loads that the river already presents. Therefore, the model presents the results of what happens with the treated effluent from the factory and the increase it causes in this river in terms of organic load and color.

Ten scenarios were considered for this study, varying the river flow (minimum flow of 1,093 m³/s and average flow of 2,179 m³/s) and the variables studied (BOD, colour, total nitrogen, total phosphorus and AOX), as shown in the table below.

As a result, the distances at which the quality of the Paraguay River meets the standards established by SEAM Resolution 222/2002 (for class 2 rivers) for BOD and color variables were verified.

Table 6 – Scenarios evaluated in the present study

Parameter	Scenario nº	River flow (m³/s)
BOD	1	1,093 ($Q_{7,10}$)
	2	2,179 ($Q_{average}$)
Color	3	1,093 ($Q_{7,10}$)
	4	2,179 ($Q_{average}$)
Total nitrogen	5	1,093 ($Q_{7,10}$)
	6	2,179 ($Q_{average}$)
Total phosphorus	7	1,093 ($Q_{7,10}$)
	8	2,179 ($Q_{average}$)
AOX	9	1,093 ($Q_{7,10}$)
	10	2,179 ($Q_{average}$)

4.3 Results of Evaluated Scenarios

4.3.1 Scenario 1 (BOD, Minimum flow - $Q_{7,10}$)

The data used in this scenario are presented in the table below.

Table 7 – Data used in the scenario 1

Parameter	River flow	Effluent flow	BOD concentration
BOD	1,093 m³/s	1.58 m³/s	25 mg/L

The results of the simulation are presented in the figures and table below.

Figure 7 – Simulation of the BOD dispersion plume in 3 dimensions.

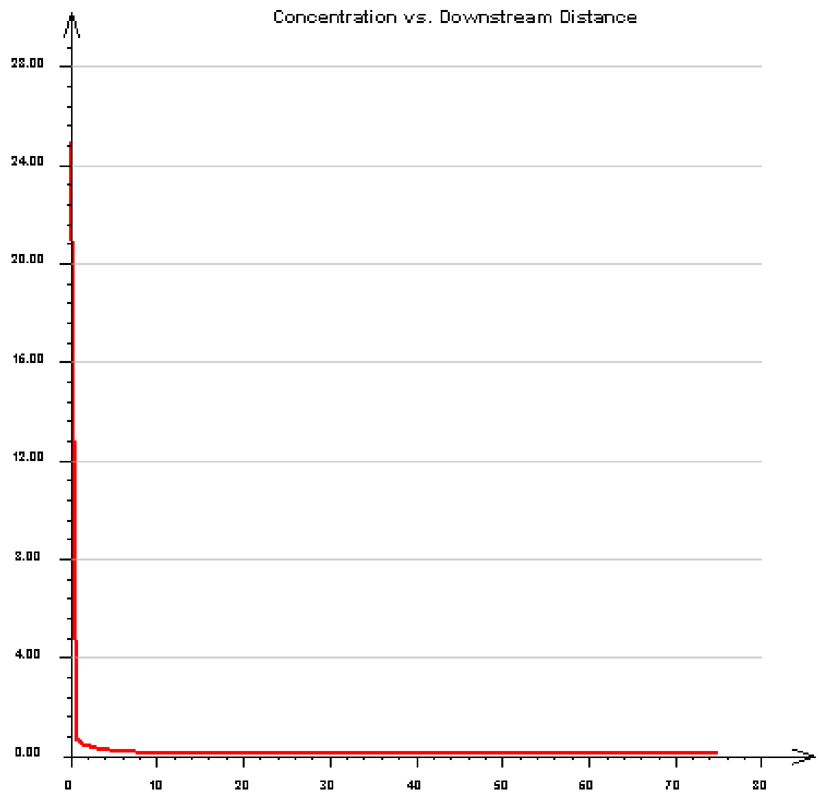

Figure 8 – Graphic of BOD concentration (mg/L) X distance (m).

Table 8 – Scenario results 1

Parameter	Quality standard[1]	Plume width to achieve the quality standard (mixing zone)[1]
BOD	5 mg/L	0.42 m

[1] Quality standard for river class 2, according to SEAM Resolution 222/2002.

4.3.2 Scenario 2 (BOD, Average flow - $Q_{average}$)

The data used in this scenario are presented in the table below.

Table 9 – Data used in this scenario

Parameter	River flow	Effluent flow	BOD concentration
BOD	2.179 m³/s	1.58 m³/s	25 mg/L

The results of the simulation are presented in the figures and table below.

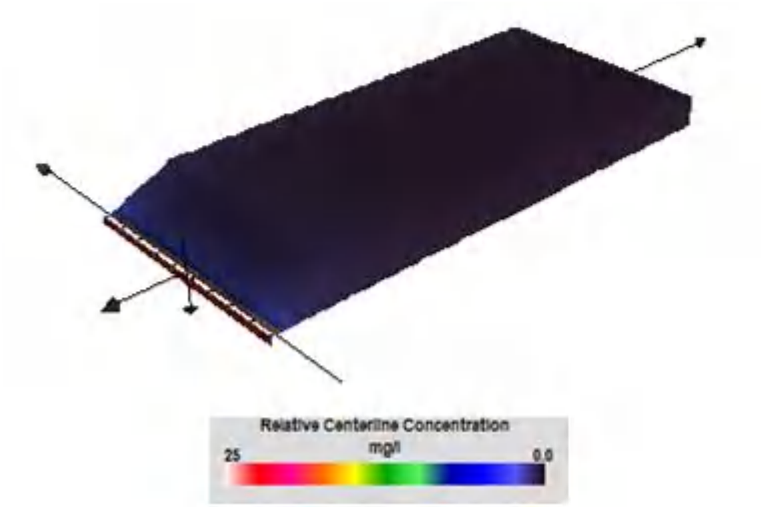

Figure 9 – Simulation of the BOD dispersion plume in 3 dimensions.

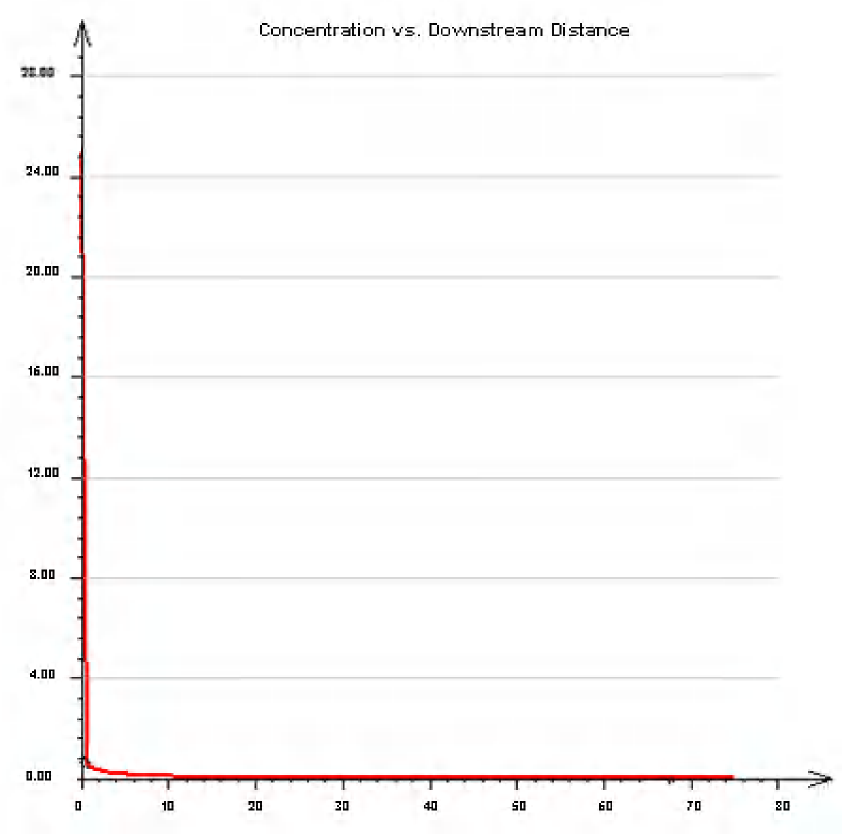

Figure 10 – Graphic of BOD concentration (mg/L) X distance (m).

Table 10 – Scenario results 2

Parameter	Quality standard [1]	Plume width to achieve the quality standard (mixing zone) [1]
BOD	5 mg/L	0.42 m

[1] Quality standard for river class 2, according to SEAM Resolution 222/2002.

4.3.3 Scenario 3 (Color, Minimum flow - $Q_{7,10}$)

The data used in this scenario are presented in the table below.

Table 11 – Data used in this scenario

Parameter	River flow	Effluent flow	Color concentration
Color	1,093 m³/s	1.58 m³/s	250 mg/L

The results of the simulation are presented in the figures and table below.

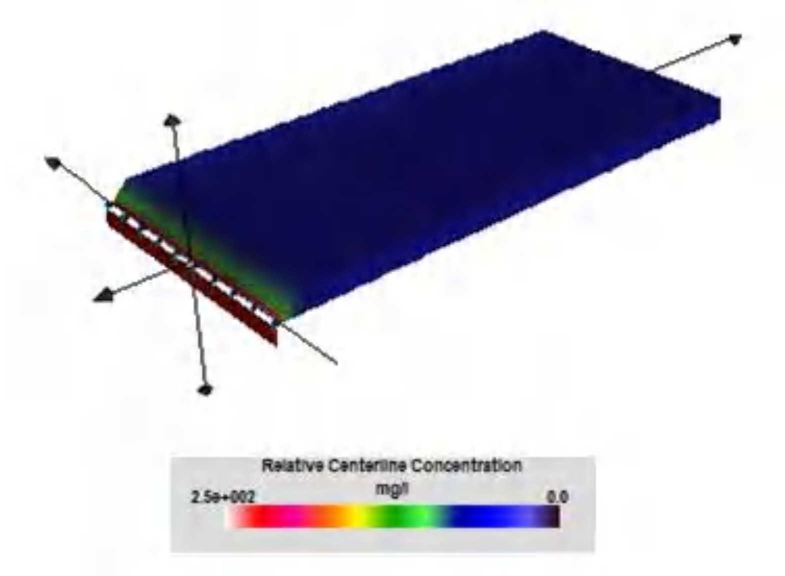

Figure 11 – Simulation of the color dispersion plume in 3 dimensions.

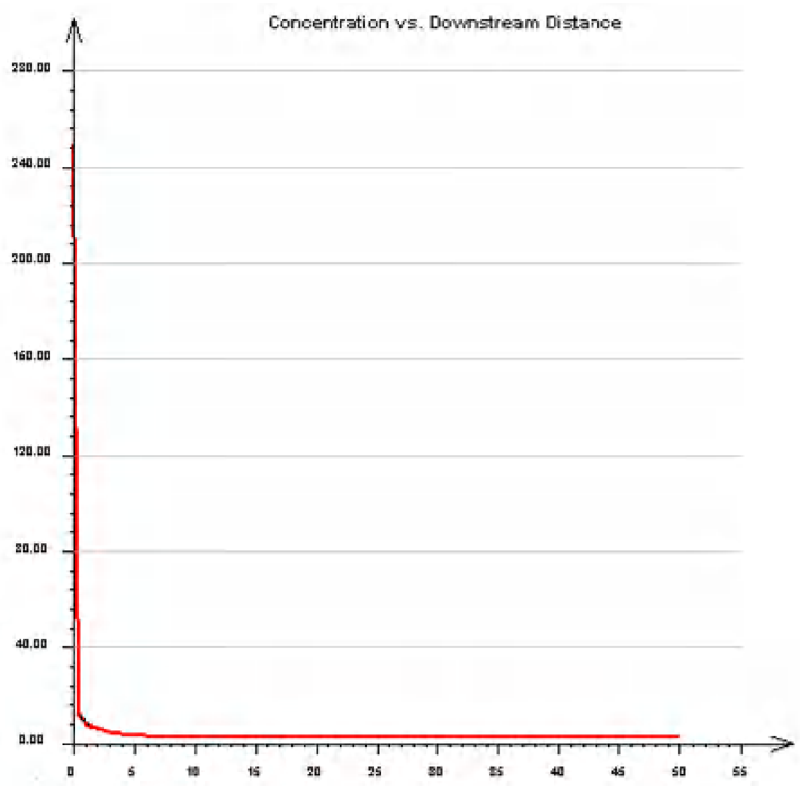

Figure 12 – Graphic of color concentration (mg/L) X distance (m).

Table 12 – Scenario results 3

Parameter	Quality standard [1]	Plume width to achieve the quality standard (mixing zone) [1]
Color	75 mg/L	0.37 m

[1] Quality standard for river class 2, according to SEAM Resolution 222/2002.

4.3.4 Scenario 4 (Color, Average flow - $Q_{average}$)

The data used in this scenario are presented in the table below.

Table 13 – Data used in this scenario

Parameter	River flow	Effluent flow	Color concentration
Color	2.179 m³/s	1.58 m³/s	250 mg/L

The results of the simulation are presented in the figures and table below.

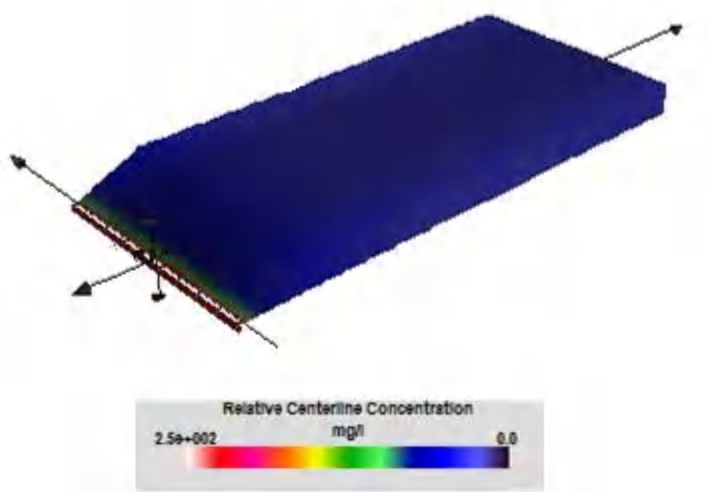

Figure 13 – Simulation of the color dispersion plume in 3 dimensions.

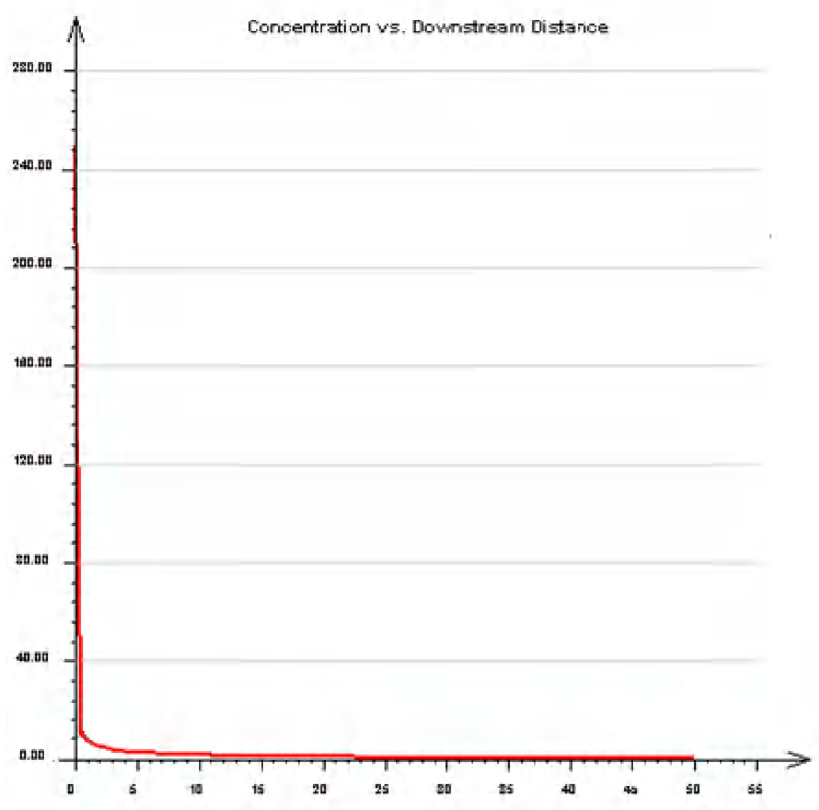

Figure 14 – Graphic of color concentration (mg/L) X distance (m).

Table 14 – Scenario results 4

Parameter	Quality standard [1]	Plume width to achieve the quality standard (mixing zone) [1]
Color	75 mg/L	0.37 m

[1] Quality standard for river class 2, according to SEAM Resolution 222/2002.

4.3.5 Scenario 5 (Total nitrogen, Minimum flow - $Q_{7,10}$)

The data used in this scenario are presented in the table below.

Table 15 – Data used in this scenario

Parameter	River flow	Effluent flow	Total nitrogen concentration
Total nitrogen	1,093 m³/s	1.58 m³/s	7 mg/L

The results of the simulation are presented in the figures and table below.

Figure 15 – Simulation of the nitrogen dispersion plume in 3 dimensions.

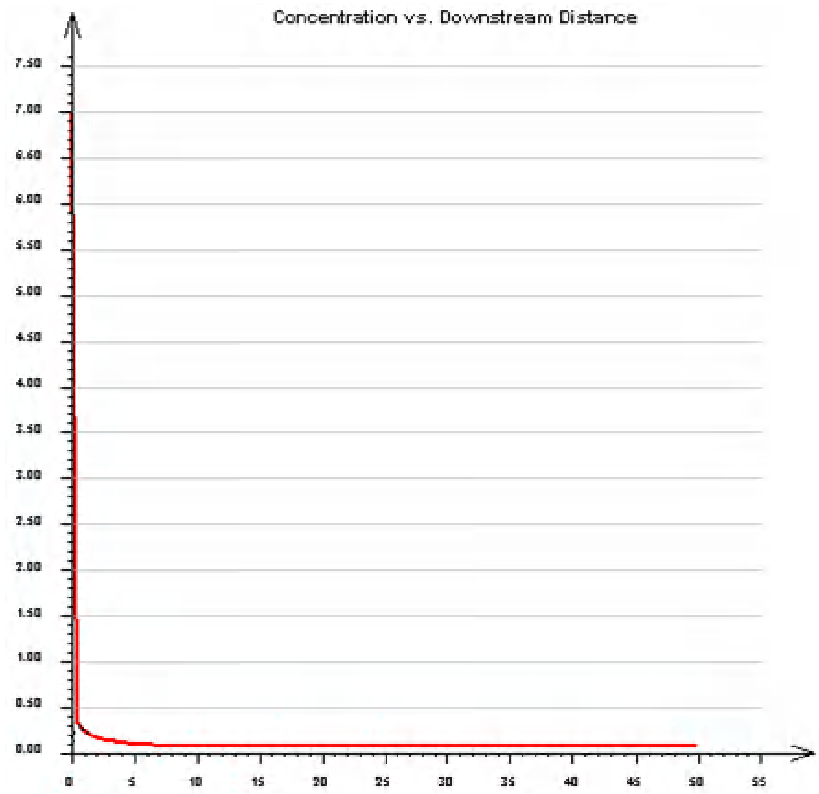

Figure 16 – Graphic of nitrogen concentration (mg/L) X distance (m).

Table 16 – Scenario results 5

Parameter	Quality standard[1]	Plume width to achieve the quality standard (mixing zone)[1]
Total nitrogen	0.6 mg/L	0.48 m

[1] Quality standard for river class 2, according to SEAM Resolution 222/2002.

4.3.6 Scenario 6 (Total nitrogen, Average flow - $Q_{average}$)

The data used in this scenario are presented in the table below.

Table 17 – Data used in this scenario

Parameter	River flow	Effluent flow	Total nitrogen concentration
Total nitrogen	2.179 m³/s	1.58 m³/s	7 mg/L

The results of the simulation are presented in the figures and table below.

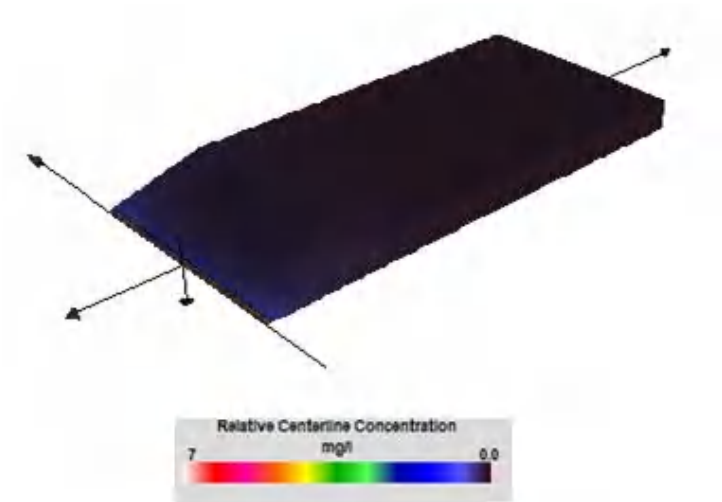

Figure 17 – Simulation of the nitrogen dispersion plume in 3 dimensions.

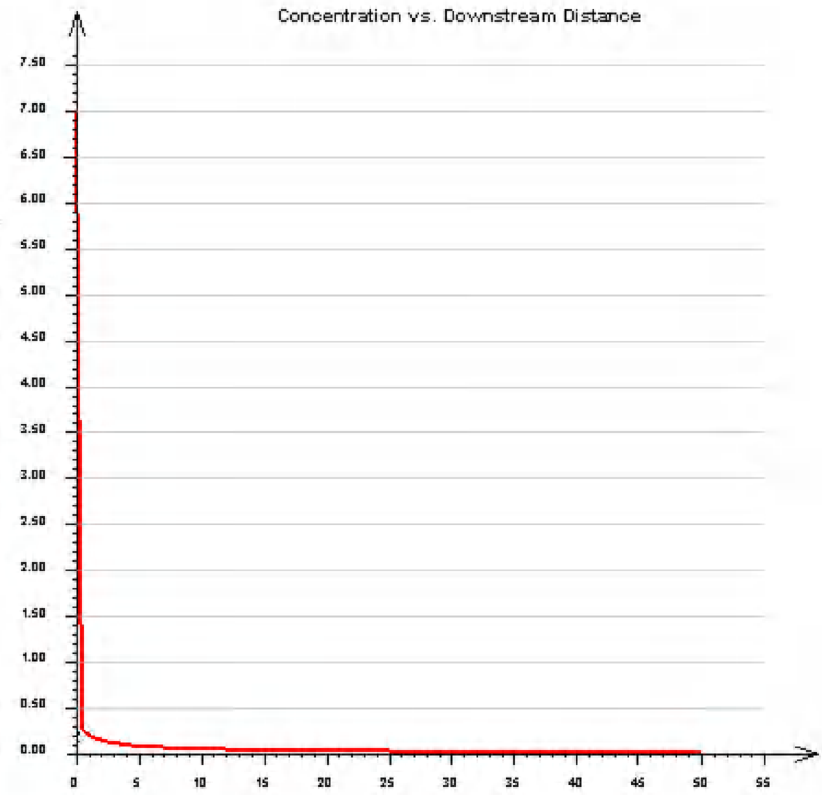

Figure 18 – Graphic of nitrogen concentration (mg/L) X distance (m).

Table 18 – Scenario results 6

Parameter	Quality standard [1]	Plume width to achieve the quality standard (mixing zone) [1]
Total nitrogen	0.6 mg/L	0.48 m

[1] Quality standard for river class 2, according to SEAM Resolution 222/2002.

4.3.7 Scenario 7 (Total phosphorus, Minimum flow - $Q_{7,10}$)

The data used in this scenario are presented in the table below.

Table 19 – Data used in this scenario

Parameter	River flow	Effluent flow	Total phosphorus concentration
Total phosphorus	1,093 m³/s	1.58 m³/s	1 mg/L

The results of the simulation are presented in the figures and table below.

Figure 19 – Simulation of the phosphorus dispersion plume in 3 dimensions.

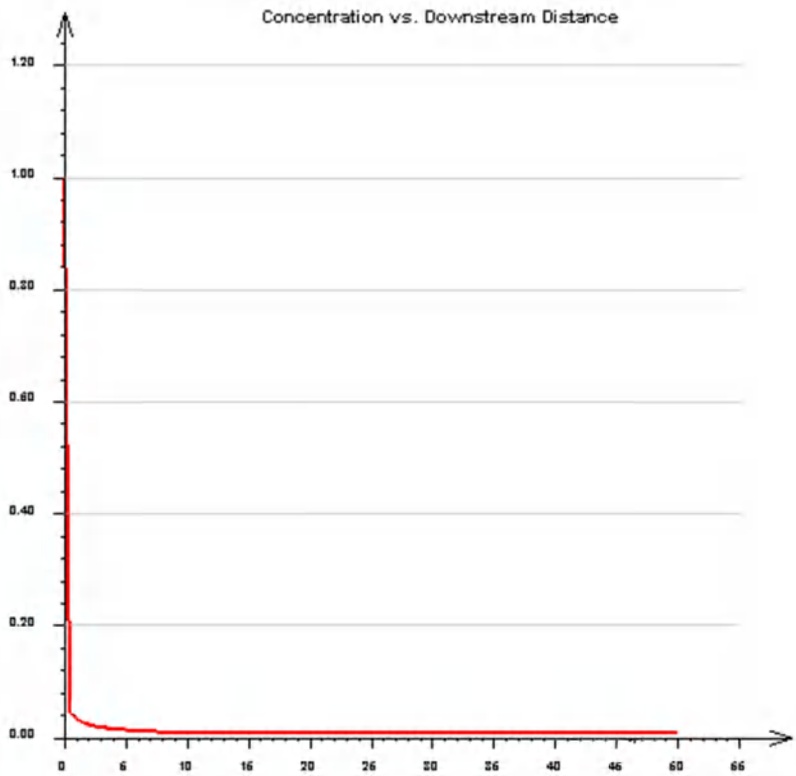

Figure 20 – Graphic of phosphorus concentration (mg/L) X distance (m).

Table 20 – Scenario results 7

Parameter	Quality standard[1]	Plume width to achieve the quality standard (mixing zone)[1]
Total phosphorus	0.05 mg/L	0.50 m

[1] Quality standard for river class 2, according to SEAM Resolution 222/2002.

4.3.8 Scenario 8 (Total phosphorus, Average flow - $Q_{average}$)

The data used in this scenario are presented in the table below.

Table 21 – Data used in this scenario

Parameter	River flow	Effluent flow	Total phosphorus concentration
Total phosphorus	2.179 m³/s	1.58 m³/s	1 mg/L

The results of the simulation are presented in the figures and table below.

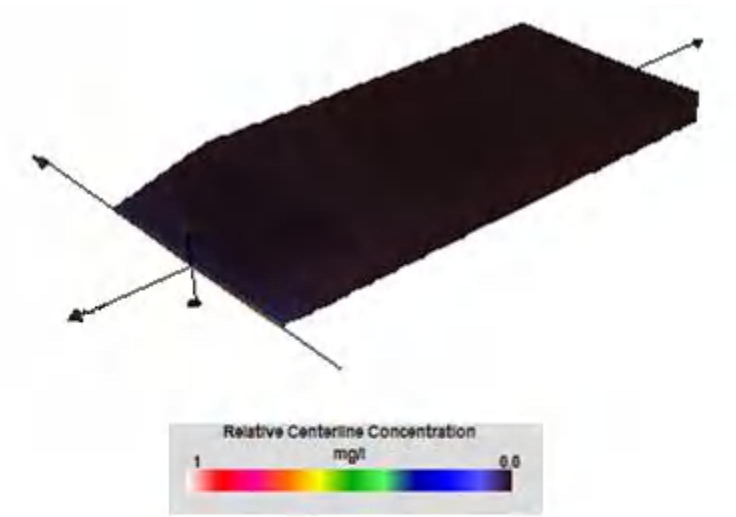

Figure 21 – Simulation of the dispersion plume in 3 dimensions.

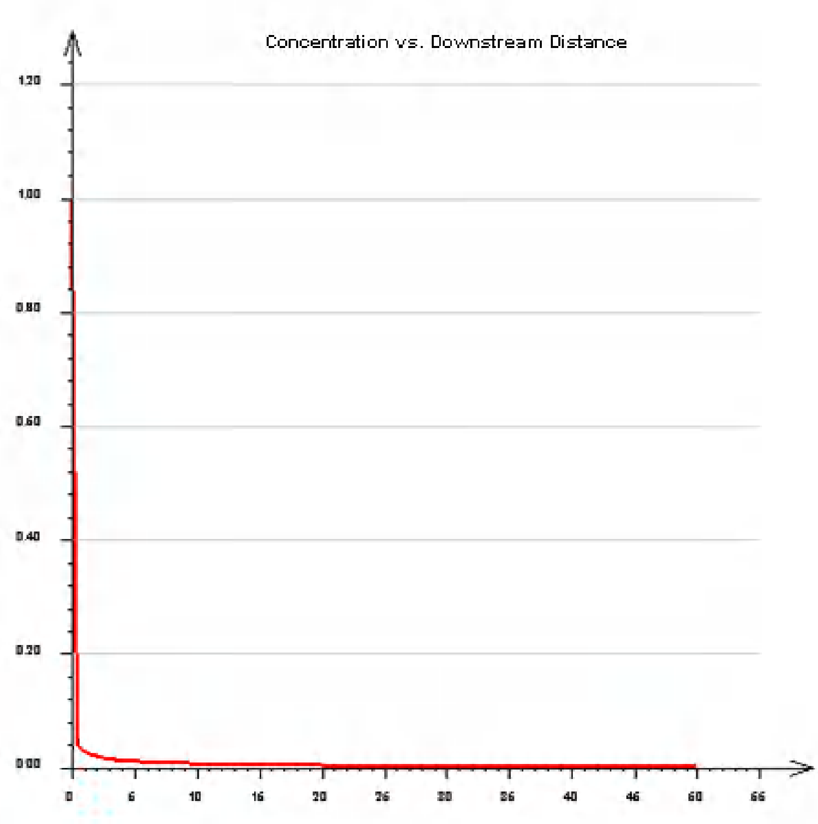

Figure 22 – Graphic of concentration (mg/L) X distance (m).

Table 22 – Scenario results 8

Parameter	Quality standard [1]	Plume width to achieve the quality standard (mixing zone) [1]
Total phosphorus	0.05 mg/L	0.50 m

[1] Quality standard for river class 2, according to SEAM Resolution 222/2002.

4.3.9 Scenario 9 (AOX, Minimum flow - $Q_{7,10}$)

The data used in this scenario are presented in the table below.

Table 23 – Data used in this scenario

Parameter	River flow	Effluent flow	AOX concentration
AOX	1,093 m³/s	1.58 m³/s	3 mg/L

The results of the simulation are presented in the figures and table below.

Figure 23 – Simulation of the AOX dispersion plume in 3 dimensions.

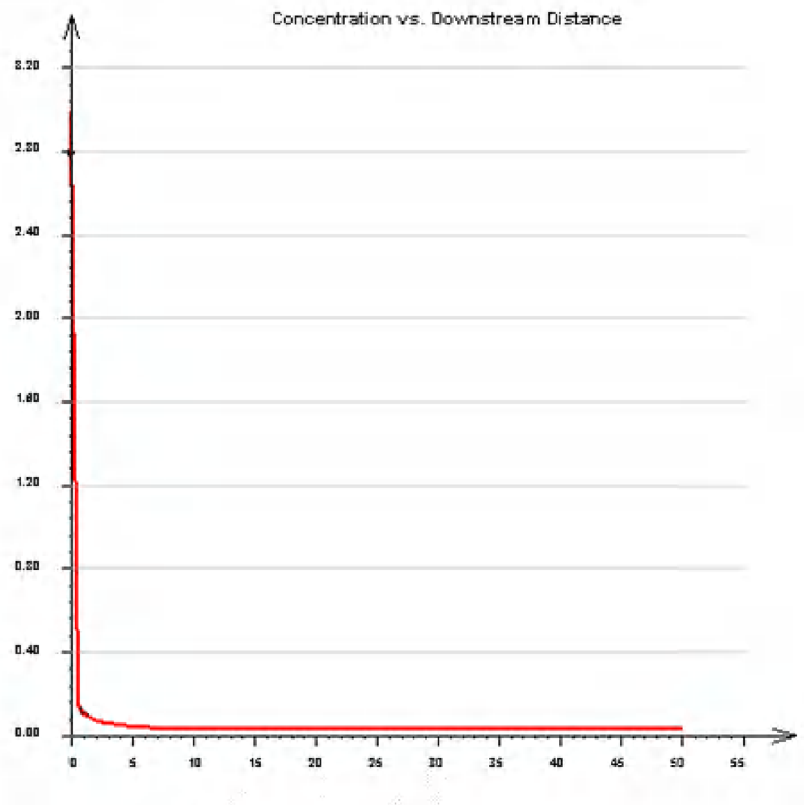

Figure 24 – Graphic of AOX concentration (mg/L) X distance (m).

Table 24 – Scenario results 9

Parameter	Quality standard[1]	Plume width to achieve the quality standard (mixing zone)[1]
AOX	0.15 mg/L	0.50 m

[1] Average AOX concentration obtained in the 3 campaigns of water quality of the Paraguay River at the point of discharge.

4.3.10 Scenario 10 (AOX, Average flow - $Q_{average}$)

The data used in this scenario are presented in the table below.

Table 25 – Data used in this scenario

Parameter	River flow	Effluent flow	AOX concentration
AOX	2.179 m³/s	1.58 m³/s	3 mg/L

The results of the simulation are presented in the figures and table below.

Figure 25 – Simulation of the AOX dispersion plume in 3 dimensions.

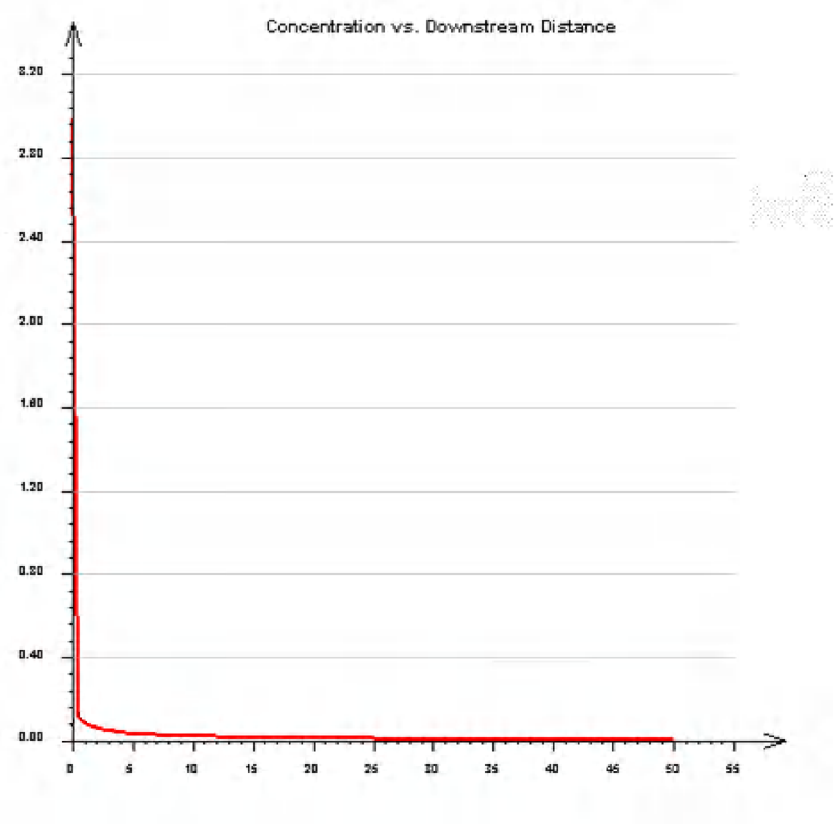

Figure 26 – Graphic of AOX concentration (mg/L) X distance (m).

Table 26 – Scenario results 10

Parameter	Quality standard [1]	Plume width to achieve the quality standard (mixing zone) [1]
AOX	0.15 mg/L	0.50 m

[1] Average AOX concentration obtained in the 3 campaigns of water quality of the Paraguay River at the point of discharge.

5 CONCLUSIONS

For the study of the mixing zone of the Paraguay River, 10 simulations were carried out, varying the flow of the river (flow $Q_{7,10}$ of 1,093 m^3/s and average flow of 2,179 m^3/s) and the parameters under study (BOD, color, nitrogen, phosphorus and AOX), in which the distances at which the quality of the Paraguay River complies with the standards established by Resolution 222/2002 (for class 2 rivers) and with the current quality of the Paraguay River in the case of AOX were verified.

Table 27 – Results of the CORMIX simulations

Parameter	Scenario	River flow (m^3/s)	Quality standard (mg/L)	Plume width to achieve the quality standard (mixing zone)
BOD	1	1,093 ($Q_{7,10}$)	5[1]	0.42 m
	2	2.179 ($Q_{average}$)		0.42 m
Color	3	1,093 ($Q_{7,10}$)	75[1]	0.37 m
	4	2.179 ($Q_{average}$)		0.37 m
Total nitrogen	5	1,093 ($Q_{7,10}$)	0.6[1]	0.48 m
	6	2.179 ($Q_{average}$)		0.48 m
Total phosphorus	7	1,093 ($Q_{7,10}$)	0.05[1]	0.50 m
	8	2.179 ($Q_{average}$)		0.50 m
AOX	9	1,093 ($Q_{7,10}$)	0.15[2]	0.50 m
	10	2.179 ($Q_{average}$)		0.50 m

[1]Quality standard for river class 2, according to SEAM Resolution 222/2002. [2]Average AOX concentration obtained in the 3 campaigns of water quality of the Paraguay River at the point of discharge.

According to the results of the simulations, it is observed that in order to comply with the quality standards established by SEAM Resolution 222/2002, with respect to the parameters of BOD, color, nitrogen and phosphorus, both under the most critical conditions (minimum flow - $Q_{7,10}$) and under average flow conditions, the distances required for the mixing zone of the effluents treated by PARACEL in the Paraguay River vary between 0.37 and 0.50 m. In the case of AOX, to reach the concentration equal to that obtained in the quality campaigns, the distances required are 0.50 m.

In general, due to the results obtained, the dispersion of treated effluents from PARACEL in the Paraguay River is rapid and occurs very close to the point of discharge of the effluents. Because of this, the simulation for the far field was not performed. However, it is important to note that the mathematical model does not consider the Paraguay River's BOD, color, nitrogen, phosphorus, and AOX concentrations. However, according to the simulation the distance at which the near field variables cease to prevail, i.e. the distance from the near field is 50 m.

It should be noted that the mill's water collection point will be located downstream of the effluent discharge point. This reinforces PARACEL's commitment to environmental issues and demonstrates the commitment and security that PARACEL must have with respect to the factory's future effluent treatment system in order to maintain the water quality standard of the Paraguay River.

In addition, it is important to emphasize that the discharge of effluent from PARACEL's factory will not cause a cumulative impact on the waters of the Paraguay River, due to the existence of few industrial discharges into the river and high flow rates.

6 REFERENCES

CIC – COMITÉ INTERGUBERNAMENTAL COORDINADOR DE LOS PAÍSES DE LA CUENCA DEL PLATA. 2020. Available in: <https://cicplata.org/es/>.

CIC – COMITÉ INTERGUBERNAMENTAL COORDINADOR DE LOS PAÍSES DE LA CUENCA DEL PLATA. Análisis Diagnóstico Transfronterizo de la Cuenca del Plata-ADT. – 1ª ed. - Ciudad Autónoma de Buenos Aires : Comité Intergubernamental Coordinador de los Países de la Cuenca del Plata - CIC ; Estados Unidos : Organización de los Estados Americanos - OEA, 2017. Available in: <https://cicplata.org/wp-content/uploads/2017/09/analisis_diagnostico_transfronterizo_de_la_cuenca_del_plata.pdf>.

DONEKER, R. L.; JIRKA, G. H. Cormix User Manual - A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters. Washington D. C: MixZon Inc, 2007.

MADES – MINISTERIO DEL AMBIENTE Y DESARROLLO SOSTENIBLE, 2020. Available in: <http://www.mades.gov.py/areas-tematicas/recursos-hidricos/>.

SEAM. Resolution No. 222/2002 – By which the standard of quality of the waters in the national territory is established.

SEAM. Resolution No. 255/2006 – Classification of All Waters of Paraguay in Class 2.

ANNEX I
CORMIX SIMULATIONS

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0   September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  DBO
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Sample Files\Sample2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/05/2020--17:51:17
******************************************************************************
SUMMARY OF INPUT DATA:
------------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                                = bounded
  Width                             BS         = 740 m
  Channel regularity                ICHREG = 1
  Ambient flowrate                  QA         = 1093 m^3/s
  Average depth                     HA         = 0.98 m
  Depth at discharge                HD         = 0.78 m
  Ambient velocity                  UA         = 1.5072 m/s
  Darcy-Weisbach friction factor    F          = 0.0711
    Calculated from Manning's n                = 0.03
  Wind velocity                     UW         = 2 m/s
  Stratification Type               STRCND = U
  Surface temperature                          = 29 degC
  Bottom temperature                           = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                   RHOAS  = 995.9449 kg/m^3
  Bottom density                    RHOAB  = 995.9449 kg/m^3
------------------------------------------------------------------------------
DISCHARGE PARAMETERS:               Submerged Multiport Diffuser Discharge
  Diffuser type                     DITYPE = unidirectional perpendicular
  Diffuser length                   LD         = 100 m
  Nearest bank                                 = left
  Diffuser endpoints                YB1        = 205 m;     YB2 = 305 m
  Number of openings                NOPEN  = 10
  Number of Risers                  NRISER = 10
  Ports/Nozzles per Riser           NPPERR  = 1
  Spacing between risers/openings SPAC     = 11.11 m
  Port/Nozzle diameter              D0         = 0.1936 m
    with contraction ratio                     = 0.6
  Equivalent slot width             B0         = 0.0029 m
  Total area of openings            TA0        = 0.2945 m^2
  Discharge velocity                U0         = 5.36 m/s
  Total discharge flowrate          Q0         = 1.58 m^3/s
  Discharge port height             H0         = 0.2 m
  Nozzle arrangement                BETYPE = unidirectional without fanning
  Diffuser alignment angle          GAMMA      = 90 deg
  Vertical discharge angle          THETA      = 0 deg
  Actual Vertical discharge angle THEAC        = 0 deg
  Horizontal discharge angle        SIGMA      = 0 deg
  Relative orientation angle        BETA       = 90 deg
  Discharge temperature (freshwater)           = 38 degC
  Corresponding density             RHO0       = 992.9612 kg/m^3
  Density difference                DRHO       = 2.9837 kg/m^3
  Buoyant acceleration              GP0        = 0.0294 m/s^2
  Discharge concentration           C0         = 25 mg/l
  Surface heat exchange coeff.      KS         = 0 m/s
  Coefficient of decay              KD         = 0 /s
-------------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)           q0         = 0.0158 m^2/s
```

```
  Discharge (volume flux)          q0       = 0.0158 m^2/s
  Momentum flux                    m0       = 0.084760 m^3/s^2
  Buoyancy flux                    j0       = 0.000464 m^3/s^3
--------------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m          Lm  = 0.04 m          LM  = 14.10 m
  lm' = 99999 m          Lb' = 99999 m          La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
--------------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number                FR0     = 576.71
  Port/nozzle Froude number        FRD0    = 71.12
  Velocity ratio                   R       = 3.56
--------------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                          = no
  Water quality standard specified         = yes
  Water quality standard           CSTD    = 5 mg/l
  Regulatory mixing zone                   = no
  Region of interest                       = 10000 m downstream
*********************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = MU2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 0.78 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 692.8

*********************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

---------------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
---------------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.3283 mg/l
  Dilution at edge of NFR              s = 76.1
  NFR Location:                        x = 50 m
    (centerline coordinates)           y = 0 m
                                       z = 0.78 m
  NFR plume dimensions:  half-width (bh) = 48.89 m
                          thickness (bv) = 0.78 m
Cumulative travel time:       31.6932 sec.
---------------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-------------------------------------------------------------------------------- -
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field
```

```
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                      = 5  mg/l
  Corresponding dilution                    s = 17.0
  Plume location:                           x = 0.42 m
    (centerline coordinates)                y = 0 m
                                            z = 0.22 m
  Plume dimensions:       half-width (bh) = 49.97 m
                           thickness (bv) = 0.09 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0  September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  DBO
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Sample Files\Sample2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/05/2020--17:48:46
***************************************************************************
SUMMARY OF INPUT DATA:
---------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                                = bounded
  Width                               BS       = 740 m
  Channel regularity                  ICHREG = 1
  Ambient flowrate                    QA       = 2179 m^3/s
  Average depth                       HA       = 3.28 m
  Depth at discharge                  HD       = 3.08 m
  Ambient velocity                    UA       = 0.8977 m/s
  Darcy-Weisbach friction factor      F        = 0.0475
    Calculated from Manning's n                = 0.03
  Wind velocity                       UW       = 2 m/s
  Stratification Type                 STRCND = U
  Surface temperature                          = 29 degC
  Bottom temperature                           = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                     RHOAS  = 995.9449 kg/m^3
  Bottom density                      RHOAB  = 995.9449 kg/m^3
---------------------------------------------------------------------------
DISCHARGE PARAMETERS:                 Submerged Multiport Diffuser Discharge
  Diffuser type                       DITYPE = unidirectional perpendicular
  Diffuser length                     LD       = 100 m
  Nearest bank                                 = left
  Diffuser endpoints                  YB1      = 205 m;    YB2 = 305 m
  Number of openings                  NOPEN  = 10
  Number of Risers                    NRISER = 10
  Ports/Nozzles per Riser             NPPERR  = 1
  Spacing between risers/openings SPAC        = 11.11 m
  Port/Nozzle diameter                D0       = 0.1936 m
    with contraction ratio                      = 0.6
  Equivalent slot width               B0       = 0.0029 m
  Total area of openings              TA0      = 0.2945 m^2
  Discharge velocity                  U0       = 5.36 m/s
  Total discharge flowrate            Q0       = 1.58 m^3/s
  Discharge port height               H0       = 0.2 m
  Nozzle arrangement                  BETYPE = unidirectional without fanning
  Diffuser alignment angle            GAMMA  = 90 deg
  Vertical discharge angle            THETA  = 0 deg
  Actual Vertical discharge angle THEAC  = 0 deg
  Horizontal discharge angle          SIGMA  = 0 deg
  Relative orientation angle          BETA   = 90 deg
  Discharge temperature (freshwater)         = 38 degC
  Corresponding density               RHO0   = 992.9612 kg/m^3
  Density difference                  DRHO   = 2.9837 kg/m^3
  Buoyant acceleration                GP0    = 0.0294 m/s^2
  Discharge concentration             C0     = 25 mg/l
  Surface heat exchange coeff.        KS     = 0 m/s
  Coefficient of decay                KD     = 0 /s
---------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)             q0     = 0.0158 m^2/s
```

```
  Momentum flux                   m0      = 0.084760 m^3/s^2
  Buoyancy flux                   j0      = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m          Lm  = 0.11 m          LM  = 14.10 m
  lm' = 99999 m          Lb' = 99999 m          La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0     = 576.71
  Port/nozzle Froude number       FRD0    = 71.12
  Velocity ratio                  R       = 5.98
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = no
  Water quality standard specified        = yes
  Water quality standard          CSTD    = 5 mg/l
  Regulatory mixing zone                  = no
  Region of interest                      = 10000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = MU2  |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 3.08 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 1380.1

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.1405 mg/l
  Dilution at edge of NFR              s = 177.9
  NFR Location:                        x = 50 m
    (centerline coordinates)           y = 0 m
                                       z = 3.08 m
  NFR plume dimensions:  half-width (bh) = 49.19 m
                          thickness (bv) = 3.08 m
Cumulative travel time:       53.8857 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
```

```
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                      = 5   mg/l
  Corresponding dilution                    s = 19.8
  Plume location:                           x = 0.42 m
    (centerline coordinates)                y = 0 m
                                            z = 0.24 m
  Plume dimensions:       half-width (bh) = 49.98 m
                           thickness (bv) = 0.09 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0   September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  COR
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Sample Files\Sample2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/05/2020--17:41:58
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = bounded
  Width                         BS         = 740 m
  Channel regularity            ICHREG     = 1
  Ambient flowrate              QA         = 1093 m^3/s
  Average depth                 HA         = 0.98 m
  Depth at discharge            HD         = 0.78 m
  Ambient velocity              UA         = 1.5072 m/s
  Darcy-Weisbach friction factor F         = 0.0711
    Calculated from Manning's n            = 0.03
  Wind velocity                 UW         = 2 m/s
  Stratification Type           STRCND     = U
  Surface temperature                      = 29 degC
  Bottom temperature                       = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density               RHOAS      = 995.9449 kg/m^3
  Bottom density                RHOAB      = 995.9449 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Submerged Multiport Diffuser Discharge
  Diffuser type                 DITYPE     = unidirectional perpendicular
  Diffuser length               LD         = 100 m
  Nearest bank                             = left
  Diffuser endpoints            YB1        = 205 m;     YB2 = 305 m
  Number of openings            NOPEN      = 10
  Number of Risers              NRISER     = 10
  Ports/Nozzles per Riser       NPPERR      = 1
  Spacing between risers/openings SPAC     = 11.11 m
  Port/Nozzle diameter          D0         = 0.1936 m
    with contraction ratio                 = 0.6
  Equivalent slot width         B0         = 0.0029 m
  Total area of openings        TA0        = 0.2945 m^2
  Discharge velocity            U0         = 5.36 m/s
  Total discharge flowrate      Q0         = 1.58 m^3/s
  Discharge port height         H0         = 0.2 m
  Nozzle arrangement            BETYPE     = unidirectional without fanning
  Diffuser alignment angle      GAMMA      = 90 deg
  Vertical discharge angle      THETA      = 0 deg
  Actual Vertical discharge angle THEAC    = 0 deg
  Horizontal discharge angle    SIGMA      = 0 deg
  Relative orientation angle    BETA       = 90 deg
  Discharge temperature (freshwater)       = 38 degC
  Corresponding density         RHO0       = 992.9612 kg/m^3
  Density difference            DRHO       = 2.9837 kg/m^3
  Buoyant acceleration          GP0        = 0.0294 m/s^2
  Discharge concentration       C0         = 250 mg/l
  Surface heat exchange coeff.  KS         = 0 m/s
  Coefficient of decay          KD         = 0 /s
-----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)       q0         = 0.0158 m^2/s
```

```
  Discharge (volume flux)         q0      = 0.0158 m^2/s
  Momentum flux                   m0      = 0.084760 m^3/s^2
  Buoyancy flux                   j0      = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m          Lm  = 0.04 m          LM  = 14.10 m
  lm' = 99999 m          Lb' = 99999 m          La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number              FR0     = 576.71
  Port/nozzle Froude number       FRD0    = 71.12
  Velocity ratio                  R       = 3.56
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = no
  Water quality standard specified        = yes
  Water quality standard          CSTD    = 75 mg/l
  Regulatory mixing zone                  = no
  Region of interest                      = 10000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS     = MU2  |
  *-------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 0.78 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 692.8

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge   c = 3.2833 mg/l
  Dilution at edge of NFR               s = 76.1
  NFR Location:                         x = 50 m
    (centerline coordinates)            y = 0 m
                                        z = 0.78 m
  NFR plume dimensions:  half-width (bh) = 48.89 m
                          thickness (bv) = 0.78 m
Cumulative travel time:        31.6932 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
```

```
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                  = 75  mg/l
  Corresponding dilution                s = 15.0
  Plume location:                       x = 0.37 m
    (centerline coordinates)            y = 0 m
                                        z = 0.22 m
  Plume dimensions:      half-width (bh) = 49.98 m
                          thickness (bv) = 0.08 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0  September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  COR
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Sample Files\Sample2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/05/2020--17:45:59
****************************************************************************
SUMMARY OF INPUT DATA:
----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                               = bounded
  Width                              BS       = 740 m
  Channel regularity                 ICHREG = 1
  Ambient flowrate                   QA       = 2179 m^3/s
  Average depth                      HA       = 3.28 m
  Depth at discharge                 HD       = 3.08 m
  Ambient velocity                   UA       = 0.8977 m/s
  Darcy-Weisbach friction factor     F        = 0.0475
    Calculated from Manning's n               = 0.03
  Wind velocity                      UW       = 2 m/s
  Stratification Type                STRCND = U
  Surface temperature                         = 29 degC
  Bottom temperature                          = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                    RHOAS  = 995.9449 kg/m^3
  Bottom density                     RHOAB  = 995.9449 kg/m^3
----------------------------------------------------------------------------
DISCHARGE PARAMETERS:                Submerged Multiport Diffuser Discharge
  Diffuser type                      DITYPE = unidirectional perpendicular
  Diffuser length                    LD       = 100 m
  Nearest bank                                = left
  Diffuser endpoints                 YB1      = 205 m;     YB2 = 305 m
  Number of openings                 NOPEN  = 10
  Number of Risers                   NRISER = 10
  Ports/Nozzles per Riser            NPPERR  = 1
  Spacing between risers/openings SPAC    = 11.11 m
  Port/Nozzle diameter               D0       = 0.1936 m
    with contraction ratio                    = 0.6
  Equivalent slot width              B0       = 0.0029 m
  Total area of openings             TA0      = 0.2945 m^2
  Discharge velocity                 U0       = 5.36 m/s
  Total discharge flowrate           Q0       = 1.58 m^3/s
  Discharge port height              H0       = 0.2 m
  Nozzle arrangement                 BETYPE = unidirectional without fanning
  Diffuser alignment angle           GAMMA    = 90 deg
  Vertical discharge angle           THETA    = 0 deg
  Actual Vertical discharge angle THEAC    = 0 deg
  Horizontal discharge angle         SIGMA    = 0 deg
  Relative orientation angle         BETA     = 90 deg
  Discharge temperature (freshwater)          = 38 degC
  Corresponding density              RHO0     = 992.9612 kg/m^3
  Density difference                 DRHO     = 2.9837 kg/m^3
  Buoyant acceleration               GP0      = 0.0294 m/s^2
  Discharge concentration            C0       = 250 mg/l
  Surface heat exchange coeff.       KS       = 0 m/s
  Coefficient of decay               KD       = 0 /s
----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)            q0       = 0.0158 m^2/s
```

```
  Momentum flux                       m0      = 0.084760 m^3/s^2
  Buoyancy flux                       j0      = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ   = 0.00 m          Lm  = 0.11 m          LM  = 14.10 m
  lm' = 99999 m          Lb' = 99999 m          La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number                  FR0     = 576.71
  Port/nozzle Froude number           FRD0    = 71.12
  Velocity ratio                      R       = 5.98
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                             = no
  Water quality standard specified            = yes
  Water quality standard              CSTD    = 75 mg/l
  Regulatory mixing zone                      = no
  Region of interest                          = 10000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = MU2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 3.08 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 1380.1

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 1.405 mg/l
  Dilution at edge of NFR              s = 177.9
  NFR Location:                        x = 50 m
    (centerline coordinates)           y = 0 m
                                       z = 3.08 m
  NFR plume dimensions:  half-width (bh) = 49.19 m
                          thickness (bv) = 3.08 m
Cumulative travel time:       53.8857 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
```

```
------------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
------------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                  = 75   mg/l
  Corresponding dilution                s = 17.5
  Plume location:                       x = 0.37 m
    (centerline coordinates)            y = 0 m
                                        z = 0.23 m
  Plume dimensions:      half-width (bh) = 49.98 m
                          thickness (bv) = 0.08 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0  September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  Nitrogeno total
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Sample Files\Sample2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/21/2020--15:36:09
******************************************************************************
SUMMARY OF INPUT DATA:
------------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                          = bounded
  Width                         BS       = 740 m
  Channel regularity            ICHREG = 1
  Ambient flowrate              QA       = 1093 m^3/s
  Average depth                 HA       = 0.98 m
  Depth at discharge            HD       = 0.78 m
  Ambient velocity              UA       = 1.5072 m/s
  Darcy-Weisbach friction factor F       = 0.0711
    Calculated from Manning's n          = 0.03
  Wind velocity                 UW       = 2 m/s
  Stratification Type           STRCND = U
  Surface temperature                    = 29 degC
  Bottom temperature                     = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density               RHOAS  = 995.9449 kg/m^3
  Bottom density                RHOAB  = 995.9449 kg/m^3
------------------------------------------------------------------------------
DISCHARGE PARAMETERS:           Submerged Multiport Diffuser Discharge
  Diffuser type                 DITYPE = unidirectional perpendicular
  Diffuser length               LD       = 100 m
  Nearest bank                           = left
  Diffuser endpoints            YB1      = 205 m;    YB2 = 305 m
  Number of openings            NOPEN  = 10
  Number of Risers              NRISER = 10
  Ports/Nozzles per Riser       NPPERR  = 1
  Spacing between risers/openings SPAC   = 11.11 m
  Port/Nozzle diameter          D0       = 0.1936 m
    with contraction ratio               = 0.6
  Equivalent slot width         B0       = 0.0029 m
  Total area of openings        TA0      = 0.2945 m^2
  Discharge velocity            U0       = 5.36 m/s
  Total discharge flowrate      Q0       = 1.58 m^3/s
  Discharge port height         H0       = 0.2 m
  Nozzle arrangement            BETYPE = unidirectional without fanning
  Diffuser alignment angle      GAMMA  = 90 deg
  Vertical discharge angle      THETA  = 0 deg
  Actual Vertical discharge angle THEAC  = 0 deg
  Horizontal discharge angle    SIGMA  = 0 deg
  Relative orientation angle    BETA   = 90 deg
  Discharge temperature (freshwater)   = 38 degC
  Corresponding density         RHO0   = 992.9612 kg/m^3
  Density difference            DRHO   = 2.9837 kg/m^3
  Buoyant acceleration          GP0    = 0.0294 m/s^2
  Discharge concentration       C0     = 7 mg/l
  Surface heat exchange coeff.  KS     = 0 m/s
  Coefficient of decay          KD     = 0 /s
------------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)       q0     = 0.0158 m^2/s
```

```
  Discharge (volume flux)          q0      = 0.0158 m^2/s
  Momentum flux                    m0      = 0.084760 m^3/s^2
  Buoyancy flux                    j0      = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m         Lm  = 0.04 m         LM  = 14.10 m
  lm' = 99999 m         Lb' = 99999 m         La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number                FR0     = 576.71
  Port/nozzle Froude number       FRD0    = 71.12
  Velocity ratio                  R       = 3.56
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                         = no
  Water quality standard specified        = yes
  Water quality standard          CSTD    = 0.6 mg/l
  Regulatory mixing zone                  = no
  Region of interest                      = 10000 m downstream
******************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = MU2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 0.78 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 692.8

******************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

------------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
------------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.0919 mg/l
  Dilution at edge of NFR              s = 76.1
  NFR Location:                        x = 50 m
    (centerline coordinates)           y = 0 m
                                       z = 0.78 m
  NFR plume dimensions:  half-width (bh) = 48.89 m
                          thickness (bv) = 0.78 m
Cumulative travel time:       31.6932 sec.
------------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
------------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
```

```
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 0.6  mg/l
  Corresponding dilution               s = 19.3
  Plume location:                      x = 0.48 m
    (centerline coordinates)           y = 0 m
                                       z = 0.22 m
  Plume dimensions:      half-width (bh) = 49.97 m
                          thickness (bv) = 0.10 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0  September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  Nitrogeno total
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Sample Files\Sample2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/21/2020--15:54:43
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = bounded
  Width                           BS       = 740 m
  Channel regularity              ICHREG = 1
  Ambient flowrate                QA       = 2179 m^3/s
  Average depth                   HA       = 3.28 m
  Depth at discharge              HD       = 3.08 m
  Ambient velocity                UA       = 0.8977 m/s
  Darcy-Weisbach friction factor  F        = 0.0475
    Calculated from Manning's n            = 0.03
  Wind velocity                   UW       = 2 m/s
  Stratification Type             STRCND = U
  Surface temperature                      = 29 degC
  Bottom temperature                       = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                 RHOAS  = 995.9449 kg/m^3
  Bottom density                  RHOAB  = 995.9449 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Submerged Multiport Diffuser Discharge
  Diffuser type                   DITYPE = unidirectional perpendicular
  Diffuser length                 LD       = 100 m
  Nearest bank                             = left
  Diffuser endpoints              YB1      = 205 m;     YB2 = 305 m
  Number of openings              NOPEN  = 10
  Number of Risers                NRISER = 10
  Ports/Nozzles per Riser         NPPERR  = 1
  Spacing between risers/openings SPAC   = 11.11 m
  Port/Nozzle diameter            D0       = 0.1936 m
    with contraction ratio                  = 0.6
  Equivalent slot width           B0       = 0.0029 m
  Total area of openings          TA0      = 0.2945 m^2
  Discharge velocity              U0       = 5.36 m/s
  Total discharge flowrate        Q0       = 1.58 m^3/s
  Discharge port height           H0       = 0.2 m
  Nozzle arrangement              BETYPE = unidirectional without fanning
  Diffuser alignment angle        GAMMA  = 90 deg
  Vertical discharge angle        THETA  = 0 deg
  Actual Vertical discharge angle THEAC  = 0 deg
  Horizontal discharge angle      SIGMA  = 0 deg
  Relative orientation angle      BETA   = 90 deg
  Discharge temperature (freshwater)      = 38 degC
  Corresponding density           RHO0   = 992.9612 kg/m^3
  Density difference              DRHO   = 2.9837 kg/m^3
  Buoyant acceleration            GP0    = 0.0294 m/s^2
  Discharge concentration         C0     = 7 mg/l
  Surface heat exchange coeff.    KS     = 0 m/s
  Coefficient of decay            KD     = 0 /s
-----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0     = 0.0158 m^2/s
```

```
  Discharge (voIume fIux)          q0      = 0.0158 m^2/s
  Momentum fIux                    m0      = 0.084760 m^3/s^2
  Buoyancy fIux                    j0      = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m          Lm  = 0.11 m          LM  = 14.10 m
  Im' = 99999 m         Lb' = 99999 m         La  = 99999 m
  (These refer to the actuaI discharge/enviroument Iength scaIes.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
SIot Froude number              FR0     = 576.71
  Port/nozzIe Froude number       FRD0    = 71.12
  VeIocity ratio                  R       = 5.98
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                          = no
  Water quaIity standard specified         = yes
  Water quaIity standard          CSTD     = 0.6 mg/I
  ReguIatory mixing zone                   = no
  Region of interest                       = 10000 m downstream
****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = MU2 |
  *------------------------*
  This fIow configuration appIies to a Iayer corresponding to the fuII water
  depth at the discharge site.
  AppIicabIe Iayer depth = water depth = 3.08 m

  Limiting DiIution S = (QA/Q0)+ 1.0 = 1380.1

****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and reguIatory summary):

----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is Iocated at the BOTTOM beIow the port/diffuser center:
    255 m from the Ieft bank/shore.
  Number of dispIay steps NSTEP = 100 per moduIe.
----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initiaI mixing.  It has no reguIatory
  impIication.  However, this information may be usefuI for the discharge
  desiguer because the mixing in the NFR is usuaIIy sensitive to the
  discharge desigu conditions.
  PoIIutant concentration at NFR edge   c = 0.0393 mg/I
  DiIution at edge of NFR               s = 177.9
  NFR Location:                         x = 50 m
    (centerIine coordinates)            y = 0 m
                                        z = 3.08 m
  NFR pIume dimensions:  haIf-width (bh) = 49.19 m
                          thickness (bv) = 3.08 m
CumuIative traveI time:        53.8857 sec.
----------------------------------------------------------------------------
Buoyancy assessment:
  The effIuent density is Iess than the surrounding ampient water
  density at the discharge IeveI.
  Therefore, the effIuent is POSITIVELY BUOYANT and wiII tend to rise towards
  the surface.
----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
```

```
  in the near field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 0.6  mg/l
  Corresponding dilution               s = 22.5
  Plume location:                      x = 0.48 m
    (centerline coordinates)           y = 0 m
                                       z = 0.24 m
  Plume dimensions:      half-width (bh) = 49.98 m
                          thickness (bv) = 0.10 m
```

```
CORM1X SESS1ON REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                     CORMIX MIXING ZONE EXPERT SYSTEM
                         CORMIX Version 9.0E
                   HYDRO2:Version-9.0.0.0  September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  Fosforo total
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Samble Files\Samble2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/21/2020--16:36:41
***************************************************************************
SUMMARY OF INPUT DATA:
---------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = bounded
  Width                           BS       = 740 m
  Channel regularity              ICHREG = 1
  Ambient flowrate                QA       = 1093 m^3/s
  Average depth                   HA       = 0.98 m
  Depth at discharge              HD       = 0.78 m
  Ambient velocity                UA       = 1.5072 m/s
  Darcy-Weisbach friction factor  F        = 0.0711
    Calculated from Manning's n            = 0.03
  Wind velocity                   UW       = 2 m/s
  Stratification Type             STRCND = U
  Surface temperature                      = 29 degC
  Bottom temperature                       = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                 RHOAS  = 995.9449 kg/m^3
  Bottom density                  RHOAB  = 995.9449 kg/m^3
---------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Submerged Multiport Diffuser Discharge
  Diffuser type                   DITYPE = unidirectional perpendicular
  Diffuser length                 LD       = 100 m
  Nearest bank                             = left
  Diffuser endpoints              YB1      = 205 m;    YB2 = 305 m
  Number of openings              NOPEN  = 10
  Number of Risers                NRISER = 10
  Ports/Nozzles per Riser         NPPERR  = 1
  Spacing between risers/openings SPAC   = 11.11 m
  Port/Nozzle diameter            DO       = 0.1936 m
    with contraction ratio                 = 0.6
  Equivalent slot width           BO       = 0.0029 m
  Total area of openings          TAO      = 0.2945 m^2
  Discharge velocity              UO       = 5.36 m/s
  Total discharge flowrate        QO       = 1.58 m^3/s
  Discharge port height           HO       = 0.2 m
  Nozzle arrangement              BETYPE = unidirectional without fanning
  Diffuser alignment angle        GAMMA  = 90 deg
  Vertical discharge angle        THETA  = 0 deg
  Actual Vertical discharge angle THEAC  = 0 deg
  Horizontal discharge angle      SIGMA  = 0 deg
  Relative orientation angle      BETA   = 90 deg
  Discharge temperature (freshwater)       = 38 degC
  Corresponding density           RHOO   = 992.9612 kg/m^3
  Density difference              DRMO   = 2.9837 kg/m^3
  Buoyant acceleration            GPO    = 0.0294 m/s^2
  Discharge concentration         CO     = 1 mg/l
  Surface heat exchange coeff.    KS     = 0 m/s
  Coefficient of decay            KD     = 0 /s
---------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0     = 0.0158 m^2/s
```

```
  Momentum flux                    m0     = 0.084760 m^3/s^2
  Buoyancy flux                    j0     = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m          Lm  = 0.04 m         LM  = 14.10 m
  lm' = 99999 m          Lb' = 99999 m         La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number                FR0    = 576.71
  Port/nozzle Froude number        FRD0   = 71.12
  Velocity ratio                   R      = 3.56
-----------------------------------------------------------------------------
HYDRODYNAMIC CLASSIFICATION:
  *-------------------------*
  | FLOW CLASS    = MU2 |
  *-------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 0.78 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 692.8

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.0131 mg/l
  Dilution at edge of NFR              s = 76.1
  NFR Location:                        x = 50 m
    (centerline coordinates)           y = 0 m
                                       z = 0.78 m
  NFR plume dimensions:  half-width (bh) = 48.89 m
                          thickness (bv) = 0.78 m
Cumulative travel time:       31.6932 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
```

```
   Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY ***********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
   plume position:
   Water quality standard                    = 0.05  mg/l
   Corresponding dilution                  s = 20.0
   Plume location:                         x = 0.5 m
      (centerline coordinates)             y = 0 m
                                           z = 0.22 m
   Plume dimensions:      half-width (bh) = 49.97 m
                           thickness (bv) = 0.10 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0  September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  Fosforo total
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Samble Files\Samble2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/21/2020--16:14:52
******************************************************************************
SUMMARY OF INPUT DATA:
------------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = bounded
  Width                           BS       = 740 m
  Channel regularity              ICHREG   = 1
  Ambient flowrate                QA       = 2179 m^3/s
  Average depth                   HA       = 3.28 m
  Depth at discharge              HD       = 3.08 m
  Ambient velocity                UA       = 0.8977 m/s
  Darcy-Weisbach friction factor  F        = 0.0475
    Calculated from Manning's n            = 0.03
  Wind velocity                   UW       = 2 m/s
  Stratification Type             STRCND   = U
  Surface temperature                      = 29 degC
  Bottom temperature                       = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                 RHOAS    = 995.9449 kg/m^3
  Bottom density                  RHOAB    = 995.9449 kg/m^3
------------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Submerged Multiport Diffuser Discharge
  Diffuser type                   DITYPE   = unidirectional perpendicular
  Diffuser length                 LD       = 100 m
  Nearest bank                             = left
  Diffuser endpoints              YB1      = 205 m;    YB2 = 305 m
  Number of openings              NOPEN    = 10
  Number of Risers                NRISER   = 10
  Ports/Nozzles per Riser         NPPERR    = 1
  Spacing between risers/openings SPAC     = 11.11 m
  Port/Nozzle diameter            D0       = 0.1936 m
    with contraction ratio                 = 0.6
  Equivalent slot width           B0       = 0.0029 m
  Total area of openings          TA0      = 0.2945 m^2
  Discharge velocity              U0       = 5.36 m/s
  Total discharge flowrate        Q0       = 1.58 m^3/s
  Discharge port height           H0       = 0.2 m
  Nozzle arrangement              BETYPE   = unidirectional without fanning
  Diffuser alignment angle        GAMMA    = 90 deg
  Vertical discharge angle        THETA    = 0 deg
  Actual Vertical discharge angle THEAC    = 0 deg
  Horizontal discharge angle      SIGMA    = 0 deg
  Relative orientation angle      BETA     = 90 deg
  Discharge temperature (freshwater)       = 38 degC
  Corresponding density           RHO0     = 992.9612 kg/m^3
  Density difference              DRHO     = 2.9837 kg/m^3
  Buoyant acceleration            GP0      = 0.0294 m/s^2
  Discharge concentration         C0       = 1 mg/l
  Surface heat exchange coeff.    KS       = 0 m/s
  Coefficient of decay            KD       = 0 /s
------------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0       = 0.0158 m^2/s
```

```
  Discharge (volume flux)           q0      = 0.0138 m^2/s
  Momentum flux                     m0      = 0.084760 m^3/s^2
  Buoyancy flux                     j0      = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m          Lm  = 0.11 m          LM  = 14.10 m
  lm' = 99999 m          Lb' = 99999 m          La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number                FR0     = 576.71
  Port/nozzle Froude number         FRD0    = 71.12
  Velocity ratio                    R       = 5.98
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                           = no
  Water quality standard specified          = yes
  Water quality standard            CSTD    = 0.05 mg/l
  Regulatory mixing zone                    = no
  Region of interest                        = 10000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = MU2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 3.08 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 1380.1

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.0056 mg/l
  Dilution at edge of NFR              s = 177.9
  NFR Location:                        x = 50 m
    (centerline coordinates)           y = 0 m
                                       z = 3.08 m
  NFR plume dimensions:  half-width (bh) = 49.19 m
                          thickness (bv) = 3.08 m
Cumulative travel time:        53.8857 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
```

```
  in the near-field.
  There may be benthic impact of high pollutant concentrations.
----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                 = 0.05  mg/l
  Corresponding dilution               s = 23.4
  Plume location:                      x = 0.50 m
    (centerline coordinates)           y = 0 m
                                       z = 0.24 m
  Plume dimensions:      half-width (bh) = 49.98 m
                          thickness (bv) = 0.10 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0  September,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  AOX
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Samble Files\Samble2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/21/2020--18:21:50
*****************************************************************************
SUMMARY OF INPUT DATA:
-----------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                             = bounded
  Width                           BS        = 740 m
  Channel regularity              ICHREG = 1
  Ambient flowrate                QA        = 1093 m^3/s
  Average depth                   HA        = 0.98 m
  Depth at discharge              HD        = 0.78 m
  Ambient velocity                UA        = 1.5072 m/s
  Darcy-Weisbach friction factor  F         = 0.0711
    Calculated from Manning's n             = 0.03
  Wind velocity                   UW        = 2 m/s
  Stratification Type             STRCND = U
  Surface temperature                       = 29 degC
  Bottom temperature                        = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                 RHOAS  = 995.9449 kg/m^3
  Bottom density                  RHOAB  = 995.9449 kg/m^3
-----------------------------------------------------------------------------
DISCHARGE PARAMETERS:             Submerged Multiport Diffuser Discharge
  Diffuser type                   DITYPE = unidirectional perpendicular
  Diffuser length                 LD        = 100 m
  Nearest bank                              = left
  Diffuser endpoints              YB1       = 205 m;    YB2 = 305 m
  Number of openings              NOPEN  = 10
  Number of Risers                NRISER = 10
  Ports/Nozzles per Riser         NPPERR  = 1
  Spacing between risers/openings SPAC   = 11.11 m
  Port/Nozzle diameter            D0        = 0.1936 m
    with contraction ratio                  = 0.6
  Equivalent slot width           B0        = 0.0029 m
  Total area of openings          TA0       = 0.2945 m^2
  Discharge velocity              U0        = 5.36 m/s
  Total discharge flowrate        Q0        = 1.58 m^3/s
  Discharge port height           H0        = 0.2 m
  Nozzle arrangement              BETYPE = unidirectional without fanning
  Diffuser alignment angle        GAMMA  = 90 deg
  Vertical discharge angle        THETA  = 0 deg
  Actual Vertical discharge angle THEAC  = 0 deg
  Horizontal discharge angle      SIGMA  = 0 deg
  Relative orientation angle      BETA   = 90 deg
  Discharge temperature (freshwater)       = 38 degC
  Corresponding density           RHO0   = 992.9612 kg/m^3
  Density difference              DRHO   = 2.9837 kg/m^3
  Buoyant acceleration            GP0    = 0.0294 m/s^2
  Discharge concentration         C0        = 3 mg/l
  Surface heat exchange coeff.    KS        = 0 m/s
  Coefficient of decay            KD        = 0 /s
-----------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)         q0        = 0.0158 m^2/s
```

```
  Discharge (volume flux)          q0       = 0.0158 m^2/s
  Momentum flux                    m0       = 0.084760 m^3/s^2
  Buoyancy flux                    j0       = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ   = 0.00 m         Lm   = 0.04 m         LM   = 14.10 m
  lm' = 99999 m         Lb' = 99999 m          La   = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number                FR0      = 576.71
  Port/nozzle Froude number        FRD0     = 71.12
  Velocity ratio                   R        = 3.56
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                           = no
  Water quality standard specified          = yes
  Water quality standard           CSTD     = 0.15 mg/l
  Regulatory mixing zone                    = no
  Region of interest                        = 10000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS    = MU2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 0.78 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 692.8

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.0394 mg/l
  Dilution at edge of NFR              s = 76.1
  NFR Location:                        x = 50 m
    (centerline coordinates)           y = 0 m
                                       z = 0.78 m
  NFR plume dimensions:  half-width (bh) = 48.89 m
                          thickness (bv) = 0.78 m
Cumulative travel time:       31.6932 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
```

```
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                  = 0.15  mg/l
  Corresponding dilution                s = 20.0
  Plume location:                       x = 0.5 m
    (centerline coordinates)            y = 0 m
                                        z = 0.22 m
  Plume dimensions:      half-width (bh) = 49.97 m
                          thickness (bv) = 0.10 m
```

```
CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
                      CORMIX MIXING ZONE EXPERT SYSTEM
                          CORMIX Version 9.0E
                       HYDRO2:Version-9.0.0.0  Septamber,2014
SITE NAME/LABEL:                PARACEL
  DESIGN CASE:                  AOX
  FILE NAME:                    C:\Program Files\CORMIX 9.0\Samble Files\Samble2
  Using subsystem CORMIX2:     Multiport Diffuser Discharges
  Start of session:             05/21/2020--18:33:56
********************************************************************************
SUMMARY OF INPUT DATA:
--------------------------------------------------------------------------------
AMBIENT PARAMETERS:
  Cross-section                            = bounded
  Width                             BS     = 740 m
  Channel regularity                ICHREG = 1
  Ambient flowrate                  QA     = 2179 m^3/s
  Average depth                     HA     = 3.28 m
  Depth at discharge                HD     = 3.08 m
  Ambient velocity                  UA     = 0.8977 m/s
  Darcy-Weisbach friction factor    F      = 0.0475
    Calculated from Manning's n            = 0.03
  Wind velocity                     UW     = 2 m/s
  Stratification Type               STRCND = U
  Surface temperature                      = 29 degC
  Bottom temperature                       = 29 degC
  Calculated FRESH-WATER DENSITY values:
  Surface density                   RHOAS  = 995.9449 kg/m^3
  Bottom density                    RHOAB  = 995.9449 kg/m^3
--------------------------------------------------------------------------------
DISCHARGE PARAMETERS:               Submerged Multiport Diffuser Discharge
  Diffuser type                     DITYPE = unidirectional perpendicular
  Diffuser length                   LD     = 100 m
  Nearest bank                             = left
  Diffuser endpoints                YB1    = 205 m;    YB2 = 305 m
  Number of openings                NOPEN  = 10
  Number of Risers                  NRISER = 10
  Ports/Nozzles per Riser           NPPERR  = 1
  Spacing between risers/openings   SPAC   = 11.11 m
  Port/Nozzle diameter              D0     = 0.1936 m
    with contraction ratio                 = 0.6
  Equivalent slot width             B0     = 0.0029 m
  Total area of openings            TA0    = 0.2945 m^2
  Discharge velocity                U0     = 5.36 m/s
  Total discharge flowrate          Q0     = 1.58 m^3/s
  Discharge port height             H0     = 0.2 m
  Nozzle arrangement                BETYPE = unidirectional without fanning
  Diffuser alignment angle          GAMMA  = 90 deg
  Vertical discharge angle          THETA  = 0 deg
  Actual Vertical discharge angle   THEAC  = 0 deg
  Horizontal discharge angle        SIGMA  = 0 deg
  Relative orientation angle        BETA   = 90 deg
  Discharge temperature (freshwater)       = 38 degC
  Corresponding density             RHO0   = 992.9612 kg/m^3
  Density difference                DRHO   = 2.9837 kg/m^3
  Buoyant acceleration              GP0    = 0.0294 m/s^2
  Discharge concentration           C0     = 3 mg/l
  Surface heat exchange coeff.      KS     = 0 m/s
  Coefficient of decay              KD     = 0 /s
--------------------------------------------------------------------------------
FLUX VARIABLES PER UNIT DIFFUSER LENGTH:
  Discharge (volume flux)           q0     = 0.0158 m^2/s
```

```
  Discharge (volume flux)            q0     = 0.01[illegible] m^2/s
  Momentum flux                      m0     = 0.084760 m^3/s^2
  Buoyancy flux                      j0     = 0.000464 m^3/s^3
-----------------------------------------------------------------------------
DISCHARGE/ENVIRONMENT LENGTH SCALES:
  LQ  = 0.00 m         Lm  = 0.11 m         LM  = 14.10 m
  lm' = 99999 m         Lb' = 99999 m         La  = 99999 m
  (These refer to the actual discharge/environment length scales.)
-----------------------------------------------------------------------------
NON-DIMENSIONAL PARAMETERS:
Slot Froude number                FR0    = 576.71
  Port/nozzle Froude number        FRD0   = 71.12
  Velocity ratio                   R      = 5.98
-----------------------------------------------------------------------------
MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:
  Toxic discharge                           = no
  Water quality standard specified          = yes
  Water quality standard           CSTD     = 0.15 mg/l
  Regulatory mixing zone                    = no
  Region of interest                        = 10000 m downstream
*****************************************************************************
HYDRODYNAMIC CLASSIFICATION:
  *------------------------*
  | FLOW CLASS   = MU2 |
  *------------------------*
  This flow configuration applies to a layer corresponding to the full water
  depth at the discharge site.
  Applicable layer depth = water depth = 3.08 m

  Limiting Dilution S = (QA/Q0)+ 1.0 = 1380.1

*****************************************************************************
MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

-----------------------------------------------------------------------------
X-Y-Z Coordinate system:
  Origin is located at the BOTTOM below the port/diffuser center:
    255 m from the left bank/shore.
  Number of display steps NSTEP = 100 per module.
-----------------------------------------------------------------------------
NEAR-FIELD REGION (NFR) CONDITIONS :
Note: The NFR is the zone of strong initial mixing.  It has no regulatory
  implication.  However, this information may be useful for the discharge
  designer because the mixing in the NFR is usually sensitive to the
  discharge design conditions.
  Pollutant concentration at NFR edge  c = 0.0169 mg/l
  Dilution at edge of NFR              s = 177.9
  NFR Location:                        x = 50 m
    (centerline coordinates)           y = 0 m
                                       z = 3.08 m
  NFR plume dimensions:  half-width (bh) = 49.19 m
                          thickness (bv) = 3.08 m
Cumulative travel time:        53.8857 sec.
-----------------------------------------------------------------------------
Buoyancy assessment:
  The effluent density is less than the surrounding ambient water
  density at the discharge level.
  Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards
  the surface.
-----------------------------------------------------------------------------
Near-field instability behavior:
  The diffuser flow will experience instabilities with full vertical mixing
  in the near-field.
```

```
  There may be benthic impact of high pollutant concentrations.
-----------------------------------------------------------------------------
FAR-FIELD MIXING SUMMARY:
  Plume becomes vertically fully mixed ALREADY IN NEAR-FIELD at 50 m
  downstream and continues as vertically mixed into the far-field.
-----------------------------------------------------------------------------
PLUME BANK CONTACT SUMMARY:
  Plume in bounded section does not contact bank.
************************ TOXIC DILUTION ZONE SUMMARY ************************
No TDZ was specified for this simulation.
********************** REGULATORY MIXING ZONE SUMMARY **********************
No RMZ has been specified.
However:
The ambient water quality standard was encountered at the following
  plume position:
  Water quality standard                  = 0.15  mg/l
  Corresponding dilution                s = 23.4
  Plume location:                       x = 0.50 m
    (centerline coordinates)            y = 0 m
                                        z = 0.24 m
  Plume dimensions:       half-width (bh) = 49.98 m
                           thickness (bv) = 0.10 m
```

ANNEX III
PRELIMINARY RISK ANALYSIS STUDY

Pöyry Tecnologia Ltda.
Av. Alfredo Egídio de Souza Aranha, 100
Bloco B - 5º Andar
04726-170 - São Paulo-SP
Tel. (11) 3472 6955
Fax (11) 3472 6980
E-mail: contato.br@poyry.com
www.poyry.com.br

ENVIROMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

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Página 1

PARACEL

Pulp Mill, Port, Transmission Line and Electrical Substation in Concepción – Paraguay

VOLUME IV - COMPLEMENTARY STUDIES
Preliminary Risk Analysis Study

Content

Content	1	INTRODUCTION
	2	PROJECT AND REGION Characterization
	3	PHYSICOCHEMICAL AND TOXICOLOGICAL CHARACTERISTICS OF PRODUCTS
	4	RISK IDENTIFICATION
	5	CONCLUSIONS
	6	BIBLIOGRAPHIC REFERENCES
Attachments	I	Process flow diagram
	II	Mill project layout
	III	Material Safety Data Sheet (MSDS)
	IV	Preliminary Hazard Analysis Sheet (APP)

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SUMMARY

1 INTRODUCTION....5
1.1 General....5
1.2 Methodology....5
1.3 Project and Region Characterization....7
1.4 Physicochemical Characteristics of the Implicated Products....7
1.5 Identifying Hazards and Consolidating Accidental Scenarios....7
2 PROJECT AND REGION Characterization....7
2.1 Project History....7
2.2 Project Information....8
2.3 Location....9
2.4 Brief Description of the Productive Process....10
2.5 Environmental Control....30
2.5.1 Liquid Effluent....30
2.5.2 Rainwater drainage....38
2.5.3 Atmospheric Emissions....38
2.5.4 Solid Waste....40
2.6 Weather and Meteorological Characteristics....52
3 PHYSICOCHEMICAL AND TOXICOLOGICAL CHARACTERISTICS OF PRODUCTS....68
4 RISK IDENTIFICATION....69
4.1 Introduction....69
4.2 Historical Accident Analysis....69
4.3 Preliminary Risk Analysis....71
4.3.1 Methodology....71
4.3.2 Hazard Identification....75
5 CONCLUSIONS....77
6 BIBLIOGRAPHIC REFERENCES....77

FIGURE LIST

Figure 1 – Stages of the Preliminary Analysis Study elaboration....6
Figure 2 – PARACEL mil location. Source: Google Earth, 2020.....9
Figure 3 – Eucalyptus forest, with separation of bark in the field....11
Figure 4 – Discharge of eucalyptus logs into the wood yard.....11
Figure 5 – Wood chip pile....12
Figure 6 – Cooking....13
Figure 7 – Bleaching....14
Figure 8 – Drying....15
Figure 9 – Evaporation Plant....16
Figure 10 – Lime Kilns....18
Figure 11 – Chemical Plant....18
Figure 12 – Example of surface water collection.....23
Figure 13 – Cooling towers....25
Figure 14 – Aeration tanks....35
Figure 15 – Illustration of the discharge system....37
Figure 16 – Effluents emissary pipeline....37
Figure 17 – Flowchart of compost production....46
Figure 18 – Flowchart of acidity corrector production.....49
Figure 19 – Map of the location of the weather stations distant from the project. Source: Google Earth, 2020.....53
Figure 20 – Climate Classification of Köppen (1971-2010). Source: Pasten et al. (2011)....54
Figure 21 – Average monthly atmospheric pressure at the Puerto Casado station....55
Figure 22 – Average monthly atmospheric pressure at the Pozo Colorado station.....55
Figure 23 – Average monthly air pressure at San Pedro station....56
Figure 24 – Average monthly atmospheric pressure at the Teniente Coronel Carmelo Peralta station....56
Figure 25 – Average monthly temperature at Puerto Casado station.....57
Figure 26 – Average monthly temperature at Pozo Colorado station....57
Figure 27 – Average monthly temperature at San Pedro station....57
Figure 28 – Average monthly temperature at station Teniente Coronel Carmelo Peralta....58
Figure 29 – Average monthly relative humidity at Puerto Casado station....58
Figure 30 – Average monthly relative humidity at station Pozo Colorado....59
Figure 31 – Average monthly relative humidity at San Pedro station.....59
Figure 32 – Average monthly relative humidity at station Teniente Coronel Carmelo Peralta....59
Figure 33 – Average wind speed at Puerto Casado station....60
Figure 34 – Wind rose observed at the station Puerto Casado....61
Figure 35 – Average wind speed at station Pozo Colorado....62
Figure 36 – Wind rose observed at Pozo Colorado station....63
Figure 37 – Average wind speed at the station San Pedro....64
Figure 38 – Wind rose observed at the station San Pedro....65
Figure 39 – Average wind speed at the station Teniente Coronel Carmelo Peralta....66
Figure 40 – Wind rose observed at the station Teniente Coronel Carmelo Peralta....67
Figure 41 – APP – Preliminary Risk Analysis Sheet....72
Figure 42 – Risk Classification Matrix....75
Figure 43 – Risk matrix with the quantification of the hypotheses....76

TABLE LIST

Table 1 – Chemical substances..........19
Table 2 – Colors of containers at offices and operational areas..........42
Table 3 – Treatment or final disposal..........43
Table 4 – Criteria for selection of the composting plant area..........45
Table 5 – Criteria for selecting the area of the corrective production plant..........47
Table 6 – Main products and risk class/subclass by ONU..........68
Table 7 – Number of incidents per type of substance..........70
Table 8 – Severity Categories..........73
Table 9 – Frequency Categories..........74

1 INTRODUCTION

1.1 General

For more than four decades, process industries have developed a specific approach to potential failures and hazards arising from their activities, which can cause loss of life and property.

The industrial accidents contributed significantly to attract the attention of government authorities, the industry sector and the society as a whole, in order to look for mechanisms to prevent such episodes that may compromise the human safety and the environmental quality.

In the 1960s, there was a great development specially in the chemical and petrochemical industries, which were the most critical and represented a greater danger. At the same time, process facilities began to grow, and industries processes became more complex.

These developments did not occur in isolated form, the social context was also changing, and other problems, such as environmental pollution, began to be a concern among the people. As a result, the industry was forced to review the effects of its operations and reinforced the need for development in the area of risk assessment and loss prevention.

Therefore, the purpose of this study is to present the Preliminary Risk Analysis Study, which aims to identify, analyze and evaluate the potential hazards imposed on the environment and safety as a result of the activities related to the operation of the PARACEL pulp mill, with a capacity of 1,500,000 t/year of beached pulp for paper or 900,000 t/year of dissolving pulp, located in the municipality of Concepción, Department of Conception, Paraguay.

The mill will also be a source of clean energy, because the burning of biomass and wood liquor are renewable natural resources. 220 MW will be cogenerated in case of option for the production of bleached pulp is chosen, being that the plant will consume about 120 MW of electricity and there will be a surplus of 100 MW for sale in the grid; or in case the dissolving pulp process is chosen, 240 MW will be cogenerated and the mill will consume about 110 MW of electricity, with a surplus of 130 MW to export to the grid.

This study is part of the EIAp/RIMA PARACEL pulp mill and its purpose is to provide guidance to the licensing process for obtaining the environmental permit from the Ministry of Environment and Sustainable Development – MADES.

1.2 Methodology

This Preliminary Risk Analysis Study was carried out on the basis of the criteria of the TERM OF REFERENCE - Development of a Risk Analysis Study - punctual projects, from CETESB P4.261/2011 Standard. It should be noted that, due to the current licensing phase, the study was carried out until the hazard identification stage.

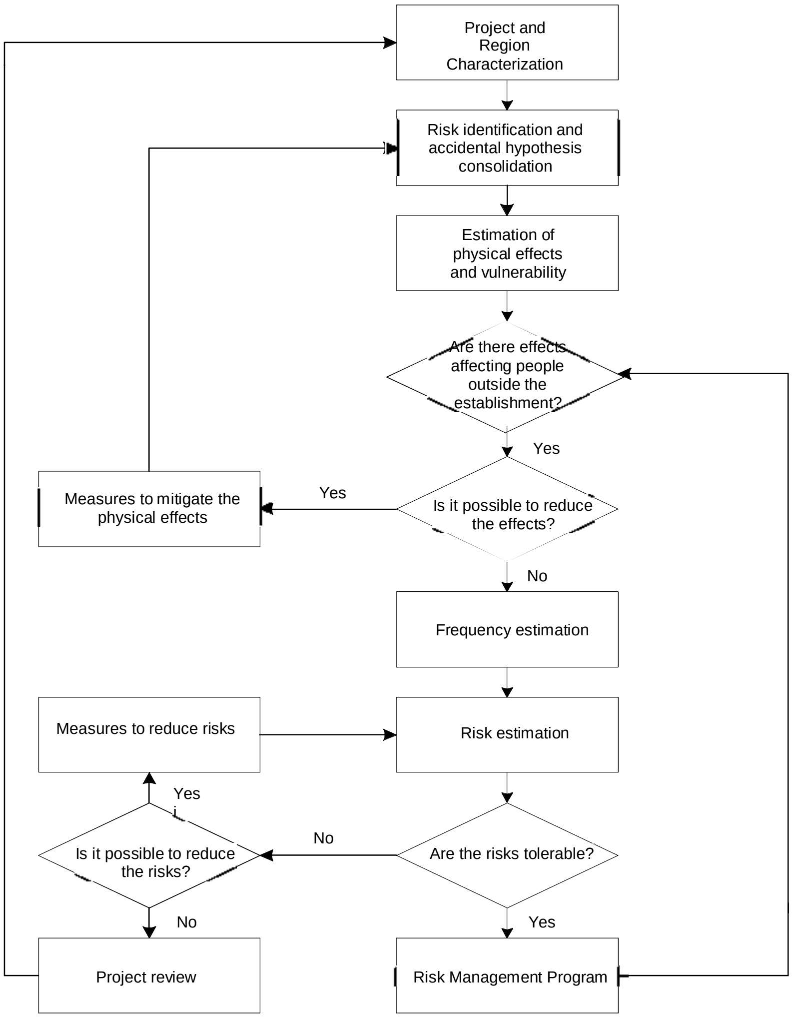


Figure 1 – Stages of the Preliminary Analysis Study elaboration

1.3 Project and Region Characterization

This stage presents the physical and operational aspects of the pulp mill, and the peculiarities of the region, covering the following items:

– Description/company history;

– Description of the design under study;

– Description of the region; and

– Meteorological data.

1.4 Physicochemical Characteristics of the Implicated Products

The physicochemical and toxicological properties of the product handled at PARACEL pulp mill, will be presented through the Material Safety Data Sheet (MSDS).

1.5 Identifying Hazards and Consolidating Accidental Scenarios

It consists on the application of the methodologies developed for the identification and characterization of events that can generate unintended consequences such as injury to people, property damage and impacts on the environment.

There are several techniques that can be applied in hazards identification. The technique applied in this study was Preliminary Hazard Analysis - APP.

2 PROJECT AND REGION CHARACTERIZATION

2.1 Project History

PARACEL is a Paraguayan project arisen from the innovative vision of the Zapag family. This vision, coupled with the experience of the Swedish group Girindus Investments, achieves the accession of other Paraguayan and foreign investors to carry out the largest productive industrial enterprise of the country and the largest private investment in the history of Paraguay.

The strength of this combination with enthusiasm, experience and capital in PARACEL, allowed today to crystallize the project of construction, and operation of a world-class pulp mill, attending the highest standards of environmental and social sustainability, and with the capacity to satisfy the most demanding international markets.

2.2 Project Information

2.2.1 Project Main Activity

The main activity of the mill is the production of 1,500,000 tons per year of bleached pulp for paper or 900,000 tons per year of dissolving pulp.

It should be noted that PARACEL pulp mill, despite being designed to produce 1,500,000 t/year, will be able in the future to produce up to 1,800,000 t/year of bleached pulp as a result of higher overall plant efficiency, as well as higher equipment performance without the need to increase the built area or include additional new equipment. In addition, no modification will be necessary in the main environmental control equipment, nor will there be any loss in their performance, which can guarantee the same emissions of liquid effluents and atmospheric emissions considered in this EIAp/RIMA. Therefore, it can be said that in the eventuality of increasing pulp production capacity up to 1,800,000 t/year, there will be no changes in the environmental impacts identified and evaluated in this EIAp/RIMA.

This mill will use as raw material eucalyptus logs, in addition to various chemical inputs.

To produce bleached pulp, PARACEL mill will use the *kraft* process, which is a technology known by pulp producing industries and engineering and equipment suppliers, and consulting services, as an additional it has advantages to obtain the high standards of whiteness and fiber quality required by the market, combined with energy self-sufficiency capacity and environmental advantages compared to other processes.

The process chosen for pulp bleaching production was ECF (Elemental Chlorine Free), which does not use elemental chlorine in its internal stages, avoiding the emission of organochlorinated compounds into the effluent.

The mill will also be a source of clean energy, because of the burning of biomass and wood liqueur, which are renewable natural resources. 220 MW will be cogenerated in case of option for the production of bleached pulp, being that the plant will consume about 120 MW of electricity and there will be a surplus of 100 MW for sale in the grid; or in case the dissolving pulp process is chosen, 240 MW will be cogenerated and the mill will consume about 110 MW of electricity, with surplus of 130 MW to export to the grid.

This mill will use the Best Available Techniques (BAT) as well as the Best Practices on Environmental Management (BPEM).

It should be noted that, in relation to environmental control systems, this mill will have the capacity to treat and purify the environmental emissions (liquid effluents, atmospheric emissions, solid waste) from production up to 1,800,000 tons per year of bleached pulp for paper or 1,100,000 tons per year of dissolving pulp.

PARACEL pulp mill operation will require the implementation of an internal and external support infrastructure that will include road access, the river port, the reception of raw materials, inputs, water intake and treatment, the proper treatment and disposal of effluents and systems for the treatment and disposal of solid industrial wastes.

2.2.2 Personnel

It is estimated that the labor force required for the implementation of the PARACEL pulp mill is approximately 8,000 workers during the period of greatest work and assembly.

For PARACEL pulp mill operation the total labor force, considering own and third-party employees, will be approximately 1,200 people.

The working day of the industrial area employees will be held in 3 shifts of 8 hours each. In the administrative area, the work day will be carried out in 8 hours during business hours.

2.2.3 Operating Regime

PARACEL pulp mill operation will be carried out 24 hours a day, 7 days a week and 12 months a year. The actual production period will be approximately 354 days, considering the annual equipment maintenance stop.

2.3 Location

PARACEL pulp mill will be located in the municipality of Concepción, near Paraguay River, about 15 km from the city center. The following figure shows the location of the project.

Figure 2 – PARACEL mil location. Source: Google Earth, 2020.

2.4 Brief Description of the Productive Process

Barked eucalyptus logs will be sent to the debarked and chopped/chipping lines, which will cut the wood into pieces named chip. The chips produced by the chippers shall be stored in a pile and then transported to the cooking area.

The chips have controlled dimensions, which allow the penetration of chemicals during cooking, which facilitates the softening of the wood and the decomposition of the fibers, separating them from the lignin, producing the so-called brown paste/pulp (dark cellulose).

Consequently, pulp is previously bleached, through a physicochemical process, using oxygen as the main reagent. The goal is to reduce the consumption of chemical reagents in the bleaching process and generate less organic load for the effluent.

Bleaching is a purification process that aims to remove much of the residual lignin. The goal is to obtain a high degree of whiteness. For this, more selective chemical reagents and milder working conditions are used.

The bleached pulp then goes to the drying and packing section, where the pulp leaf formation occurs, to ensure greater homogeneity and avoid breakage in the machine or irregularities in the product. Pressing aims to remove water by mechanical action, consolidate the position of the fibers and provide greater resistance for the wet leaf to pass through the drying. When dried, the water is removed by evaporation by applying heat to the pulp sheet. At the exit of the dryer, the leaves are cut, weighed and packed in bales of 250 kg. The bales are stacked in two groups of four, forming a load of 2 tons.

Chemical Recovery

The *kraft* pulp industry has a system that allows the recovery of the chemicals used to obtain the pulp.

Recovery begins with the evaporation of black liquor, increasing the dry solids content from 15% to about 80%.

After evaporation, the liquor will be sent for incineration in the recovery boiler. In the boiler, the organic matter presented in the liquor will be incinerated, leaving a molten mass, formed by the inorganic compounds that will be sent to causticizing section.

In causticizing, after clarified the green liqueur there will be produced the subsequent white liqueur.

2.4.1 Detailed Process Description

2.4.1.1 Reception and Wood Processing

The wood to be processed in the pulp mill is composed of six-meters-long eucalyptus logs, which will be debarked in the forests. The wood logs will be transported by road and/or waterway.

Figure 3 – Eucalyptus forest, with separation of bark in the field

The storage capacity of pulp logs in the mill is equivalent to an average consumption of ten days. Logs shall be stored in an internal paved yard near the receiving tables, with wood handling using mobile equipment such as wheel loaders or hydraulic cranes.

The forecast is that approximately 70% of the total wood is fed directly to the tables without going through the storage area.

Figure 4 – Discharge of eucalyptus logs into the wood yard.

Three lines of wood chipping are being considered.

The feeder table will be followed by a belt and roller conveyor to remove residual bark and other contaminants, a log cleaning station and a metal detector to protect the chipper.

The receiving tables will be fed by cranes (mobile or stationary) or diesel loaders.

Figure 5 – Wood chip pile

The chip storage will be based on the FIFO (First In First Out) principle in the open, with automatic stacking and restart, and will consist of two circular stackers / reclaimers with a rotating moving screw removal system. The storage capacity will be 3 days.

The three chip lines will be installed after the storage piles. The surplus will be collected and recovered to use the fibers for pulp production, or optionally, used as biomass for burning in the boiler. Accepted chips will be sent through a line of conveyor belts to the digestors.

The residual bark will be cut and sent together with the filtered residues (fine) to a covered biomass pile, with a storage capacity of two days, with automatic stacking and continuation. The mobile extractors will recover the biomass from the pile, which will then be sent to the biomass boiler.

Log cleaning water will be recovered and recirculated, although an amount of industrial water is needed to replace losses and maintain water quality. Solid waste contaminants in the wash water after it has been decanted into the water recovery system will be largely removed by a drag conveyor and discharged from the process.

2.4.1.2 Fiber Line

Cooking

The objective of cooking is to separate the fibers and other components of the chips through a chemical reaction.

Figure 6 – Cooking

Cooking is a chemical alkaline process, since it uses the chemical reagents sodium hydroxide (NaOH) and sodium sulfide (Na_2S), the main components of the white cooking liquor, to promote the dissolution of the components that bind the fibers to each other, under favorable and optimized pressure and temperature conditions in the digester, which is a large vessel under pressure.

The chips from the wood preparation sector will be fed into a chip silo where they will be heated with steam, then discharged through a chip metering screw, mixed with white liquor and pumped into the upper separator of the digester.

After a suitable reaction time in the digester, the obtained pulp will be removed from the interior by the discharge line and washed with black liquor, to reduce the concentration of organic matter accompanying the pulp.

The light black liquor extracted from the digester during the cleaning process will be sent to the evaporation plant, to be submitted to instantaneous evaporation.

The pulp will be sent to the discharge tank and then to the brown stock washing and knot separation areas. The purified pulp will be washed and delignified with oxygen.

Extraction of Lignin by Oxygen (Delignification)

The lignin extraction process using oxygen is one of the prior stages before bleaching, which additional lignin separation takes place, by means of reactions of the pulp with an oxidant agent in an alkaline environment. The aim is to reduce the consumption of chemical reagents in the final stages of the bleaching process as much as possible, recover the maximum amount of alkali applied and mitigate the generation of organic load for the effluent.

Bleaching

Bleaching is a purification process that aims to remove elements that would prevent complete bleaching of the pulp, such as resins and much of the residual lignin not dissolved in previous operations.

The aim is to obtain ECF (elemental chlorine free) pulp with a high degree of whiteness (90% ISO) and stability, without prejudice its physical-mechanical characteristics. This high degree of whiteness is required in the process and is achieved through the use of appropriate chemical reagents in several stages, each with specific operating conditions.

The bleaching plant will consist of four stages of medium consistency: A/D Eop D P (high-temperature chlorine dioxide, alkaline extraction, chlorine dioxide, and peroxide).

The bleached pulp will be sent to the storage towers, where it will be stored at a medium consistency and then fed to the drying machine.

Figure 7 – Bleaching

2.4.1.3 Drying and Packing

From the bleached pulp storage tower, the pulp is mixed, homogenized, purified and its consistency is precisely regulated. It is then sent to two drying machines in which the fiber suspension in water is subjected to the dewatering process, forming the pulp sheets (plates). The two machines will operate in parallel to satisfy the total production of the PARACEL pulp mill.

The pulp dryer will be the type “floating sheet”, which dries the pulp while keeping it floating on a cushion of steam-heated air.

Then, the pulp sheet will be sent to a cooler, and the output will be taken out through a press and directed to the cutter, which will first cut the sheet in the longitudinal direction, and then in the transverse direction.

The sheets cut to the programmed size will be stored, pressed into packs, and covered for later identification. The packs will also be stacked and unified, following for the pulp warehouse.

Figure 8 – Drying

2.4.1.4 Recovery

<u>Evaporation Plant</u>

The purpose of evaporation is to concentrate the black liquor from the cooking between initial concentration of 14.0 - 16.0% to final concentration of 80% solids.

The evaporation plant will be a multiple effect plant using low pressure steam. The final concentration of the liquor will be achieved in the various stages of the evaporators. The concentrated liquor produced will be stored for later burning in the recovery boiler.

The evaporation condensates will be segregated into different quality grades. Therefore, segregation is important to ensure sufficient quality in the condensates that will be used in other areas of the plant.

Condensate treatment and methanol rectifier plants will be integrated into the evaporation plant.

Contaminated condensate collected from the process will be treated in the condensate treatment and purification plant. The purified condensate will be used later in the process.

The gases from the extraction column of the condensate purification plant will be sent to the rectifier column for methanol extraction. The methanol produced will be used as an auxiliary fuel in the lime kiln or biomass boiler.

Figure 9 – Evaporation Plant

Recovery boiler

The purpose of the recovery boiler is:

– Recover chemicals used in cooking;

– Reduce sodium sulfate to sulfur;

– Generate steam using the energy resulting from the burning of organic materials extracted from the wood.

The boiler will be high efficiency, low odor type with a multilevel air system to burn liquor at 80%.

The steam generated at high pressure will be sent to the turbogenerators to produce electricity.

The combustion air will be introduced into the furnace on at least four levels, with forced circulation fans, to allow optimum control of combustion, reduction of NOx emissions and reduction of smelt.

The flue gases from the combustion will pass through an electrostatic precipitator, whose efficiency is expected to be over 99.7%. The precipitator's ash treatment system will be integrated into the recovery boiler or evaporation plant.

Concentrated and diluted non-condensable gases from the line will be incinerated in the recovery boiler.

Fuel oil will be used as initial fuel, to stabilize the production process and generating electricity.

Causticizing

In the causticizing, the green liquor from the recovery boiler will be transformed into white liquor, which will then be used to cook the wood. The green liquor is formed from the solubilization of the smelt formed in the recovery boiler.

This transformation is the reaction of sodium carbonate of the green liquor with lime (calcium oxide), obtaining sodium hydroxide and calcium carbonate, which will be separated by filtration.

Before coming into contact with the lime (calcium oxide and aggregates), the green liquor will be filtered to remove impurities (dregs). The dregs will be washed and filtered in a filter or centrifuge, specific equipment for this application.

Secondary condensate from the evaporation plant or warm water will be used to wash the dregs.

The lime residues (grits) will also be washed and, like the dregs, will be sent to the recycling center to generate soil correction, or even to an industrial landfill.

After the reaction of the green liquor with the lime, the white liquor will be obtained by filtering the mixture of sodium hydroxide (white liquor) and calcium carbonate (lime mud) through a pressurized disc filter.

The white liquor will be sent for cooking and the lime mud will be washed and dewatered in a vacuum disc filter before being sent to the lime kilns.

Secondary condensate from the evaporation plant or warm water will be used to dilute and wash the lime mud. The filtrate from the sludge filter will be pumped into the weak liquor tank.

The collection and recovery of all effluent from this area is planned, as well as the closing of the cooling water circuit.

Lime kiln

The purpose of calcination is to transform the calcium carbonate obtained from the causticizing into calcium oxide (CaO + inert) to be used in the reaction with the green liquor.

The calcination will take place in two parallel rotation kilns, lined internally with heat-resistant and insulating bricks and then heated by the combustion of fuel oil or another alternative fuel that can be used in the future (biomass gas).

As an auxiliary fuel, the furnaces can burn methanol from condensate stripper.

The lime kilns will be equipped with an external dryer for the lime mud and coolers for the burnt/calcined lime.

Through an electrostatic precipitator, dust will be removed from the exhaust gases and can be returned to the lime kilns or disposed of (lime mud purge).

The flue gases will be sent to the chimney (common with the recovery boiler), from where they are released to atmosphere.

Figure 10 – Lime Kilns

2.4.1.5 Chemical handling, preparation and storage area (chemical plant)

The description of this area corresponds to differentiated systems to meet the requirements of chemical supply to the pulp mill. All chemical storage tanks shall have retention walls with a volume at least equivalent to the maximum storage volume.

Figure 11 – Chemical Plant

The area of chemical products will include:

- Discharge, handling and storage of sodium hydroxide;
- Discharge, handling and storage of sulfuric acid;
- Discharge, handling and storage of sodium bisulfite;
- Unloading, handling and storage of hydrogen peroxide;
- Unloading, handling and storage of sodium chlorate;
- Unloading, handling and storage of methanol;
- Plant for the production of chlorine dioxide;
- Plant for the production of oxygen;

Storage volumes

The volumes of chemical storage tanks are presented in the following table.

Table 1 – Chemical substances

Chemical substances	Volume (m^3)
Sodium hydroxide 50%	2 x 750
Sulfuric acid	2 x 350
Sodium bisulfite	120
Hydrogen peroxide	600
Sodium chlorate, solution	510
Methanol	160
Chlorine dioxide, 10 g/l	2 x 830

Description of chemical plant processes

Handling and storage of sodium hydroxide

Sodium hydroxide 50% will be unloaded from trucks through centrifugal pumps and deposited in the storage tanks. Most of this solution will be transferred for use in the pulp liquor, lignin extraction (delignification) and bleaching system.

Other areas of the manufacturing process will also use sodium hydroxide, such as water treatment plant, boiler water treatment plant and effluent treatment plant.

Handling and storage of sulfuric acid

The sulfuric acid (96% concentration) will be discharged from trucks by pumping and stored in a closed tank to prevent the entry of moisture. The sulfuric acid will be used in the chlorine dioxide generator, in the acidification of the pulp in the bleaching process, in the treatment of the boiler water and in the effluent treatment plant.

Handling and storage of sodium bisulfite

The sodium bisulfite will be discharged and stored in a tank, and then sent to a storage tank. The sodium bisulfite will be used for bleaching.

Handling and storage of hydrogen peroxide

The hydrogen peroxide will come to the pulp mill by truck, to be supplied in solution. From the storage tank, the product will be distributed for bleaching.

Handling and storage of sodium chlorate

Sodium chlorate will be the main raw material for obtaining chlorine dioxide and will be transported in liquid form in trucks that will be unloaded by the pump and stored in a tank, from where the product will be sent to the chlorine dioxide production plant.

Methanol handling and storage

The methanol will be transported to the pulp mill by truck and then unloaded by pump and stored in a tank. From the storage tank, the product will be sent to the chlorine dioxide production plant.

Chlorine Dioxide Production Plant

Chlorine dioxide is produced by a process in which sodium chlorate reacts with a reducing agent (methanol) in an acidic environment and in a vacuum, the reaction of which is presented below. Sodium sulphate, obtained as a by-product of chlorine dioxide generation, will be used as a sodium and Sulphur make-up in the pulp mill.

$$\mathbf{3\ NaClO_3 + 2\ H_2SO_4 + 1/2\ CH_3OH \rightarrow}$$
$$\mathbf{3\ ClO_2 + 2\ H_2O + Na_3H(SO_4)_2 + x\ HCOOH + y\ CO_2 + z\ CH_3OH}$$

The chlorine dioxide generator will be the main equipment in the process, which is a vessel (recipient usually made of titanium) where the sodium chlorate ($NaClO_3$) reacts to form ClO_2.

The generator will be designed to optimize the efficiency of the reaction, promote the growth of salt cake crystals, promote efficient gas-liquid separation and sufficient volume for easy control of the concentration of the reagents. It should be noted that the design of the components of this circuit aims to eliminate internal cleaning of the reactor.

The rate of evaporation of the water will be equal to the rate of water entering with the supply of chemicals and utilities to the generator. The partial pressure of the chlorine dioxide will be maintained at a safe level by partial vacuum and dilution with water vapor. Normally, the vacuum in the ClO_2 reaction is produced by a steam ejector.

The effluent water from the gas depurator will be transferred to the main absorption tower and consequently all the ClO_2 in the vent gases will be recovered and added to the chlorine dioxide solution.

The resulting chlorine dioxide gas from the generator will be cooled and absorbed in a tower, using cool water. The resulting product will be a strong, chlorine-free ClO_2 solution.

As the ClO_2 generator gas will not have any diluent gas like air or chlorine, the absorption efficiency will be high to reach concentrations above 10 g/l ClO_2.

The chlorine dioxide solution will be pumped into the storage tanks for use in the bleaching process.

Sodium sesquisulphate ($Na_3H(SO_4)_2$) crystals formed in the generator will be pumped for filtration to remove solids. The filter shall be equipped with a hot washing system. The sodium sesquisulphate will be discharged into a dissolution system where it will be neutralized and pumped to the plant.

Oxygen Production Plant

Oxygen production will be carried out through a plant dedicated to execute lignin extraction (delignification), bleaching and white liquor oxidation.

Oxygen generation can be performed by purifying the atmospheric air through the Vacuum Swing Adsorber (VSA) process, through molecular filters.

At the beginning of the process, the atmospheric air will pass through a filtration system, where solid particles will be removed.

The air will then be sucked in and subjected to a vacuum regime, sufficient to allow the air to flow into the purification system.

The air purification system consists mainly of adsorbent vessels, which operate in cycles. By passing through a molecular sieve bed, the moisture, CO_2 and nitrogen from the air will be removed from the main stream.

The purified air, rich in oxygen, will leave the purification system and then go to the oxygen compressor, which will compress it to the conditions necessary for its use. The waste gas will be discharged to the atmosphere through the silencer.

Product transport system

The transport of the main chemical products in liquid form will be done in bulk, using tank trucks.

It is worth mentioning that transport companies must have specific training for drivers and operators in traffic management, education and safety, in order to reduce the risks of accidents.

Chemical Plant Operational Control and Safety System

Safety and control equipment and protection structures

The chemical plant must have the following equipment and structures for storage, containment, control and safety:

- Chemical product unloading platforms, provided with containment systems through low walls;
- Storage of liquid products in metal tanks, made of carbon steel, stainless steel or fiberglass (the material will depend on the type of chemical to be stored);
- Concrete containment dikes for chemical storage tanks;
- Containment channels in the production areas and in the chemical products storage;

- Remotely operated process monitoring instruments (level, pressure, temperature, among others) to minimize the need for operators in the production or chemical storage area. Remote operation can be performed by dedicated remote control systems;
- With respect to chlorine dioxide, the following measures are foreseen:
  - Chlorine dioxide leak detection system;
  - Constant ventilation system for the tanks (with backup source);
  - Fixed foam system around the containment tank to prevent gas emission in case of leakage.
- Atmospheric Discharge Protection Systems provided with grounding networks or lightning arresters;
- One of the points of attention regarding chemical products from PARACEL's pulp mills is the transfer system from the Chemical Plant to the using points, that will be done by pipe rack, which avoids manipulation by operators and minimizes the risk of accidents.

Chemical Plant Fire Control System

The chemical plant's internal network of hydrants will be distributed in the form of a ring that will be fed by the main network of hydrants.

The hydraulic and lubrication units, depending on the volume, can be protected by an automatic sprinkler system controlled by an activation valve and independent alarm. In addition, each hydraulic and lubrication unit will be installed within a containment dyke with a volume sufficient to maintain the full volume of oil in the unit.

Portable fire extinguishers will be installed where necessary in accordance with Fire Department requirements.

Fire Department regulations also require the installation of signs in the area reserved for fire extinguishers.

The methanol storage tank must have a protection system in accordance with FM Global standards. Flood protection systems will be installed for this tank and for all metal structures that may collapse in the event of a fire in the tank or other methanol handling equipment.

The sodium chlorate storage building will be protected by an automatic system with sprinklers controlled by an independently acting system and an alarm valve.

Chemical Plant Environmental Management System

In general, the environmental management system proposed for PARACEL's Chemical Plant will have as its main guidelines the elements described below. It is worth mentioning that this system is commonly used in pulp mills around the world.

- The equipment will be designed to operate with the necessary efficiency to minimize the environmental impacts of the activities in the area;

– Installation of instrumentation to monitor and control the process;

– Implementation of an operational process control system through inspections with determined frequency, including the collection of samples and respective laboratory analysis;

– Characterization of process variables that are critical to the environment, to employee safety and to process safety;

– Maintenance management: characterization and registration of critical process equipment and instruments that require preventive/predictive maintenance, through maintenance programming of specific maintenance control software;

– Operation, maintenance and management teams with adequate training and technical skills to meet the requirements of the area;

– Structured system to identify and manage the environmental aspects and impacts and the hazards and risks of the unit, with the aim of implementing preventive actions to reduce risks and protect people and the environment;

– Implementation of an Emergency Action Plan structured to minimize the impacts of accidents, in case of emergencies;

– Structured system to analyze non-conformities and/or accidents and implement corrective actions to avoid recurrence.

2.4.1.6 Utilities

2.4.1.6.1 Industrial Water Intake and Supply

The construction of a Water Treatment Plant (WTP) is planned to serve the consumption of the PARACEL pulp mill.

The water will be intake from the Paraguay River, through a surface intake system consisting of a channel and a grid.

Figure 12 – Example of surface water collection.

It is important to note that the collection will be "wire operation" type, it means, no dam system will be built.

Four pumping systems of 2,350 m³/h each will be installed, with a total intake flow of 7,000 m³/h to supply the PARACEL pulp mill.

A 1,100 mm diameter raw water pipe will be installed.

The raw water, which arrives at the Water Treatment Plant, will be treated with aluminum sulfate, sodium hydroxide and sodium hypochlorite, the latter being used to promote the elimination of iron, in addition to oxidizing the organic matter present. After the coagulation process, polyelectrolyte will be added to promote flocculation.

Then, by gravity, the flocculated water will go to the solids removal unit, through a dissolved air flotation system or similar. The formed sludge will be periodically and automatically discharged into the central discharge channel. The collected sludge will be compacted and dewatered and then sent for final disposal.

By gravity, the clarified water will be conducted through channels to the gravity filters. After filtration, the treated water will be stored in the treated water tank that will supply the PARACEL pulp mill's various consumption points, including water for fire control and potable water. The total production capacity of treated water will be 6,700 m³/h.

2.4.1.6.2 Boiler Feedwater Plant

The water to replace the non-returned live steam condensate losses from the process will be treated by demineralization, reverse osmosis type, with final polishing through mixed beds.

The replacement water will be pre-purified by filtration through sand filters, activated carbon filters and mechanical cartridge filters before passing through the permeate. The permeate waste will be used to replace the water sealing system.

The deaerator, storage tank and feed water pumps, as well as the steam condensate collection tank, will be installed in the recovery boiler building and serve both the recovery boiler and the power boiler.

The steam condensate collected from the departments will be pumped through mechanical filters into the boiler feedwater tank.

The feed water pumps will be driven by an electric motor with a hydraulic variable speed drive. The backup pump will be powered by a steam turbine.

2.4.1.6.3 Cooling towers

The cooling water system shall be in a closed circuit, and counterflow towers with an air extractor at the top are considered to serve the following pulp mill processes:

- Cooling tower for turbogenerator + utilities: turbogenerator condensers, biomass and recovery boilers, air conditioning system chillers, turbogenerators, causticizing and lime kiln, fiber line, chemical plant, cooking, drying, wood handling and compressed air system.
- Evaporation cooling tower: evaporation plant

Figure 13 – Cooling towers

2.4.1.6.4 Biomass boiler

The function of the biomass boiler will be to supplement the steam generated in the recovery boiler for energy generation, by using waste from the preparation of wood for cooking.

Waste from wood handling and brown pulp disposal will be mixed and stored in a covered biomass pile where it will be sent to the boiler silos.

The steam produced by the biomass boiler will be mixed with the steam from the recovery boiler and sent to the turbogenerators.

An electrostatic precipitator will be installed to control air emissions.

The biomass boiler can burn methanol as an auxiliary fuel, thus being a backup burning system for lime kilns.

Bottom ash from the boiler and the precipitator will be collected in dedicated silos for subsequent disposal.

The fuel oil will be used as a starting fuel, stabilizing the production process and eventually to oxidize non-condensable gases when they are diverted to the biomass boiler.

2.4.1.6.5 Electricity Cogeneration (Turbogenerators)

The cogeneration system begins with the production of high-pressure steam by the recovery boiler and the biomass boiler.

The high-pressure steam will undergo expansion in the turbine blades and will be extracted at different pressure levels for use in the pulp manufacturing process.

Turbogenerators will have the purpose of transforming the thermal energy of the high-pressure steam into mechanical energy to activate the electrical energy generators.

The supply of steam to the turbogenerators will cover the operation, plus the contingency. The contingency is considered to absorb any variation in steam production in the recovery boiler due to variations in the solids contained in the liquor or even considering calorific value.

It is planned to install 2 turbogenerators for total generation of up to 220 MW in case of producing pulp for paper. In the first scenario, pulp production will consume about 120 MW, with a surplus of 100 MW to be exported to the grid. For the dissolving pulp option, the generation will be 240 MW, the PARACEL mill will consume about 110 MW of electrical energy, with a surplus of 130 MW to be exported to the grid.

System control and monitoring measures (including protection of steam overpressure)

Variations in steam consumption can still occur during normal pulp mill operation, with pressure control through turbines and control valves. The control and interlocking of the turbines will be carried out by means of a dedicated system, complemented by controls for the admission and extraction of steam from the turbines: pressure reduction and conditioning valves, exhaust valves and, in the latter case, safety and relief valves.

Operation monitoring covers the following components:

- indicating instruments;
- data logging instruments;
- position indicators;
- audible and visual alarm system.

The values presented by the instruments must be compared with the design values and the measuring instruments must be checked and calibrated at regular intervals.

In case of occurrence and detection of any abnormality, the maintenance team shall be informed so that corrective action can be taken.

Fire prevention and control system

Recovery boiler and biomass boiler

The boiler area will have dedicated fire prevention and control systems, which are described below.

The internal network of hydrants in the recovery boiler and biomass boiler will be distributed in the form of a ring that will be fed by the main network of fire extinguisher. The fire extinguisher will be installed at high levels in the recovery boiler building and the biomass boiler, considering a minimum action flow with adequate pressure.

Depending on the volume, the hydraulic and lubrication units can be protected by an automatic sprinkler system controlled by a separate system of activation valve and alarm. In addition, each hydraulic and lubrication unit will be installed within a containment dyke of sufficient volume to maintain the full volume of oil in the unit. Portable fire extinguishers will be installed where needed in accordance with Fire Department regulations.

Fire Department regulations also require the installation of signs in the area reserved for fire extinguishers.

Turbogenerators

The internal network of fire extinguisher in the Turbogenerators area will be distributed in the form of a ring that will be served by the main fire extinguisher network. The hydraulic and lubrication units, depending on the volume, can be protected by an automatic sprinkler system controlled by an independent activation valve and alarm. In addition, each hydraulic and lubrication unit will be installed within a containment dyke with a volume sufficient to maintain the full volume of oil in the unit.

Sprinklers will be installed:

In the region where the turbogenerator springs are located;

In all areas where oil can flow or accumulate.

Portable fire extinguishers shall be installed in the necessary locations in accordance with the requirements of the Fire Department.

Fire Department regulations also require the installation of signs in the area reserved for fire extinguishers.

Possible fuel oil leakage points, such as flanges, threaded connections, etc., depending on the pressure, may be protected to prevent fires in the form of spray.

Turbogenerator noise emission

The Turbogenerators, which will be enclosed in a dedicated building, will be remotely operated and the control room will be located at a certain distance. In addition, operators, who eventually need access to the area, must use the appropriate Personal Protective Equipment.

Steam and energy balance

The following steam balance shows the steam generated for turbogenerators and other uses.

2.4.1.6.6 Fuel storage

Fuel will be used accordingly in the areas of recovery boilers, biomass boilers and lime kilns, on the following occasions:

- Pulp mill start up;
- Annual preventive maintenance of the pulp mill with the consequent start up;
- Temporary situations of operation.

The volume of fuel oil storage will be 3,000 m³, being heated and distributed to consumers at a temperature of 70 ºC.

Fuel Storage Area Fire Control System

For the fire control system in the fuel storage area, hydrants will be installed in appropriate locations to provide cooling to the tanks, in addition to foam lines to combat occasional spills from the tanks.

All the hydrants around the tanks will be equipped with accessories for the manual supply of foam and adjustable nozzles for the production of water mist.

Portable fire extinguishers will be installed where necessary in accordance with Fire Department regulations, including portable dry chemical and foam extinguishers, which will be installed near the fuel oil pumping and discharge station.

Where appropriate, tanks shall be equipped with a fixed internal foam dispersal system.

Fire Department regulations also require the installation of signs in the area reserved for fire extinguishers.

2.4.1.6.7 Compressed air

Both the service air (pulp process) and the instrument air will be treated in a dryer to remove moisture, but there will be 2 separate air grids, one for the service (process) air and one for the instrument air.

The operating pressure shall be 7 bar (g), using an oil-free centrifugal compressor and an adsorption-type dryer.

2.4.1.6.8 Ventilation and air conditioning

The electrical rooms and the control rooms will be equipped with a fan coil air conditioning system with a chilled water plant. The water for the chiller will come from the cooling tower pumped through a dedicated.

2.4.1.7 Administrative and operational support facilities

Gatehouse

The PARACEL pulp mill will have a gate to control the access of people and vehicles.

Administrative Building

The administrative building will consist of offices, bathrooms, cafeteria and clinic.

Parking for cars and trucks

PARACEL's pulp mill will have parking for employees and visitors. In addition, there will be parking for trucks.

Weigh machine

Two weighing machines will be installed to control the entry and exit of wood and inputs to the pulp mill.

Storage

Next to the administrative building there will be a warehouse to store general materials.

Warehouse

The warehouse will be used to maintain industrial equipment and there will be reinforced concrete floors, waterproofed by masonry walls to contain any spills.

River port

The river port of the pulp mill will be a terminal-type construction on the left bank of the Paraguay River, built as an elevated platform on a structure composed of: an operating platform, an access bridge for vehicles and people, and a shed structure for the pulp transport area. All the structures will be made of reinforced concrete and the loading roof will be made of a metal structure. It will be implemented from the shore through the sustainable methodology of the Cantitraveller type with prefabricated elements.

The port will move the following loads:

- Pulp transport by river barges at an average rate of 1,500,000 t/year;
- Reception of logs with volumes varying between 2 and 5 million m^3 s sc/year;
- Reception of inputs for the pulp mill (liquid or bulk) up to 450,000 t/year.

The boats that will operate in the port will be the current models in circulation in the fluvial section of the Paraguay River with the format of convoys according to the official conditions of navigation. The typical pulp convoy will consist of 12 barges (3 x 4) with a unit capacity of up to 2,500 tons each.

The boats for wood and inputs will be suitable for each of the operations/products and will be regulated by the navigation conditions.

No dredging actions will be required for the approach channel, the evolution basin and the anchorage area of the vessels (barges and pusher craft). For platform or access bridge construction services, bottom forming services may occasionally be required at the site of underwater structures.

The selection of the positioning of the river port was defined according to the format of the pulp mill area and the morphological characteristics of the Paraguay river, using the 3320 nautical reference table.

The selected point is characterized by having natural draft conditions for boats (pulp barges) without the need for deepening actions or maintenance of dredging and preserves the conditions of regular distance from the navigation channel, in accordance with the premises and institutional regulations.

The train anchorage areas are located upstream of the river port for empty trains awaiting cargo and downstream for loaded trains awaiting final train formation.

<u>Facilities Description</u>

AWT

The AWT (All Weather Terminal) will have an area of approximately 4,600 m^2 and will be completely developed in metallic structure, therefore, the covering, the closings and the beams will be metallic. The 56 t capacity crane support columns will be made of precast concrete.

Support Building and Pump Room

These buildings will have a conventional concrete structure, structural masonry, precast slab and metal roof. The support building will house bathrooms, meeting rooms and control rooms with an area of 127 m^2. The pump room will have an area of approximately 44 m^2.

Mooring Points

The design includes 12 (twelve) tie-down points, 2 (two) main protection points and 11 (eleven) protection points of the AWT roof columns.

It is planned to use metal jacketed perforated inclined piles filled with reinforced concrete and their respective blocks, which consist of a precast bark element for the second subsequent concreting step.

Barge Pier

The barge dock will have a 133 m x 32 m wide reinforced concrete platform, with an area of 4,256 m². Its structure will be made of perforated metal-clad piles filled with reinforced concrete, beams and precast slabs in solidarity with the reinforced concrete in situ.

Access Bridge

As well as the pier, the access bridge will be made up of a 340 m x 10 m wide reinforced concrete structure with an area of 3,400 m². Its structure will be made of perforated metal-clad piles filled with reinforced concrete, beams and precast slabs in solidarity with the reinforced concrete in situ.

2.5 Environmental Control

2.5.1 Liquid Effluent

2.5.1.1 Generation sources

Basically, the sources of liquid effluent generation that will correspond to the activities of the pulp process and other support activities are the following:

- Effluents from the wood preparation area;
- Effluents from the cooking and brown pulp depuration area;
- Alkaline and acid filtrates;
- Drying machine effluents;
- Effluents from evaporation and recovery;
- Effluents from the causticizing and lime kiln area;
- Contaminated condensates;
- Sanitary effluents;
- Contaminated rainwater; and
- Miscellaneous (spills, leaks, cleaning of various areas, etc.).

2.5.1.2 Spill control system

The spill collection and management system has been designed so that accidental discharges can be collected as close as possible to the source and recycled directly to their own process stage.

The main approaches are:

- Dam with retaining walls around tanks and equipment where there are black or white liquors and chemicals. In the event of an accidental leak or spill, the material will be collected and returned directly to the process;
- Tank systems and equipment that will allow excess liquor to be properly conducted when emptying is required for maintenance. Process liquor will be taken to a spill tank and returned directly to the process instead of being discharged to the effluent network;
- In areas with potential for spills, there will be interconnection of the floor channels with the pumping wells, from which the liquids will be returned to the process;
- Emergency lagoon in Effluent Treatment Plant, where the effluents can also be directed in the event of spills that have not been contained with the means previously provided;
- Appropriate instrumentation for on-line effluent monitoring, and a good monitoring system to help operators detect accidental discharges and take appropriate corrective action; and
- Training of operators, process managers and information systems, where environmental problems and accidental discharges require continuous attention.

Digester and brown pulp line

Accidental discharges from this area may have black liquor and fibers and must be recovered.

A spill tank will be installed. The preferred point of return from this tank will be the dilution at the bottom of the discharge tank.

Whenever possible, overflows and drains from process equipment should be connected directly to the spill tank or, alternatively, to the feed tank before the equipment.

Any additional spills will be collected in floor channels and taken to a well, from where they will be pumped into the spill tank.

Bleaching

Overflows and spills in this area may contain fibers, filtrates and chemicals such as caustic soda, chlorine dioxide and sulfuric acid. Accidental fiber losses will be sent to the effluent treatment plant and separated in the primary treatment. The chemicals will be neutralized before being sent to the effluent treatment plant.

Drying Machine

Overflows and spills from this area contain fibers, but not a significant amount of dissolved elements. If not collected in the area, the fiber losses will be sent to the effluent treatment plant and separated in the primary treatment.

Evaporation

Accidental discharges from this area have a high black liquor content and must be recovered. The basic treatment is similar to that of the cooking area and the brown pulp line.

Spills from this area will be directed to the liquor spill tank, from where they will be sent to the liquor tank, with the proportional feeding. The liquor from the evaporation wash water will also be channeled to this tank, as well as any excess of contaminated condensate, in case of problems with condensate polishing.

The steam condensates from the second to last effect of the evaporator will be segregated and the condensate from the clean section of these effects will be recycled to some of the effects at the front end for internal extraction to produce condensate "A" to be used in the fiber line and in the causticizing area. Condensate "A" is a cleaner condensate, which allows it to be reused in the process.

The floor channels will be connected to a collection pit, from which the spills will be returned to the liquor spill tank. The tank will be installed inside a containment tank.

Recovery boiler

Accidental discharges or spills from this area have a high black liquor content and must be recovered. The basic treatment is similar to the cooking area and the brown pulp line.

Spills from the upper floors will be collected and sent to an unloading tank, and will go to the collection pit, which will also receive spills on the ground floor. These spills will be pumped into an overflow tank at the evaporation plant, where they will be recovered.

Causticizing

In this area, spills will be collected and sent to two collection wells, which have an agitation system, conductivity measurement and pumps. If the spill is within a certain conductivity range, it will be sent to the clarifier for recovery.

A lime mud recovery system is foreseen in case of unscheduled lime kiln stops. The temporary storage of the lime mud will be carried out in a paved place with walls, avoiding its loss.

Other areas

The chemical preparation area will be surrounded by retaining walls. In addition, the chemical tanks will also be contained by dikes. If there is a spill in the area, they will be sent to mixing tanks to adjust the pH and then sent to the effluent treatment plant.

Fuel oil storage will also be contained by retaining walls with a well. In the event of a spill, a pump will be installed to send the fuel to a tanker truck. Fuel oil heaters in process areas should have their own containment walls.

All process areas will have a spill system, gate system, and effluent conductivity. After a certain conductivity, the effluent is recovered in the process.

2.5.1.3 Effluent Treatment Plant (ETP)

The pulp mill industrial liquid effluent will be measured for flow, temperature, pH and conductivity and, depending on the results, diverted to emergency lagoon. The other part of the treatment system description is below.

Specific effluent

Effluent from the chlorine dioxide plant, ash leaching, and boiler make-up water plant will also be segregated from the main lines, as they have no organic load, requiring only pH control before release. The specific neutralized effluent will be added to the other treated effluent in the treated effluent tank for disposal in the Paraguay River.

Sanitary effluent

Sanitary effluent generated at the mill will be collected from the sanitary effluent network and sent to the ETP directly for biological treatment.

Summary of the Effluent Treatment System

PARACEL's effluent treatment system will basically consist of three stages: solids removal, organic load removal and final polishing. The main units of this system are listed and described below.

The main stages of the effluent treatment process are:

- Screening;
- Primary clarifier;
- Emergency lagoon;
- Neutralization;
- Cooling;
- Activated sludge - aeration tank;
- Secondary clarifier;
- Tertiary treatment;
- Emissary.

Screening

Effluent will be directed by gravity to a screening system to remove coarse materials. This system will have 2 sets composed of a mechanized screen and a manual screen, which will be used when the mechanized screen was subjected to maintenance.

Primary clarifier

After passing through a grid system and flow measurement, the effluent will be sent to two primary clarifiers with a diameter of 68 m to reduce the amount of suspended solids. These clarifiers will be equipped with a scraper to remove sedimentary solids and surface foam. The settled solids and the slag will be removed by pumps that will be sent to the primary sludge dewatering system. The clarified effluent will be sent to the neutralization system.

Primary sludge dewatering system

The primary sludge dewatering system will have a total capacity of 42 tDS/day. Each assembly will consist of a mechanical drum type or gravity type table thickener and a screw type dewatering press. The expected final consistency of the dewatered sludge is between 35 - 45%.

Emergency lagoon

In addition to the systems for preventing and collecting leaks and spills in each department of the mill, there will be a set of emergency lagoon at the effluent treatment plant. The purpose of these lagoons will be to receive all effluent with characteristics that are out of specification. Once discharged into the emergency lagoon, these effluents will be sent at the inlet to the neutralization tank so that no disturbance to the biological treatment is created.

Its operation will be controlled by on-line monitoring of pH, temperature and conductivity. When levels over the acceptable range occur, the valves will be closed, and the effluent diverted to the emergency lagoon.

The total volume will be approximately 70,000 m³ to receive the process effluents considered contaminated.

The lagoons will be constructed with a properly sealed bottom and sloped towards the drainage pumps.

Contaminated rain water

Rain water with the possibility of contamination will be sent to the contaminated rain water retention lagoon to avoid hydraulic overloading in the treatment plant due to high rainfall. Once discharged to the retention lagoon, the rain water will be treated and slowly diverted to the effluent treatment plant.

Effluent neutralization

The effluent clarified in the primary clarifiers will be sent to a neutralization tank. The purpose of this step will be to neutralize the effluent by adding caustic soda or sulfuric acid to maintain a pH between 6 and 8, making it suitable for biological treatment.

The neutralization tank will have a capacity of approximately 2,900 m^3 and will be equipped with mechanical agitators.

Effluent cooling

Because the neutralized effluent has a temperature considered high for biological treatment, the effluent must be cooled to a temperature that does not affect the performance of the biological treatment.

The effluent will be cooled through a cooling tower composed of six cells, which is sized for an inlet temperature of approximately 70°C and an outlet temperature of approximately 35°C.

Activated sludge

The biological treatment system adopted at PARACEL will be the activated sludge aerobic type. The activated sludge process is a proven technology and is commonly used in the pulp and paper industries worldwide.

The biological process requires sufficient concentrations of nitrogen and phosphorus in the effluent for optimum performance. The amounts required will be related to the amount of biodegradable organic matter, i.e. BOD (Biochemical Oxygen Demand) present in the untreated effluent.

Urea and phosphoric acid are considered sources of nitrogen and phosphorus and will be added, if necessary, before the effluent enters the selector tank. The amount required will depend on the amount present in the effluent (only the minimum amounts necessary should be added, to minimize discharges).

After dosing nutrients, the effluent will be sent to the selector tank, which will have a high oxygenation capacity and is intended to eliminate filamentous organisms. From this tank, the effluents will go to the aeration tank, where they will be submitted to the degradation of the organic matter present in a soluble and colloidal form through the activity of aerobic microorganisms. The injection of air into the system will be carried out through fine bubble diffusers that will be installed in the bottom of the aeration tank. These diffusers will supply the necessary oxygen for the development of bacteria and will promote the mixing of the liquid mass contained in the aeration tank, keeping the mixture in suspension.

The aeration tank (including the selector) will have a total volume of approximately 160,000 m^3 and the diffusers will be fed by blowers with a total capacity of approximately 130,000 Nm^3/h, one of which will be reserved for maintenance.

Figure 14 – Aeration tanks

In the activated sludge process, the biological mass (sludge) to be physically separated from the liquid mass (clarified effluent) will be formed by three two clarifiers, each one with a diameter of 82 m.

The secondary (biological) sludge will be constantly removed from the bottom of the clarifiers by scrapers and directed by gravity to a sludge pit, from where it will be pumped to the selector tank, with its recirculation. The excess biological sludge will be sent to the secondary sludge dewatering system.

Secondary sludge dewatering system

The secondary sludge dewatering system will have an estimated total capacity of 30 tDS/day and will consist of mechanical type thickeners and centrifuges. The expected final consistency of the dewatered sludge is between 15 and 20%.

Tertiary treatment

After the biological treatment, the effluent will undergo a tertiary treatment to remove phosphorus, color and COD.

The tertiary treatment will be through a physical-chemical process with the application of aluminum sulfate and polymer in coagulation and flocculation tanks and then directed to the dissolved air flotation (DAF). The flotation system has the advantage of obtaining an approximately thickened sludge, which reaches a consistency of 2.0 to 3.0%. The tertiary sludge is supported by a dedicated dewatering system.

As an alternative to the physicochemical flotation system, tertiary treatment can be carried out by injecting ozone into the effluent. The ozone will be produced on site, through electric discharge in oxygen. In this alternative, the effluent will pass through a sealed contact tank, which will be hermetically sealed, where the ozone will be introduced through fine diffusers. The off gas can be reused and injected into the biological treatment aeration tank. After passing through the contact chamber, the effluent will be sent to the biological filters to retain the suspended solids.

The treated effluent will be discharged through emissaries and diffusers into the Paraguay River. It should be noted that the point of discharge will be located above the point of raw water intake for PARACEL pulp mill.

Tertiary sludge dewatering system

The tertiary sludge from flotation, where a consistency of 2.0 to 3.0% is expected, will be sent to a homogenization tank equipped with a mechanical agitator. This tank will also receive the sludge from the decanters of the Water Treatment Plant (WTP). From the homogenization tank, the mixed sludge (tertiary + WTP) will be pumped to centrifuges, where it will reach a final consistency of about 15%. It is planned to add polymer to the centrifuge inlets to increase dewatering efficiency.

2.5.1.4 Effluent Final Disposal

The treated effluent will be discharged into the Paraguay River through an underwater emissary.

The emissary is intended to discharge treated effluent into the Paraguay River in a controlled and safe manner through underwater discharge under conditions that prevent the formation of foam and promote more efficient dispersion in the water body.

The complete system consists of: (a) treated effluent well; (b) an emissary of treated effluent to the margin of the Paraguay River, at the point of discharge; (c) control valves; (d) drainage pipes in the river bed; (e) vertical diffuser pipes ("risers") with holes for underwater release and dispersion in Paraguay river waters.

The underwater pipes will consist of 3 parallel HDPE (High Density Polyethylene) lines in the river bed. In certain places that favor a better dispersion in the river waters and the homogenization of the mixture, there will be vertical steel pipes ("risers"), which will conduct the treated effluent from the buried pipes approximately 50 cm above the river bed.

At the end of each "riser", there will be a 90° curve towards the horizontal. At the end of this curve, a special check valve will be installed, which will allow the discharge of effluent jets in an optimized way, as well as prevent the entry of sand and dirty particulates into the system.

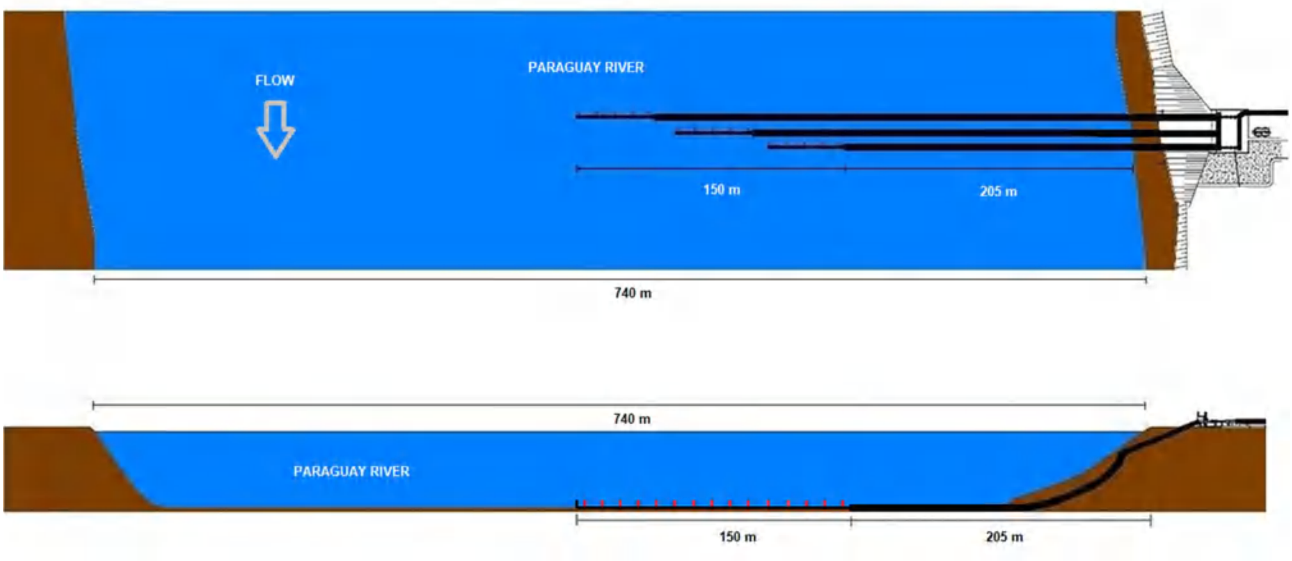


Figure 15 – Illustration of the discharge system

Figure 16 – Effluents emissary pipeline

2.5.2 Rainwater drainage

The rainwater that falls in the process areas, since they have the greatest potential for contamination, will be sent along with the effluents to the PARACEL Effluent Treatment Plant (ETP).

Rainwater falls on the roof areas, streets, etc. as well as the log storage yard, as they have less potential for contamination, will be sent to rainwater lagoons, which will receive pH and conductivity measurements to avoid hydraulic overload in the ETP due to high precipitation. In these lagoons, if pH and/or conductivity parameters are outside acceptable standards, these waters will be sent to the plant's ETP. Otherwise, they will be sent for disposal to the river, which will be done through the treated effluent drainage. It is important to note that this rainwater will be added to the treated effluent after the effluent measurement and sampling point.

2.5.3 Atmospheric Emissions

2.5.3.1 Emission sources

The main air emission sources of PARACEL pulp mill arisen from the following equipment:

- Recovery boiler;
- Lime Kiln; and
- Biomass boiler.

2.5.3.2 Main control parameters

The main control parameters related to significant air emissions from a pulp mill are:

- Particulate Material;
- TRS (total reduced sulfur);
- SOx (Sulphur oxides);
- NOx (Nitrogen oxides); and
- CO (Carbon monoxide).

2.5.3.3 Technologies to minimize, control and monitor air emissions

The mitigation, control and monitoring of air emissions will be based on the technologies already established and used with great success, which are listed below:

- Use of low odor recovery boiler;
- High dry solids content of up to 80% in the liquor burned in the recovery boiler, which minimizes SOx emissions;
- Use of high efficiency electrostatic precipitators for the recovery boiler, biomass boiler and lime kilns;

- Collection of concentrated non-condensable gases (CNCG) from the digester and evaporation, and their incineration in the recovery boiler or biomass boiler (protected flame incineration);
- Extensive collection of diluted non-condensable gases (DNCG) from the digester, brown pulp line, evaporation, with treatment in the recovery boiler;
- Treatment of gases from the dissolving tank in the recovery boiler;
- Efficient cleaning of relief gases from bleaching plant;
- Real-time gas monitoring systems and control system, rapid identification and correction of operational disturbances.

2.5.3.4 Technologies for controlling emissions of air pollutants

Recovery boiler

The recovery boiler will be equipped with a high efficiency electrostatic precipitator to remove particulate material, which will be collected and transported to the mixing tank.

This type of equipment to control air emissions from recovery boilers is used worldwide.

The electrostatic precipitator will promote the removal of solid or liquid micro-particles, charged by flue gases, through the use of static electricity.

The removal process is based on the ionization (localized concentration of electric charges) of these particles, induced by a powerful electric field, through the action of the so-called "corona effect". This effect consists of the release of electrons from the positive electrode to the gas adjacent to it, thus reaching the charged particles, causing a displacement to the other electrode (or plate) that works as a collector. This creates a layer of dust in this collector.

The powder layer is compacted and held together with the electrodes by the forces of the electric field. When this layer becomes sufficiently thick and agglomerated, it is subjected to mechanical action, which causes it to fall to the bottom of the precipitator and is removed dry by a drag conveyor.

The electrostatic capture process is highly efficient, allowing the removal of extremely fine particles.

Due to the high resistivity of the gaseous media, the potential difference to be applied between the electrodes must be high, which explains the high voltage verified in this equipment.

The precipitator to be used will have independent chambers, which will work together, in parallel. In this way, it is possible to eliminate occasionally one of the operation chambers, to provide maintenance and not to affect significantly the general efficiency of the control installation, since the system is already designed to support events of this nature.

As an integral part of the equipment, an automatic operation management and control system will be installed, based on the use of instrumentation coupled to microprocessors. Its function will be to maintain the operating conditions of the precipitator in the ideal operating ranges.

Lime kilns

For air pollution control, lime kilns shall be equipped with high efficiency electrostatic precipitators to remove particulate matter from the flue gases. This material will be returned to the lime kilns. The description of the precipitator control is similar to the description of the recovery boiler.

Biomass boiler

Due to the legal requirements regarding the emission of particles in the flue gases, the best alternative for cleaning the gases generated in the combustion by the biomass boiler will be high efficiency electrostatic precipitators to remove the particulate material.

Non-condensable gas collection and incineration system

The high concentration non-condensable gases generated in the evaporation plant will be incinerated in the recovery boiler. If burning in the recovery boiler is not possible, these gases will be incinerated in the biomass boiler (back-up equipment 1) and, if this is not possible, they will be incinerated in a flare.

Low concentration non-condensable gases collected from various sources in the process areas of the fiber line and evaporation plant will be conditioned before being introduced as secondary air to the recovery boiler or biomass boiler (back-up equipment 1).

The diluted gases from the recovery boiler dissolving tank shall be cooled in a scrubber, reheated and introduced as tertiary air to the recovery boiler.

Ventilation gases from the lime fire extinguisher, causticizing equipment, storage tanks and causticizing equipment will be collected, cooled in a heat exchanger to remove moisture and sent, via a fan, as combustion air to the lime kilns.

2.5.4 Solid Waste

2.5.4.1 Generation Sources

PARACEL pulp mill operation will generate industrial and non-industrial solid waste.

2.5.4.2 Industrial Solid Waste

The industrial solid waste generated by the pulp process will come from the wood handling, causticizing, boiler, and water and effluent treatment plant areas.

The following main waste is included in this category:

- Waste from wood preparation;
- Dregs, grits and lime mud;
- Ash from the biomass boiler;
- Primary, secondary and tertiary sludge from the effluent treatment plant; and
- Sludge from the water treatment plant.

2.5.4.3 Non-Industrial Solid Waste

Non-industrial solid waste will be generated in administrative and operational support activities such as offices, cafeteria and maintenance workshops.

The following primary waste is included in this category:

- Metal
- Paper or cardboard
- Plastic
- Glass
- Recyclable and non-recyclable organics
- Waste from health services
- Materials contaminated with oil and grease
- Used lubricating oil
- Fluorescent lamps and batteries

2.5.4.4 Solid Waste Management System

The management of solid waste generated in the operation of PARACEL's pulp mill will include the best practices, in accordance with Law n. 3,956/2009 and Decree n. 7,391/ 2017 (Integral Management of Solid Waste in the Republic of Paraguay), among which are:

- Adoption of minimization measures;
- Segregation (selective or separate collection);
- Collection, storage and transport in accordance with the law;
- Treatment or processing and use, until final disposal in sanitary (organic) or industrial landfill.

Waste classification

According to Decree 7,391/2017, solid waste in Paraguay is grouped and classified into categories: municipal solid waste, special handling waste (non-hazardous), and hazardous waste.

- <u>Urban solid waste</u>: that generated in each room, housing unit or similar.
- <u>Special handling waste (non-hazardous):</u> industrial waste, waste from agricultural, fishing, forestry and livestock activities, transport services, civil construction and others.
- <u>Hazardous waste:</u> provided for in Law 567/1995, which has explosive, flammable, oxidizing, toxic, infectious, radioactive, corrosive, etc., characteristics that may cause risks to human or environmental health.

Segregation and Conditioning of Solid Waste

The pulp mill's waste management system will have selective or separate collection, which consists of separating waste so that it can be recycled later.

The containers and bins in the offices and operational areas will have the following colors, based on Resolution S.G. 548/96 of the Ministry of Health and Public Welfare, as presented in the table below.

Table 2 – Colors of containers at offices and operational areas

Solid wastes	Color
Metal	**Yellow**
Paper or cardboard	**Blue**
Plastic	**Red**
Glass	**Green**
Hazardous waste	**Orange**
General non-recyclable waste	**Gray**
Health Service	**White**
Wood	**Black**
Organic	**Brown**

In accordance with Decree 7,391/2017, the containers and recipients used for the temporary storage of solid waste will have the following requirements:

- Reusable;
- Properly located and covered;
- Capacity to store the volume of solid waste generated, taking into account the frequency of collection;
- Built with waterproof materials and with the necessary strength for their intended use;
- Identification regarding use and types of solid waste.

Waste from health services (mainly sharps) must be segregated and conditioned in containers or recipients, in accordance with Law 3361/2007.

Non-industrial waste (non-hazardous and hazardous) will be temporarily stored in a facility until it is sent for treatment procedures specific to each type of waste.

The storage facility for non-hazardous waste will be an open, fenced, signposted yard with a compacted floor.

The storage area for hazardous waste will be a warehouse covered with metal tiles, closed at the sides, with natural ventilation, marked and with a concrete floor.

The rainwater that falls on the yard and on the roof of the storage facility (not contaminated) will be conveyed to the plant's rainwater drainage system via drainage channels to the Paraguay River.

2.5.4.5 Treatment and Final Disposal

Solid waste will be destined for treatment or final disposal, as presented in the table below.

Table 3 – Treatment or final disposal

Waste	Treatment or final disposal
Wood waste + sand	Production of compost (forest application) or burning in PARACEL's biomass boiler or industrial landfill
Dregs	Production of soil acidity corrector (forestry application) or PARACEL industrial landfill
Grits	Production of soil acidity corrector (forestry application) or PARACEL industrial landfill
Lime mud	Production of soil acidity corrector (forestry application) or PARACEL industrial landfill
Ashes + sand	Production of soil acidity corrector (forestry application) or PARACEL industrial landfill
Primary sludge ETP	Production of compost (forest application) or burning in the biomass boiler or recycling or industrial landfill PARACEL
Biological sludge ETP	Production of compost (forest application) or burning in PARACEL's biomass boiler or industrial landfill
Tertiary sludge ETP	PARACEL Industrial Landfill
WTP sludge	PARACEL Industrial Landfill
Metal	Recycling
Paper or cardboard	Recycling
Plastic	Recycling
Glass	Recycling
Recyclable and non-recyclable organics	PARACEL sanitary landfill (organic)
Waste from health services	Decontamination and sanitary landfill (external)
Oil contaminated	Incineration or co-processing
Used lubricating oil	Recycling
Fluorescent lamps and batteries	Decontamination and recycling (external)

2.5.4.5.1 Composting Plant

A composting plant will be installed at the pulp mill to treat organic (non-hazardous) industrial waste generated at the effluent treatment plant (primary and biological sludge) and in the wood yard (wood waste).

Composting has been practiced since ancient history and can be defined as an exothermic aerobic bio-oxidation of a heterogeneous organic substrate, in a solid state, characterized by the production of CO_2, water, release of mineral substances and formation of stable organic matter (PROSAB, 1999).

In practice, this means that, from organic waste, the process transforms these residues into compost, which is an agricultural input, easy to handle and free of pathogenic microorganisms (PROSAB, 1999).

The biodegradable organic components undergo successive stages of transformation under the action of various groups of microorganisms, resulting in a highly complex biochemical process (PROSAB, 1999).

Being a biological process, the most important factors influencing the degradation of organic matter are aeration, nutrients and moisture. Temperature is also an important factor, especially with respect to the speed of the biodegradation process and the elimination of pathogens but is the result of biological activity. Nutrients, mainly carbon and nitrogen, are essential for bacterial growth. Carbon is the main source of energy and nitrogen is necessary for cell synthesis (PROSAB, 1999).

The composting process has the following main objectives:

- Recycle properly, through an efficient composting system, the waste generated and likely to be used;
- Systematize and homogenize the return of the nutrients contained in the waste to the forest plantations, making fertilizations with the compost produced;
- Improve the nutritional status and physical parameters of the soil by adding organic matter;
- Promote the partial replacement of fertilizers and chemical correctives used, with environmental and economic gains;
- Ensure the proper disposal of waste generated by industry in accordance with technical standards and environmental law in force.

The use of this type of waste in the composting process to produce compost is a sustainable alternative for waste disposal, aligned with the concepts of circular economy and best available practices. From an environmental point of view there is a reduction in the generation of waste, and from an economic point of view, less agricultural inputs are used with the use of compost.

<u>Design Criteria</u>

An area of 20 hectares (200,000 m²) is planned for the installation of the composting plant and the soil acidity corrector production plant.

Some criteria were established for the selection of the composting plant area, based on SEAM Resolution 282/2004. The criteria adopted are presented in the table below.

Table 4 – Criteria for selection of the composting plant area

Criteria	Values
Distance from water courses, flood areas, springs and wetlands	More than 200 meters, distance measured from the maximum flood level
Distances from environmental and cultural protection areas	1,000 meters
Depth of groundwater	With base waterproofing through compacted clay layer the distance from the groundwater to the base of more than 3.0 meters and the waterproofing layer must have a permeability coefficient of 1 x 10^{-6} cm or less.
Distance from nearest housing, water supply wells, education and health centers	500 meters

<u>Composting plant description</u>

The design of the composting plant will include the following elements:

- Soil waterproofing system
- Storm water drainage system
- Groundwater monitoring system

The description of the project elements is presented below.

Soil Protection System

The waterproofing of the floors of the open yards and the warehouse will be with a layer of compacted clay (permeability coefficient of 1 x 10^{-6} cm or less) and must be more than 3.0 meters away from the groundwater level.

Rainwater Drainage System

<u>Contaminated Rainwater</u>

Rainwater falling over the open yards will be directed by gravity to a lagoon or tank, where it will be pumped to the Effluent Treatment Plant.

<u>Uncontaminated Rainwater</u>

Rainwater falling on the roofs of the storage (non-contaminated) will be led to the rainwater drainage system of the pulp mill, through natural drainage in the ground or through drainage channels up to the Paraguay river.

Groundwater monitoring system

The groundwater monitoring system will include several monitoring wells in the area surrounding the composting plant.

<u>Description of Compost Production</u>

The waste generated in the effluent treatment (primary and biological sludge) and in the wood yard (wood waste) will be transported to the composting plant, where they will be temporarily stored in open yards (waterproofed floor with a clay layer) or sent directly to the process.

The wood waste will undergo a chipping process to reduce the size of the waste and optimize the composting process.

The waste will be mixed in the open composting yard (waterproof floor with clay layer), where the rows will be formed through a loader.

The composting process (bio-stabilization phase + maturation phase) will last 120 days. At the end of this process, the compost will be ready, but with irregular granulometry. In this way, it will be sent to the beneficiary for evaluation.

During the composting process, windrows will be turned (to provide aeration) and process controls will be carried out (temperature, moisture, pH and C/N ratio). In addition, water irrigation will be carried out to maintain the moisture of the material when necessary.

The compost produced will be transported to a warehouse, where it will undergo mechanical processing, consisting of rotary sieving, to standardize its granulometry.

The finished compost will be transported to its destination using trucks.

The following figure shows the flow chart of compost production.

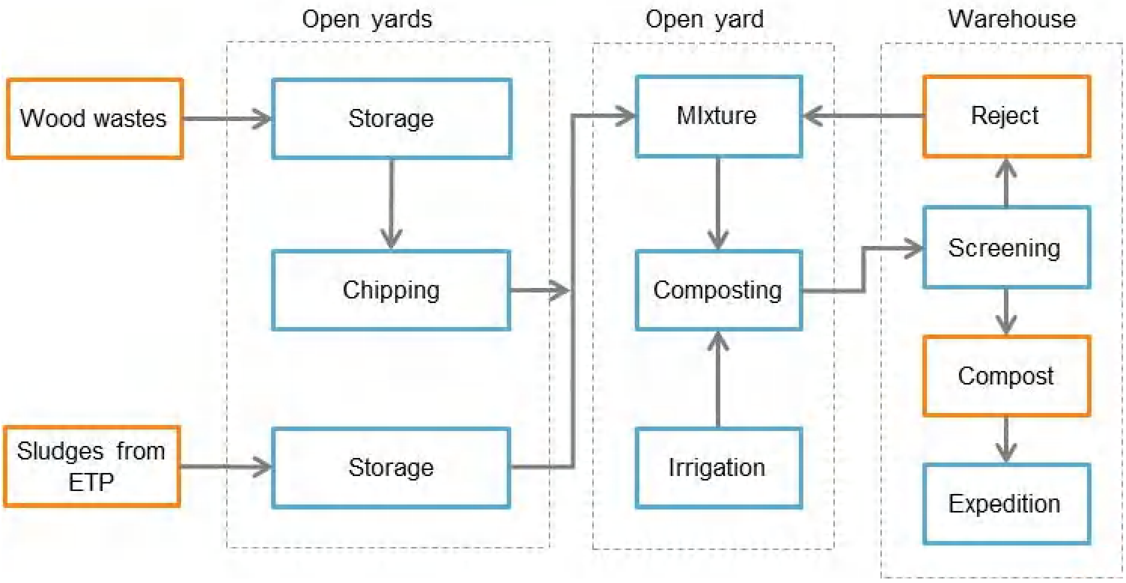


Figure 17 – Flowchart of compost production

2.5.4.5.2 Sludge incineration in biomass boiler

An alternative to the composting process, which can be used by PARACEL, is the burning of primary and biological sludge together with biomass in the biomass boiler (designed for this purpose).

Currently, several companies in the pulp and paper sector have used the biomass boiler to burn primary and biological sludge from the ETP, instead of its destination for composting or industrial landfill, such as Klabin, Suzano, Eldorado, Veracel, Cenibra, CMPC and Arauco.

The use of these wastes as fuel in the biomass boiler, for the generation of steam and electric energy, is a sustainable energy matrix alternative. From an environmental point of view, there is a reduction in the generation of waste, and from an economic point of view, less biomass is used due to the use of sludge.

2.5.4.5.3 Soil Acidity Corrector Production Plant

The pulp mill will be equipped with a plant to produce a soil acidity corrector, to treat the inorganic (non-hazardous) industrial waste generated in the causticizing (dregs, grits and lime mud) and in the biomass boiler (ash).

The production of the soil acidity corrector consists of drying the waste (dregs, grits, lime mud and ashes) and making a balanced mixture.

Depending on their composition, lime mud and ashes can be used individually as soil acidity correctors.

Lime mud and the mixture of dregs and grits are alkaline, basically carbonate by-products, which have a high concentration of nutrients such as calcium and magnesium and have a high capacity for neutralization.

The ash, despite the low capacity of neutralization, has a concentration of macronutrients such as phosphorus, potassium, calcium and magnesium that enrich the acidity corrector of the soil. These nutrients are important for the development of the plantation.

Design Criteria

An area of 20 hectares (200,000 m²) is planned for the construction of the soil acidity corrector production plant and the composting plant.

Some criteria were established for the selection of the area of the corrector production plant, based on SEAM Resolution 282/2004. The criteria adopted are presented in the following table.

Table 5 – Criteria for selecting the area of the corrective production plant

Criteria	Value
Distance from water courses, flood areas, springs and wetlands	Greater than 200 meters, distance measured from the maximum flood level
Distances from environmental and cultural protection areas	1,000 meters
Depth of groundwater	With base waterproofing through plastic membranes the distance from the water table to the base is more than 1.5 meters.
Distance from nearest housing, water supply wells, education and health centers	With base waterproofing through compacted clay layer the distance from the groundwater level to the base of more than 3.0 meters and the waterproofing layer must have a

Criteria	Value
	permeability coefficient of 1 x 10^{-6} cm or less.

Description of the Acidity Corrector Production Plant

The design of the corrector production plant will include the following elements:

- Soil waterproofing system
- Storm water drainage system
- Groundwater monitoring system

The description of the project elements is presented below.

Soil protection system

The soil of the open patios and two greenhouses will be covered with a layer of compacted clay (permeability coefficient of 1 x 10-6 cm or less) and must be more than 3.0 meters away from the groundwater.

The impermeabilization of the warehouse floor will be made of concrete.

Rainwater drainage system

Contaminated rainwater

Rainwater falling on the open yards will be directed by gravity to a lagoon or tank, where it will be pumped to the wastewater treatment plant.

Non-Contaminated Rainwater

The rainwater that falls on the roofs of the warehouses and greenhouses (non-contaminated) will be led to the rainwater drainage system of the pulp mill, through natural drainage in the ground or by means of drainage channels up to the Paraguay river.

Groundwater monitoring system

The groundwater monitoring system will include several monitoring wells in the area surrounding the corrective production plant.

Acidity Corrector Production Description

The waste generated in the pulp production process (dregs, grits, lime mud and ashes) will be transported to the soil acidity corrector production plant, where they will be temporarily stored in open yards or sent directly to the drying process.

Wet waste (dregs, grits and lime mud) will undergo the natural drying process to reduce the moisture content. This drying process will take place in agricultural greenhouses.

After drying, the dry residues can be sent directly to the agricultural crop or to produce the soil acidity corrector.

The dry residues, including boiler ashes, are mixed in ideal proportions, constituting the soil acidity corrector which is then screened to standardize its granulometry. This whole process will take place in a warehouse.

The ready acidity corrector will be temporarily stored or loaded onto trucks. On leaving the plant, these trucks will be weighed, and the corrector will be transported to its final destination.

The following figure shows the flow chart of the production of soil acidity corrector.

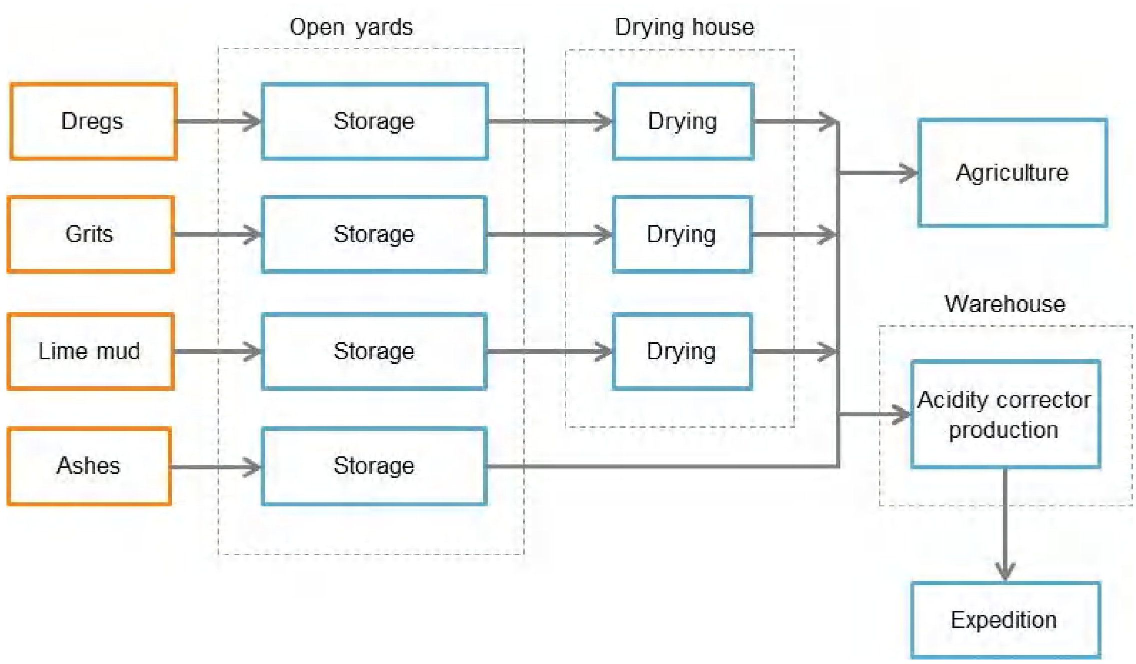


Figure 18 – Flowchart of acidity corrector production.

2.5.4.5.4 Industrial landfill

An industrial landfill will be installed at the pulp mill for the final disposal of industrial (non-hazardous) waste generated in the production process, which cannot be used for the proposed treatments (composting and production of soil acidity corrector).

<u>**Industrial landfill description**</u>

The industrial landfill project will include the following elements, in accordance with Decree 7,391/2017 and the best available practices:

- Soil protection system
- Leak detection system
- Leachate handling and pumping system
- Gas handling system
- Rainwater drainage system
- Groundwater monitoring system

Soil protection system

In order to protect the soil and groundwater, the landfill will have waterproofing of the base and slopes through a layer of compacted clay soil (50 cm) and a double membrane of High Density Polyethylene (HDPE), with a thickness of 1 mm. In addition, the distance from the groundwater to the base will be more than 1.5 meters, in accordance with Decree 7,391/2017.

The soil permeability coefficient must be at least very low (permeability between 10^{-5} and 10^{-7} cm/s), in order to reduce the possibility of groundwater pollution.

Leak detection system

A leak detection system, consisting of HDPE pipes, will be installed below the base waterproofing between the membranes and connected to a monitoring well.

Leakage control will occur through visual verification of the monitoring well, which must always be dry. On the contrary, leaks are occurring through the HDPE membrane.

Leachate handling and pumping system

Above the base sealed, drainage pipes, of the Kananet type (diameter of 250 mm or similar), will be installed to collect the leachate generated in the decomposition of the waste. The drainage pipes will be protected by a geotextile blanket. In addition, there will be vertical perforated pipes in concrete, also to collect the leachate generated.

The leachate collected in the pipes will be directed by gravity to the pumping tank, where it will be sent to the wastewater treatment plant.

Gas handling system

The gas drainage pipes, of the Kananet type (100 mm diameter or similar), will be connected in the leachate drainage pipes and will rise through the slopes to the surface, where the release of the gases will occur.

This system has the function of dispersing the gases formed in the biodegradation of the waste into the atmosphere, minimizing the risks of accumulation of these gases in the mass of waste (creating gas pockets).

Rainwater drainage system

The rainwater drainage system will include half-round channels that will carry water to the mill drainage system.

Groundwater monitoring system

The groundwater monitoring system will comprise several monitoring wells to be installed in the area surrounding the industrial landfill.

2.5.4.5.5 Sanitary landfill (Organic)

A sanitary landfill (organic) will be installed at the pulp mill for the final disposal of the waste generated in the refectory, in the bathrooms and non-recyclable.

Description of Sanitary Landfill

The landfill project will include the following elements, in accordance with Decree 7,391/2017 and the best available practices:

- Soil waterproofing system
- Leak detection system
- Leachate handling and pumping system
- Gas handling system
- Storm water drainage system
- Groundwater monitoring system

Soil protection system

In order to protect the soil and groundwater, the landfill will have waterproofing of the base and slopes through a layer of compacted clay soil (50 cm) and a double membrane of High Density Polyethylene (HDPE), with a thickness of 1mm. In addition, the distance from the groundwater (phreatic) to the base will be more than 1.5 meters, according to Decree 7,391/2017.

The soil permeability coefficient must be at least very low infiltration (permeability between 10^{-5} and 10^{-7} cm/s), in order to reduce the possibility of groundwater pollution.

Leak detection system

A leak detection system, consisting of HDPE pipes, will be installed below the base waterproofing between the membranes and connected to a monitoring well.

Leakage control will occur through visual verification of the monitoring well, which must always be dry. Otherwise, leaks could have occurred from the HDPE membrane.

Leachate handling and pumping system

Above the ground protection, drainage pipes of the Kananet type (250 mm diameter or similar) will be installed to collect the leachate generated in the decomposition of the waste. The drainage pipes will be protected by a geotextile blanket. In addition, there will be vertical perforated pipes in concrete, also to collect the leachate generated.

The leachate collected in the pipes will be directed by gravity to the pumping tank, where it will be sent to the wastewater treatment plant.

Gas handling system

The gas drainage pipes, of the Kananet type (100 mm diameter or similar), will be connected to the leachate drainage pipes and will rise through the slope to the surface, where the release of the gases will occur.

This system has the function of dispersing the gases formed in the biodegradation of the waste into the atmosphere, minimizing the risks of accumulation of these gases in the mass of waste (creating gas pockets).

Rainwater drainage system

The storm water drainage system will include half-round channels that will carry water to the mill drainage system.

Groundwater monitoring system

The groundwater monitoring system will comprise several monitoring wells to be installed in the area surrounding the sanitary landfill.

2.6 Weather and Meteorological Characteristics

The climatic characterization of the region where the pulp mill is located considered the analysis of the following parameters: temperature, relative humidity, wind direction and speed, precipitation, solar radiation and water balance.

The meteorological and climatic information presented comes from the Climatological and Meteorological Study, carried out by the Company "CATAVENTO AMBIENTALE METEOROLOGIA E MEIO AMBIENTE", the data were obtained by surface meteorological stations approved in the region of the company.

The data used for the study of the region's climate were obtained from the Integrated Surface Database (ISD), which can be consulted on the website of the National Oceanic and Atmospheric Administration (NOAA). Four surface weather stations were chosen for the analysis of climate conditions in the region, which were more representative of the company's area, as shown below.

- Puerto Casado (USAF:860860/ICAO:SGLV), located 116 km of the north of the project, installed in the coordinates 22°16'58.80 "S e 57°55'58.80 "W. The data series examined is composed of 7 years (from 01/01/2013 to 12/31/2019);
- Pozo Colorado (USAF: 861280/ICAO: SGPC), located 136 km west of the project, at coordinates 23°30'0.00 "S e 58°46'58.80 "W. The data series examined is composed of 7 years (from 01/01/2013 to 12/31/2019);
- San Pedro (USAF: 861850/ICAO: SGSP), 99 km south of the project, located at coordinates 24° 4'1.20 "S e 57° 4'58.80 "W The data series examined is composed of 7 years (from 01/01/2013 to 12/31/2019);
- Teniente Coronel Carmelo Peralta (USAF: 861340/ICAO: SGCO), used as a reference station for the region, about 21 km from the project, located at coordinates 23°26'31.20 "S e 57°25'37.20 "W. The data series examined is composed of 10 years (from 01/01/2010 to 12/31/2019).

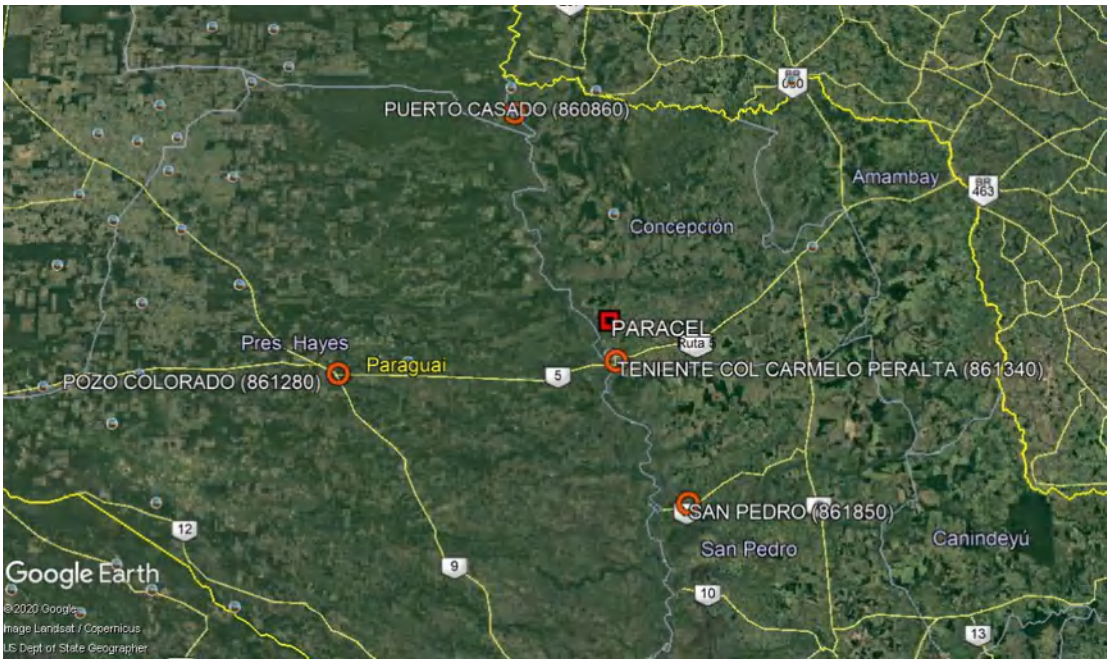


Figure 19 – Map of the location of the weather stations distant from the project. Source: Google Earth, 2020.

The climate type in Paraguay is tropical to subtropical, governed by tropical air mass and polar air mass, with hot and rainy summers and low and less rainy winters. The average annual temperature is 23°C and the average annual maximum is 29°C. There is a marked difference between the distribution of rainfall in the two regions into which the country is divided. In the Eastern Region, the average annual temperature ranges from 21°C to 23°C. In the Western Region, the average annual temperature is 24°C. The average recorded rainfall is 1,700 mm in the eastern region and 400 mm in the western region, near the border with Argentina and Bolivia (DGEEC, 2011).

According to Grassi et al. (2005), the Eastern Region, has an undulating and humid feature confined between the Paraguay and Paraná rivers, has a rugged topography with good drainage and a growing rainfall regime to the east and where the climate varies from humid sub-humid to humid, in the same orientation, giving rise to the large subtropical forests of the Atlantic basin.

According to this classification Pasten et al. (2011), the Eastern Region is defined with two types of climates:

- Tropical Shroud/Dry Winter (Aw): covers much of the department of Concepción and a small portion of northwest San Pedro;
- Temperate/No Dry Season/Hot Summer (Cfa) includes the departments of Amambay, Canindeyú, Central, Cordillera, Caaguazú, Alto Paraná, Paraguarí, Guairá, Ñeembucú, Misiones Itapúa and much of San Pedro.

The result of Köppen's climate classification, which can be seen in the Figure below, determined that in Paraguay there are three types of climate: tropical savannah with dry winter (Aw), semi-arid (Steppe) warm during all year (Bsh) and temperate climate, without dry season and hot summer (Cfa), this is the predominant climate in much of Paraguay (Pasten et al. 2011).

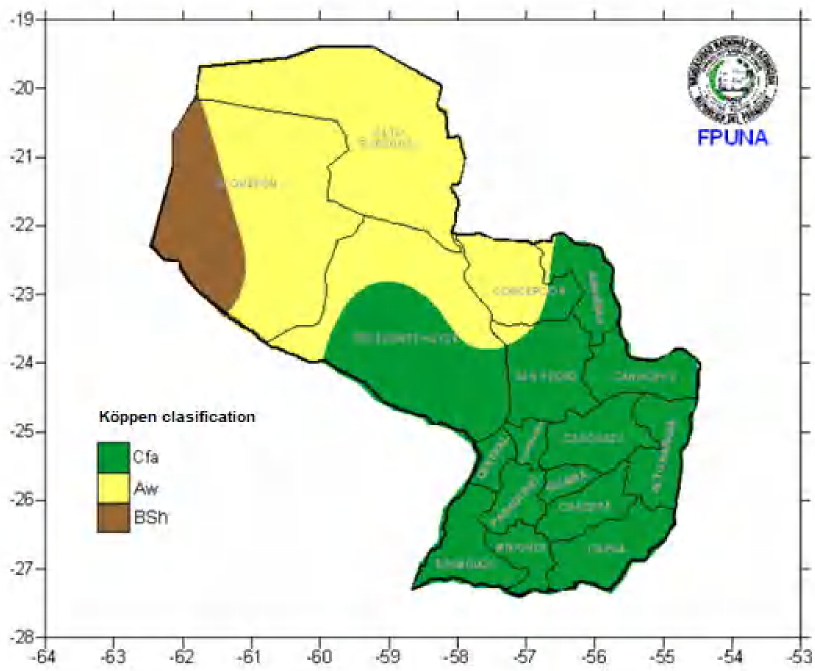


Figure 20 – Climate Classification of Köppen (1971-2010). Source: Pasten et al. (2011)

The parameters analyzed were: precipitation (mm), atmospheric pressure (hPa), air temperature (°C), relative humidity (%), wind speed(m/s) and wind direction (degrees).

2.6.1 Rainfall precipitation

No rainfall data are available in the database used for the study. Therefore, the study of rainfall precipitation was carried out by consulting the bibliography with information from previous studies of the region and the country.

Most of the country's rainfall is convective, produced by isolated storms or lines of instability that are frequent in spring and autumn. The average annual precipitation shows a great spatial variation. The greatest amplitude is towards the south of the country, varying zonally from 400 mm in the northwest of the Chaco to more than 1,800 mm in the Eastern Region.

The Paraná River basin is the wettest, with annual averages above 1,800 mm, while the Paraguay River basin receives maximums of 1,600 mm in the eastern region. Rainfall also shows great seasonal variability. They are lowest in July and August, and the average of the least rainy month usually does not reach 5% of the annual total. The highest volumes of precipitation occur during the months of October to April and are generally recorded in the form of storms or rainfall, as a result of atmospheric instability caused by strong warming of the lower layers of the atmosphere (Mayeregger and Romero 2017).

The highest precipitation rates in the region of Concepción occur in the summer. The month with the lowest rates is August, with an average of 28mm. In February and November, precipitation reaches its highest levels, between 128 and 152 mm on average. The average annual rainfall is approximately 1,190 mm (https://es.weatherspark.com/).

2.6.2 Atmospheric pressure

At the Puerto Casado station (860860), located 116 km north of PARACEL pulp mill, the atmospheric pressure varied between 1,001.4 and 1,004.9 hPa, while the average for the period from 2013 to 2019 was 1,002.9 hPa.

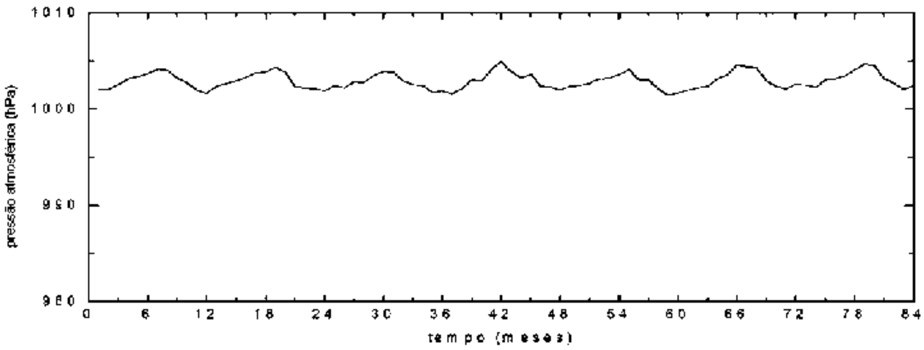


Figure 21 – Average monthly atmospheric pressure at the Puerto Casado station

At the Pozo Colorado station (861280), located 136 km west of the project, the atmospheric pressure varied between 999.4 and 1,002.7 hPa, while the average for the period from 2013 to 2019 was 1,000.8 hPa.

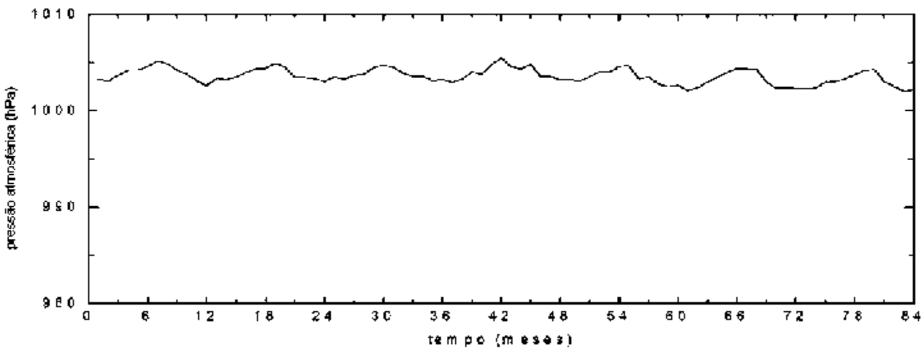


Figure 22 – Average monthly atmospheric pressure at the Pozo Colorado station.

At the San Pedro station (861850), located 99 km southeast of the project, the atmospheric pressure varied between 1,002.1 and 1,005.5 hPa, while the average for the period from 2013 to 2019 was 1,003.6 hPa.

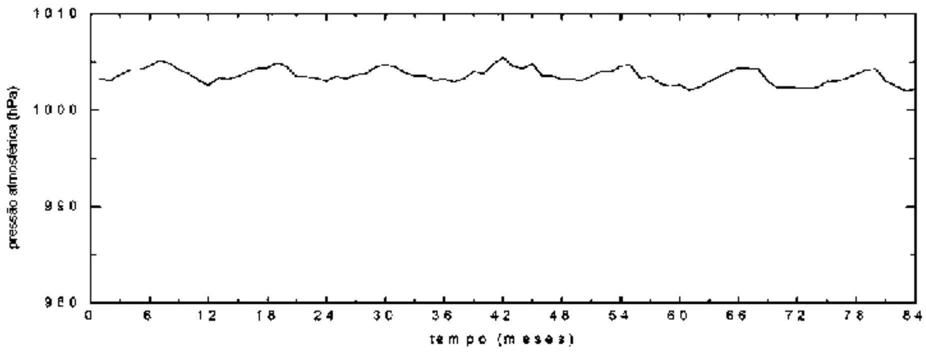


Figure 23 – Average monthly air pressure at San Pedro station

At the Lieutenant Colonel Carmelo Peralta station (861340), 21 km from the project, the atmospheric pressure varied between 1,001.5 and 1,007.5 hPa, while the provisional average climate for the period from 2010 to 2019 was 1,003.9 hPa.

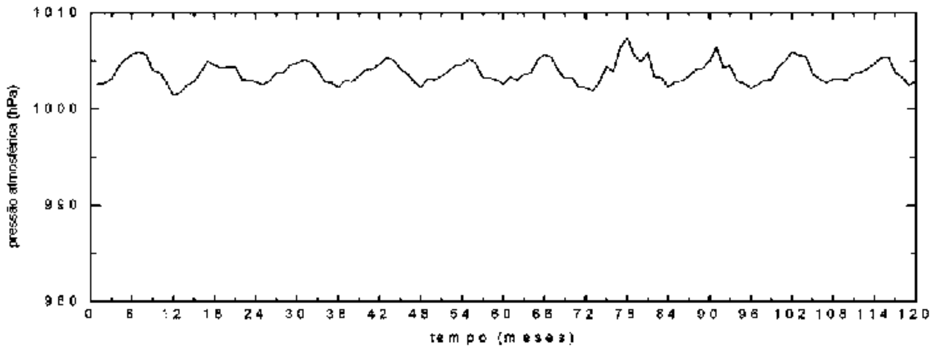


Figure 24 – Average monthly atmospheric pressure at the Teniente Coronel Carmelo Peralta station

Although the four weather stations cover a relatively large area and are separated by considerable distances, the atmospheric pressure behavior was similar in all stations and the average for the region was 1,002.8hPa.

2.6.3 Air Temperature

At the Puerto Casado station, the average monthly temperature varied between 16.9˚C and 31˚C, while the average for the period from 2013 to 2019 was 25.7˚C.

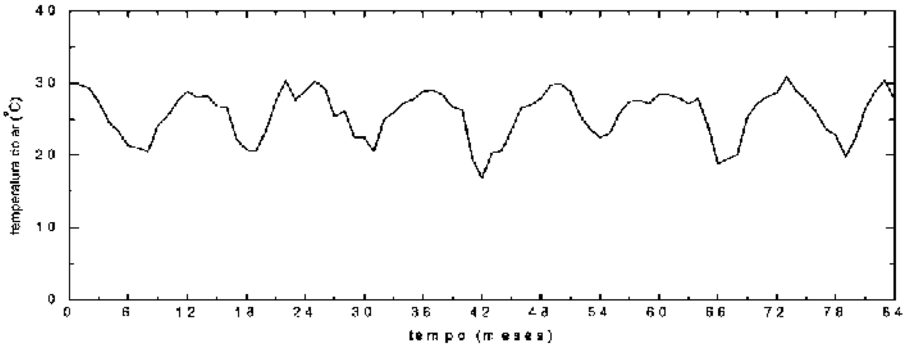


Figure 25 – Average monthly temperature at Puerto Casado station.

At Pozo Colorado station, the monthly average temperature varies between 15.5˚C and 31.2˚C, while the average for the period from 2013 to 2019 was 24.7˚C.

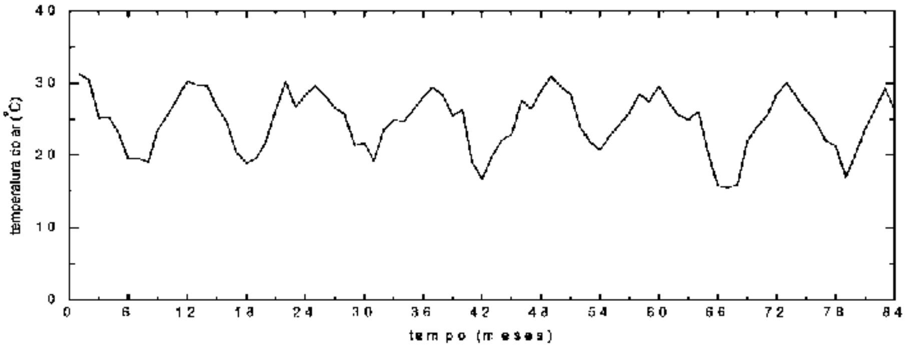


Figure 26 – Average monthly temperature at Pozo Colorado station

At the San Pedro station, the average monthly temperature varied between 16.5˚C and 30.5˚C, while the average climate for the period from 2013 to 2019 was 24.1˚C.

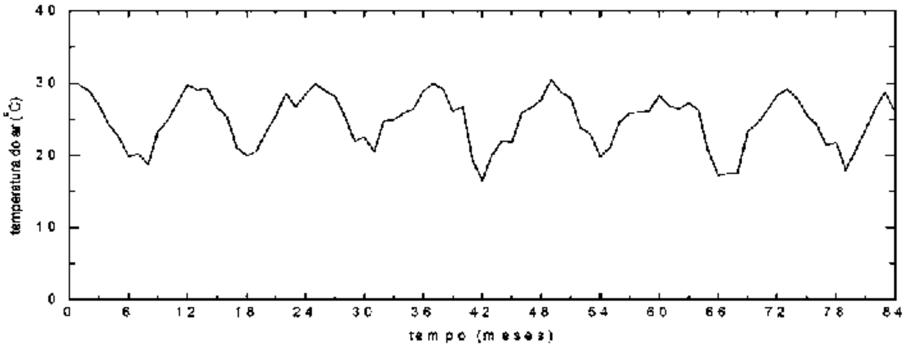


Figure 27 – Average monthly temperature at San Pedro station

At Teniente Coronel Carmelo Peralta station, the average monthly temperature varied between 15.5˚C and 29.6˚C, while the provisional average climate for the period from 2010 to 2019 was 24.3˚C.

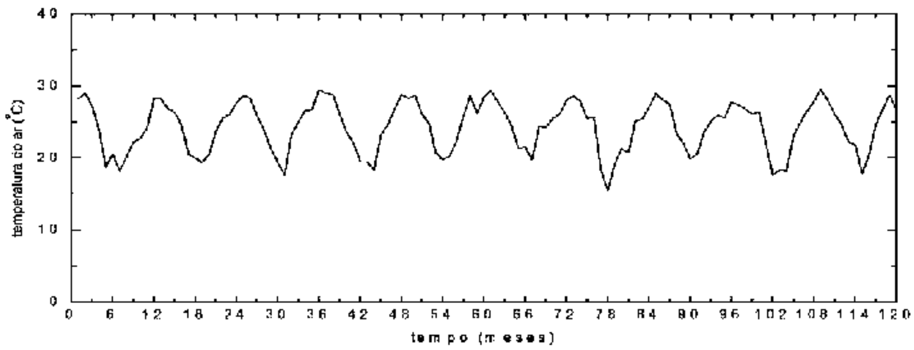


Figure 28 – Average monthly temperature at station Teniente Coronel Carmelo Peralta

The air temperature in the region is defined by the effect of continentality and topographic uniformity, presenting a great amplitude. In summer, as it is a tropical region, the maximum temperatures can exceed 30˚C, and in winter frost phenomena can be registered as a consequence of the entry of cold fronts.

The average temperatures are very similar in all the weather stations, from 24.1˚C in the San Pedro station, which is further south, to 25.7˚C in the Puerto Casado station, located further north. In the large region analyzed, the average temperature was 24.7˚C.

2.6.4 Relative Humidity

At the Puerto Casado station, the monthly relative humidity varied between 46.7% and 79.6%, while the average for the period from 2013 to 2019 was 63%.

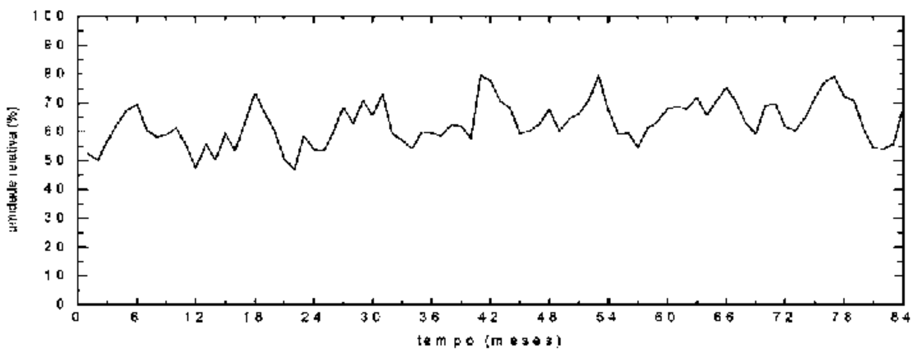


Figure 29 – Average monthly relative humidity at Puerto Casado station

At the Pozo Colorado station, the monthly relative humidity varied between 51.7% and 83.6%, while the average for the period from 2013 to 2019 was 70.2%.

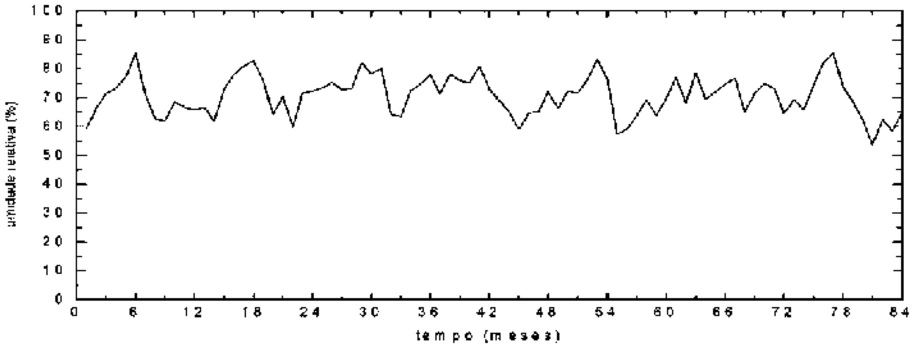


Figure 30 – Average monthly relative humidity at station Pozo Colorado

In the San Pedro station, the monthly relative humidity varied between 56.1% and 85.4%, while the average for the period from 2013 to 2019 was 70.5%.

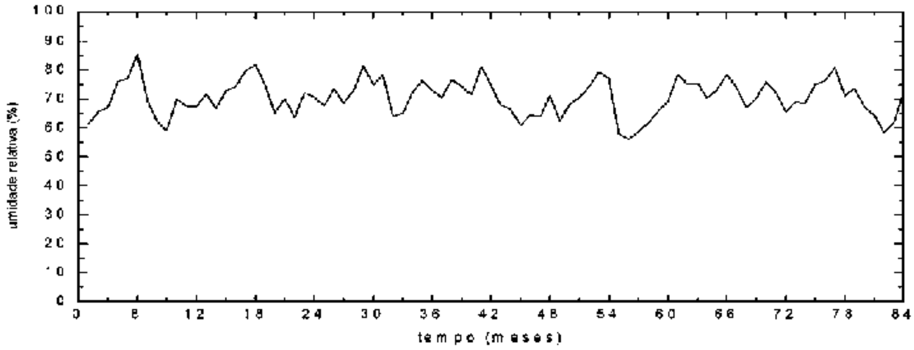


Figure 31 – Average monthly relative humidity at San Pedro station

At Teniente Coronel Carmelo Peralta station, the monthly relative humidity varied between 51.4% and 85.5%, while the provisional average for the period from 2010 to 2019 was 70.9%.

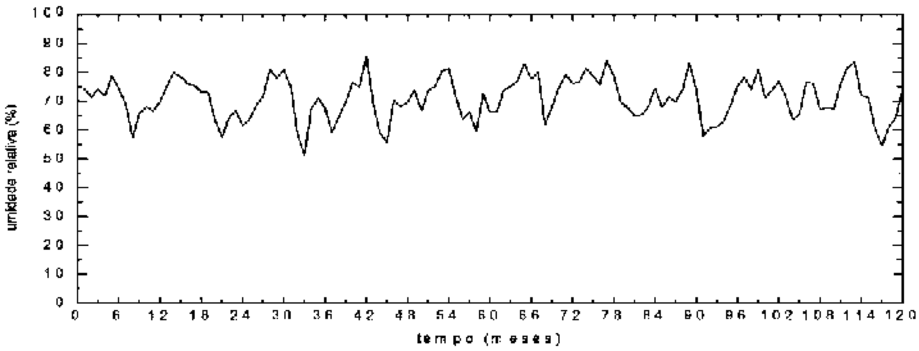


Figure 32 – Average monthly relative humidity at station Teniente Coronel Carmelo Peralta

The relative humidity at the Puerto Casado station, to the north of the future PARACEL factory, has an average relative humidity of 63%. The other regions presented values between 70.2% and 70.9%, the highest value being at the station of Lieutenant Colonel Carmelo Peralta. This difference is due to the variability of rainfall among the regions.

2.6.5 Wind

At the Puerto Casado station, the average monthly wind speed varied between 0.76 and 2.49 m/s, while the average for the period from 2013 to 2019 was 1.47 m/s.

At the Puerto Casado station, the average monthly wind speed varied between 0.76 and 2.49 m/s, while the average for the period from 2013 to 2019 was 1.47 m/s.

The wind rose generated with the data obtained at the Puerto Casado station proves the predominance of south and north winds.

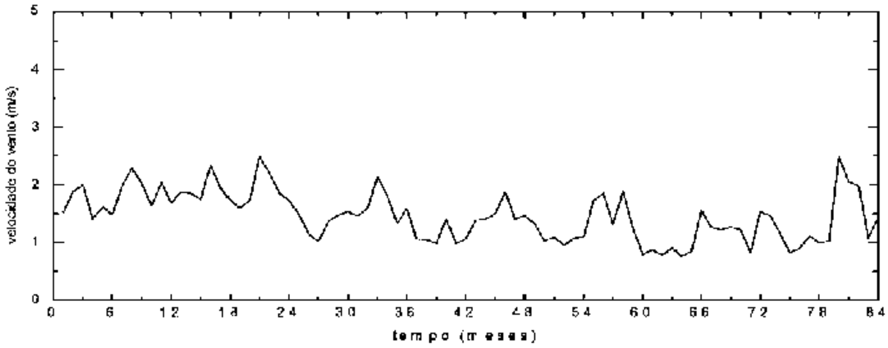


Figure 33 – Average wind speed at Puerto Casado station

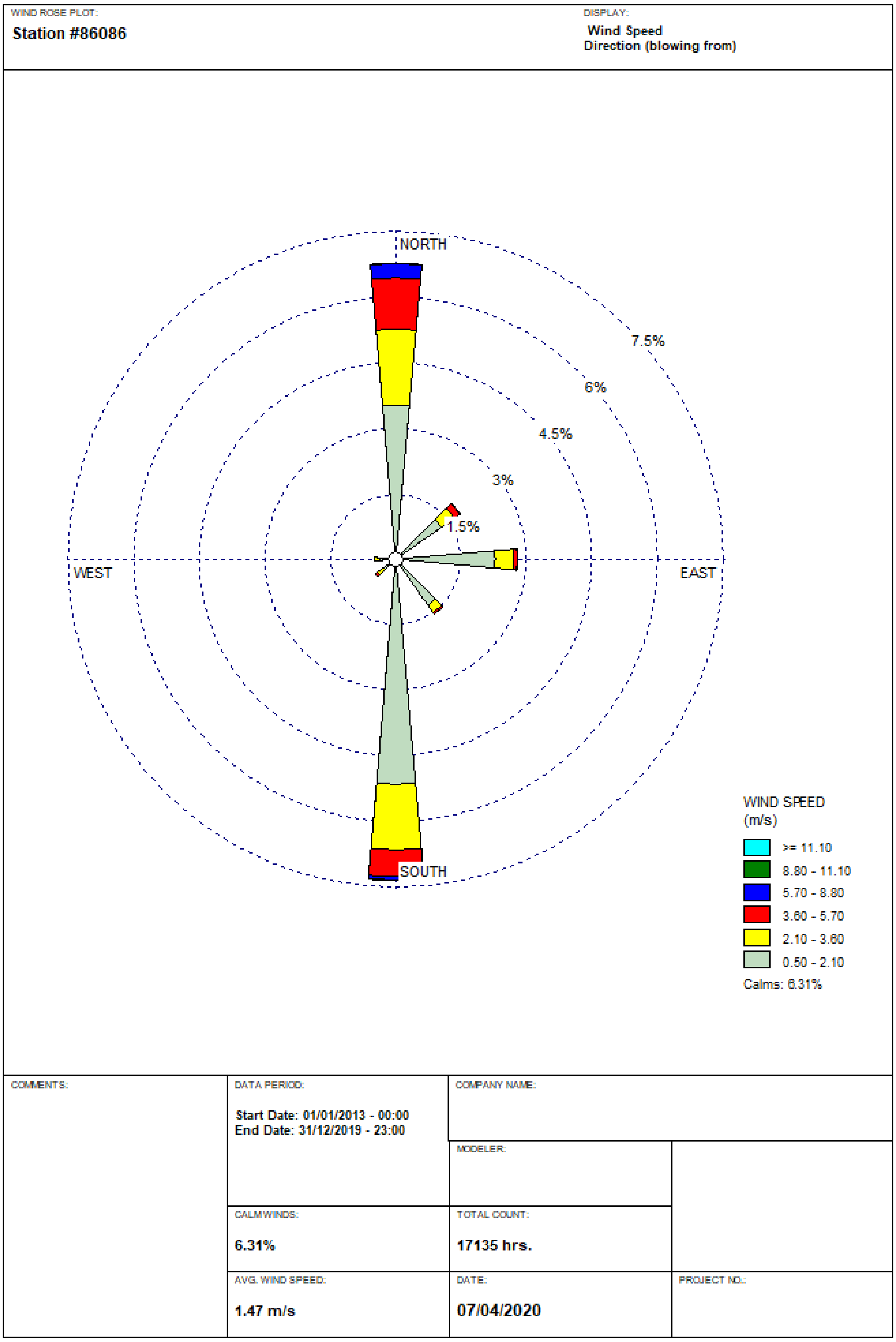


Figure 34 – Wind rose observed at the station Puerto Casado

At the Pozo Colorado station, the average monthly wind speed varied between 0.7 and 5.0 m/s, while the average for the period from 2013 to 2019 was 2.5 m/s.

The wind rose generated with the data observed at the Pozo Colorado station proves the predominance of south and north winds, with important components from the northeast and east.

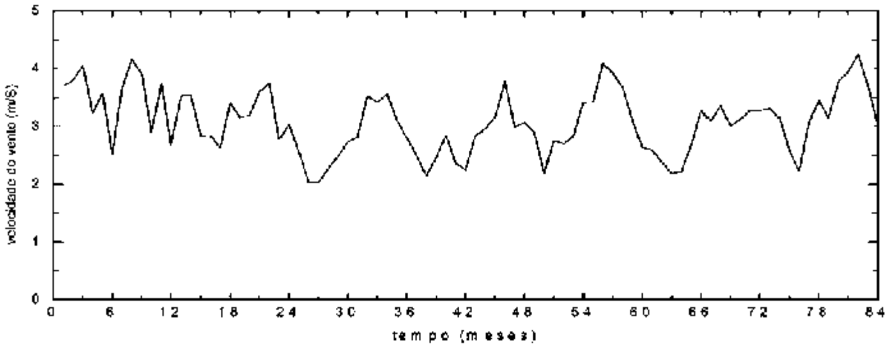


Figure 35 – Average wind speed at station Pozo Colorado

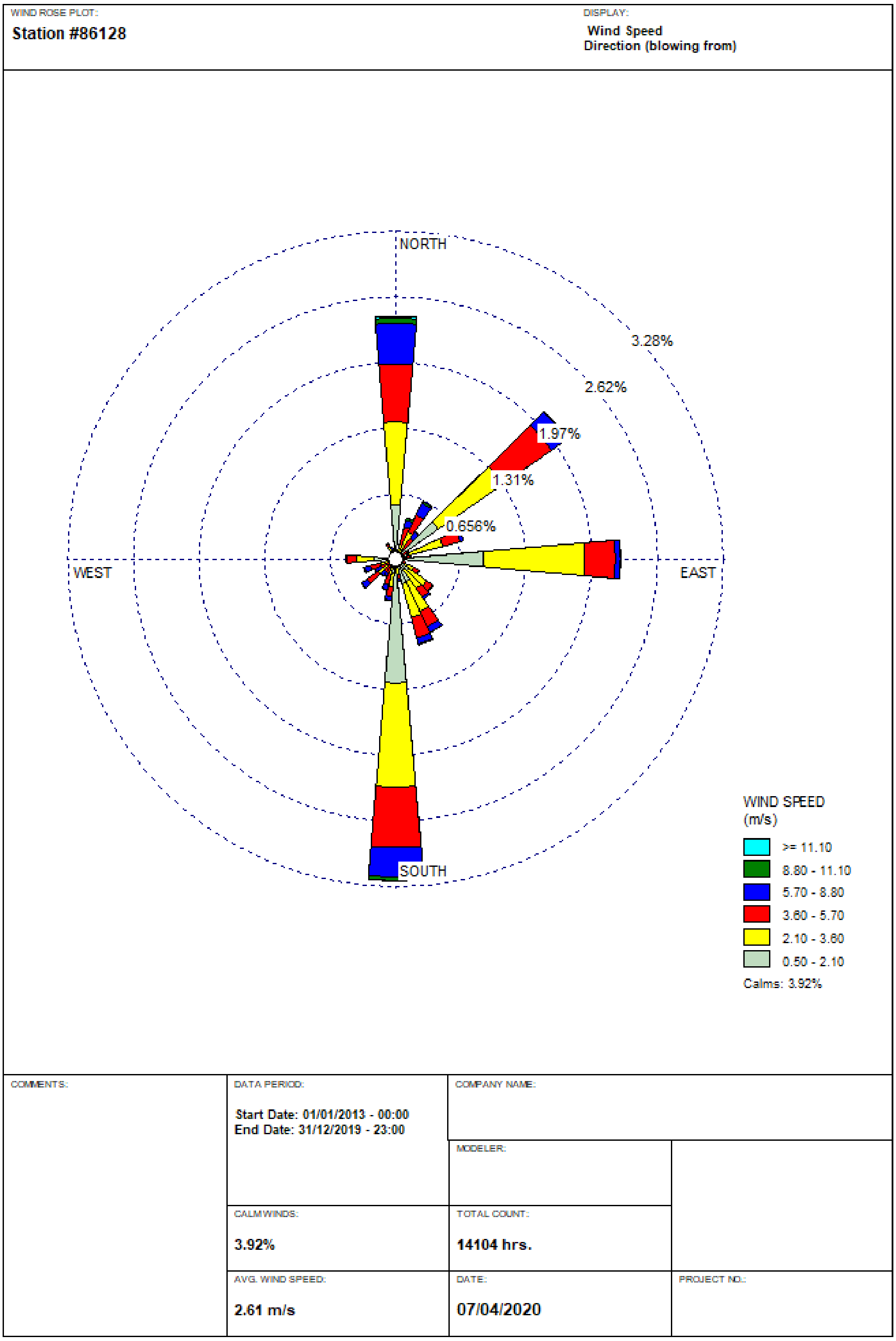


Figure 36 – Wind rose observed at Pozo Colorado station

At the San Pedro station, the average monthly wind speed varied between 0.5 and 3.7 m/s, while the average for the period from 2013 to 2019 was 1.9 m/s.

The wind rose generated with the data observed at the San Pedro station proves the predominance of two winds from the south and north, followed by winds from the east.

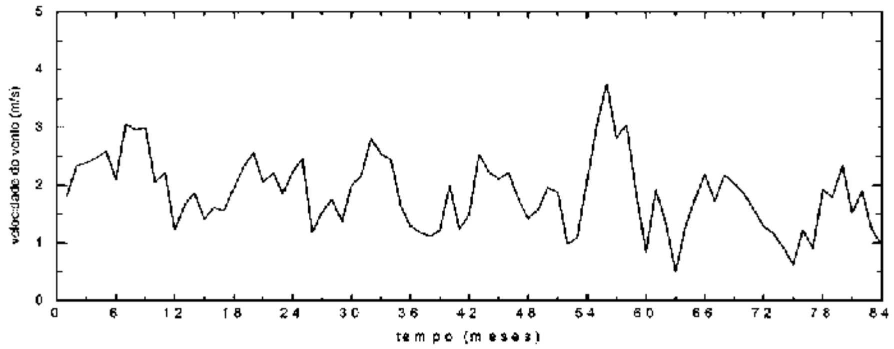


Figure 37 – Average wind speed at the station San Pedro

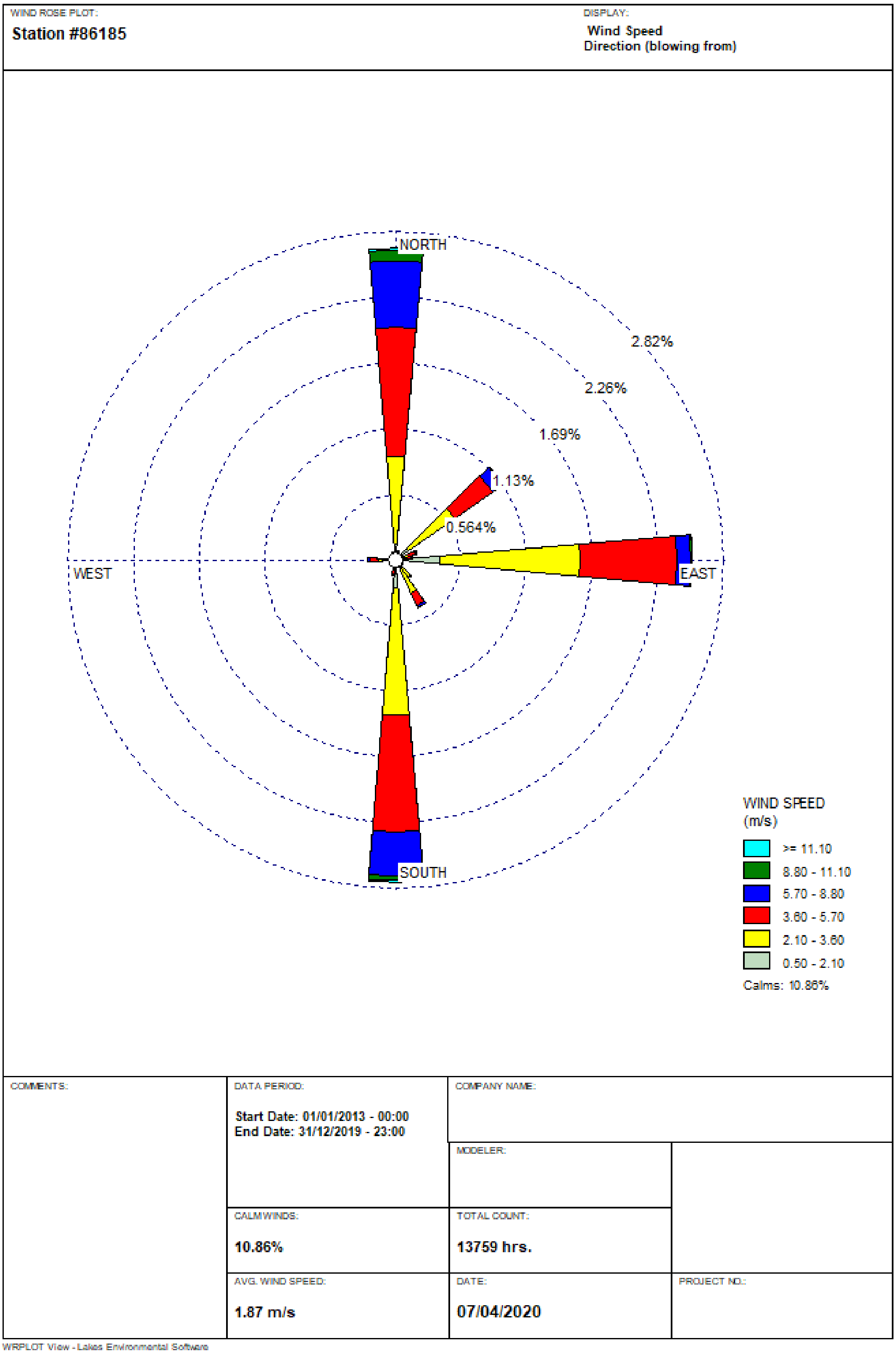


Figure 38 – Wind rose observed at the station San Pedro

At the Teniente Coronel Carmelo Peralta station, the average monthly wind speed varied between 1.8 and 4.9 m/s, while the provisional average for the period from 2010 to 2019 was 3.2 m/s.

The wind rose generated with the data observed at the Teniente Coronel Carmelo Peralta station proves the predominance of two winds from the south, followed by northeast and east, and with a less important component from the southeast.

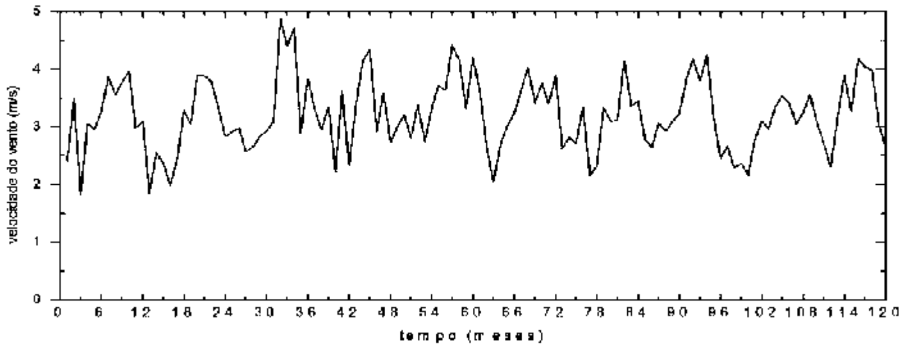


Figure 39 – Average wind speed at the station Teniente Coronel Carmelo Peralta

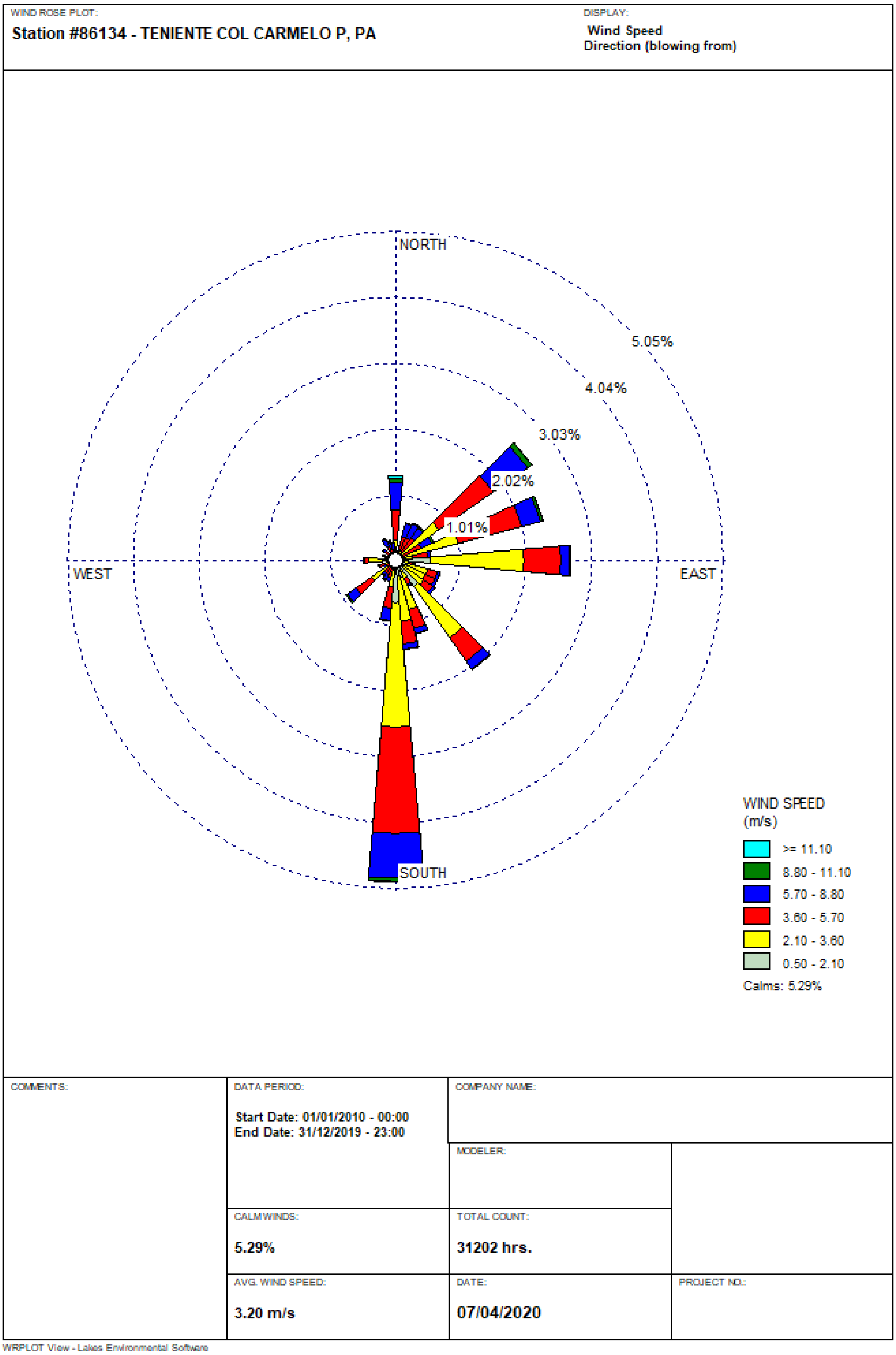


Figure 40 – Wind rose observed at the station Teniente Coronel Carmelo Peralta

The wind intensities in all regions are very similar and can be classified as weak winds, between 1.4 and 3.2 m/s. The highest wind speeds were registered at Teniente Coronel Carmelo Peralta station. The predominant wind directions are north and south, followed by northeast and east winds.

3 PHYSICOCHEMICAL AND TOXICOLOGICAL CHARACTERISTICS OF PRODUCTS

PARACEL pulp mill facilities involve a series of chemical products. The table below presents the main products and respective risk class / subclass established by the ONU.

Table 6 – Main products and risk class/subclass by ONU

Product	ONU Number	Risk Class	Risk Label
Methanol	1230	3 – Flammable Liquid	
Caustic Soda	1824	8 – Corrosive Substance	
Sulfuric acid	1830	8 – Corrosive Substance	
Diesel	1202	3 – Flammable Liquid	
Fuel	3256	3 – Flammable Liquid	
Sodium chlorate	2428	5.1 – Oxidant	
Chlorine Dioxide	3139	6.1 – Toxic Gas	
Sodium bisulphite	2693	8 – Corrosive Substance	
Oxygen	1072	2.2 – Non-toxic compressed gas	

Product	ONU Number	Risk Class	Risk Label
Hydrogen peroxide	2014	5.1 - Oxidant	

NOTE: * It should be noted that, in a conservative way, chlorine was considered as a representative substance of chlorine dioxide, assuming that in a possible release of chlorine, the detached product would be chlorine. It should also be noted that PARACEL will not use chlorine in its bleaching process (it will use the ECF - Elemental Chlorine Free Process).

From the initial characterization of the products, to continue the Preliminary Risk Analysis Study, the most representative liquid or gaseous chemicals substances were selected in terms of flammability and toxicity. For this purpose, the criteria used is the one established by CETESB from Brazil for the classification of chemicals according to their hazard.

The Material Safety Data Sheets (MSDS) are presented in **ANNEX III**.

4 RISK IDENTIFICATION

4.1 Introduction

This chapter describes the methodology used to identify the risks relating to PARACEL pulp mill facilities and presents the identified hazards results through the application of the Preliminary Hazard Analysis (APP) technique.

The following section 4.2 presents a historical analysis of accidents, while section 4.3 provides a brief description of the APP technique and methodology used for risk identification.

4.2 Historical Accident Analysis

The *Major Hazard Incidents Data Service* – MHIDAS is an international database of accidents/incidents in industrial production, transportation and storage of chemicals products that result in a potential risk to the community.

According to the MHIDAS database, accidents with hazardous substances used in the pulp and paper industries have been reported. Since 1974, 6 accidents related to this sector have been found, 1 being related to the explosion of recirculated pulp powder, 1 related to the rupture of an effluent lagoon and the discharge of partially treated effluents, 4 related to the release of chlorine (2 by pipeline rupture and 2 due to explosion in the generation unit).

The following table shows the number of incidents reported in MHIDAS that occurred in different types of industries.

Table 7 – Number of incidents per type of substance

Substance	State	Incidents
Sodium chlorate	Crystallized or powdered	19
Methanol	Liquid	197
Chlorine dioxide	Gas	1
Hydrogen peroxide	Solution	30
Fuel	Liquid	356

Source: MHIDAS

According to MHIDAS, accidents were reported with hazardous substances present in the pulp industry:

– Methanol: Accidents with detachment and formation of puddles, fires and explosions, caused by floods, lightning, human faults and impacts during transport were catalogued.

– Chlorine dioxide: Only a laboratory accident was reported because explosions occurred due to the release of the substance by its misuse.

– Hydrogen peroxide: Peroxide accidents that occurred during loading and unloading of containers or leaks in distributors' warehouses were catalogued, requiring area insulation and cleaning; none of these incidents were identified in the pulp industries.

– Fuel: Accidents with tank explosions with this substance were reported due to human faults, external fires, extreme temperatures. During transport, accidents occurred due to impacts followed by fire and/or explosion.

– Boilers: Explosion accidents caused by low water operating conditions, operator errors or poor maintenance, as well as human supervision failures and lack of knowledge, were responsible for 69% of injuries and 60% of reported deaths.

In addition, some accidents were found in pulp mills, according to information published by the press:

– In Brazil, in 1988, the chemical recovery boiler exploded in the northern region of the country;

– In 1994, at mill in the United States, a digester explosion occurred;

– In 2007, at a plant in northeastern Brazil, the black liquor tank broke;

– In 2017, there was an explosion of a digester at a plant in the United States;

– In 2020, there was an explosion of two digesters at a plant in the United States.

4.3 Preliminary Risk Analysis

4.3.1 Methodology

The Preliminary Risk Analysis (APP) was developed by the military safety program of the United States Department of Defense (MIL-STD-882B).

It is a structure technique having as purpose to identify the hazards existing in an installation, which are caused by undesirable events. Commonly it is used in the initial stage of a project, although it has been also applied in operation units, allowing a critical analysis of the existing safety systems and the identification of possible eventual incidents.

The APP is centered on hazardous events that failures were originated at the installation being analyzed, covering both the intrinsic failures of equipment, instruments and materials, and errors such as human fails.

APP identifies the risks, their causes, the effects and their respective categories of severity, pointing out possible observations and recommendations pertinent to the hazards identified. The results are presented in standardized worksheet, as shown in figure bellow.

<table>
<tr><th colspan="8">APP – PRELIMINARY RISK ANALYSIS</th></tr>
<tr><td colspan="8">Area:</td></tr>
<tr><th rowspan="2">Item</th><th rowspan="2">Hazard</th><th rowspan="2">Possible causes</th><th rowspan="2">Possible effects</th><th colspan="3">Grade</th><th rowspan="2">Remarks
Recommendations</th></tr>
<tr><th>Frequency</th><th>Severity</th><th>Risk</th></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="3"></td><td></td></tr>
</table>

Figure 41 – APP – Preliminary Risk Analysis Sheet

- **Item:** sequence number of the hazard identified in the study;
- **Hazard:** characterizes the undesired event, which is usually associated with one or more conditions having the potential to cause harm to people, damage property or environment;
- **Causes:** possible causes associated with a certain hazard;
- **Effects:** possible consequences associated with a certain hazard;
- **Severity Category:** qualitative level of the effect associated with the incident scenario;
- **Remarks/Recommendations:** observations pertaining to the hazard and their accidental scenarios, existing safety systems or recommendations for managing the associated risks.

The criteria for the classification of the probabilities of occurrence of hazards, severities applied to associated effects and risk categories are presented in the following section.

Criteria for Frequency Classification and Severity

For the categorization of effects, the criterion of severity levels traditionally adopted in the application of APP was used, as presented in table below.

Table 8 – Severity Categories

Category	Denomination	Description
I	Negligible	Events associated with no non-measurable damage or damage.
II	Marginal	Occurrences with the potential to cause irrelevant damage to the environment, the installation and the internal and external communities.
III	Critical	Situations with potential to cause impacts to the external environment to the facility with reduced recovery time, and may cause moderate injuries in the external population.
IV	Catastrophic	Occurrences with the potential to generate significant environmental impacts in areas outside the facilities and with a high recovery time, which may also cause deaths or serious injuries to the population.

For the categorization of frequency of occurrence, the criterion of frequency levels traditionally adopted in the application of APP was used, as presented in following table.

Table 9 – Frequency Categories

Category	Denomination	Description
A	Very unlikely	Conceptually possible, but extremely unlikely to occur during the lifetime of the facility. Incidents that depend on the occurrence of multiple failures.
B	Unlikely	Not expected to occur during the lifetime of the installation. Incidents associated with several faults or ruptures of large equipment.
C	Remote	Unlikely to occur during the lifetime of the installation. The occurrence depends on a single fault (human or equipment).
D	Probable	Expected to occur at least once during the lifetime of the installation.
E	Frequent	Expected to occur several times during the lifetime of the installation.

The risk matrix, shown in following figure, is the result of the interaction between severity and frequency, resulting in the exposed risk.

		FREQUENCY OF OCCURRANCE				
		A	B	C	D	E
SEVERITY	IV	**Mn**	**M**	**S**	**C**	**C**
	III	**D**	**Mn**	**M**	**S**	**C**
	II	**D**	**D**	**Mn**	**M**	**S**
	I	**D**	**D**	**D**	**Mn**	**M**

Severity		**Frequency**	
I	Negligible	**A**	Very unlikely
II	Marginal	**B**	Unlikely
III	Critical	**C**	Remote
IV	Catastrophic	**D**	Probable
		E	Frequent

Risk	
D	Negligible
Mn	Minor
M	Moderate
S	Serious
C	Critical

Figure 42 – Risk Classification Matrix

4.3.2 Hazard Identification

In the pulp mill of PARACEL, the hazards will basically arise from the accidental release of the products handled; thus, as a basic principle used in the application of APP, typical situations related to large and medium releases, associated with component faults, such as connections, blocking valves, flanges and lines, among others, were identified.

The APP worksheets were completed by PÖYRY Tecnologia technicians based on Process Flowcharts (**ANNEX I**), identifying the main hazards, their causes and their associated effects.

For each of the possible effects generated by the accidental hypotheses a degree of severity was attributed, according to the criterion presented previously. **ANNEX IV** presents the completed worksheets of the APP.

From the application of the APP to identify the hazards related to the installations and operations with the products handled in PARACEL, 53 hazards were identified, always considering relevant accidental situations, that is, events caused by non-condensable gas, methanol and chlorine dioxide leaks, significant at the factory in question, as described in Chapter 2.

The possible effects associated to the accidental hypotheses identified in the APP were classified in terms of severity, always considering two types of phenomena, when pertinent; that is, large and medium leakages, associated with the loss of containment of such products.

The distribution of the effects associated with these accidents (hazard) hypotheses are as follows:

- 13 hazards (24%) classified as Negligible Risk;
- 10 hazards (19%) of Minor Risk;
- 26 hazards (49%) of Moderate Risk;
- 4 hazards (8 %) of Serious Risk;
- No hazard classified as Critical Risk.

The following figure presents the risk matrix with the quantification of the hypotheses according to the classifications adopted.

		FREQUENCY OF OCCURRENCE				
		A	B	C	D	E
SEVERITY	IV					
	III		**3**	**4**	**4**	
	II	**3**	**10**	**6**	**22**	
	I				**1**	

Figure 43 – Risk matrix with the quantification of the hypotheses

5 CONCLUSIONS

This Preliminary Risk Analysis Study was developed with the aim to qualitatively assess the risks imposed by the operational activities of the PARACEL pulp mill, to be implemented in the municipality of Concepción, in the Department of Conception - Paraguay, which can cause fires, explosions, toxic dispersions, effluent or gases leaks.

In this risk analysis, it was verified, through the application of the APP methodology - Preliminary Risk Analysis, that no hazard was classified as Critical, and that most of the identified risks (92%) are classified as Negligible, Minor or Moderate.

Therefore, the start-up of the pulp mill can be considered feasible, however, by strengthening its complying with the measures to be taken, which are described as follow, in order to keep the risks at acceptable levels.

- Installing the lightning discharge protection system;
- Installation of relief valves in equipment subject to overpressure;
- Construction of containment basin for chemical and flammable storage tanks;
- Implementation of a high level instrumentation equipment to allow monitoring all process variables;
- Implementation of redundancy (additional security) in interlocks at critical safety points and process;
- Development of operational procedures, including instructions on health, safety and the environment aspects;
- Implementation of preventive and corrective maintenance programs at all mill's equipment;
- Periodic training of operators and employees in the maintenance sector;
- Preparation of the Contingency Prevention and Management Program, which includes the Emergency Action Protocol, which specifies the location of emergency alarms and gas detectors, the procedures, escape routes and meeting points;
- Installation of firefighting systems in process areas, auxiliary and administrative buildings, and in the fuel storage area;
- Periodic execution of fire simulation and other types of emergency.

6 BIBLIOGRAPHIC REFERENCES

COMPANHIA AMBIENTAL DO ESTADO DE SÃO PAULO (CETESB). P.4.261 Norma Técnica – Risco de Acidente de Origem Tecnológica – Método para decisão e termos de referência, 2011.

COMPANHIA AMBIENTAL DO ESTADO DE SÃO PAULO (CETESB). Manual de Produtos Químicos Perigosos.

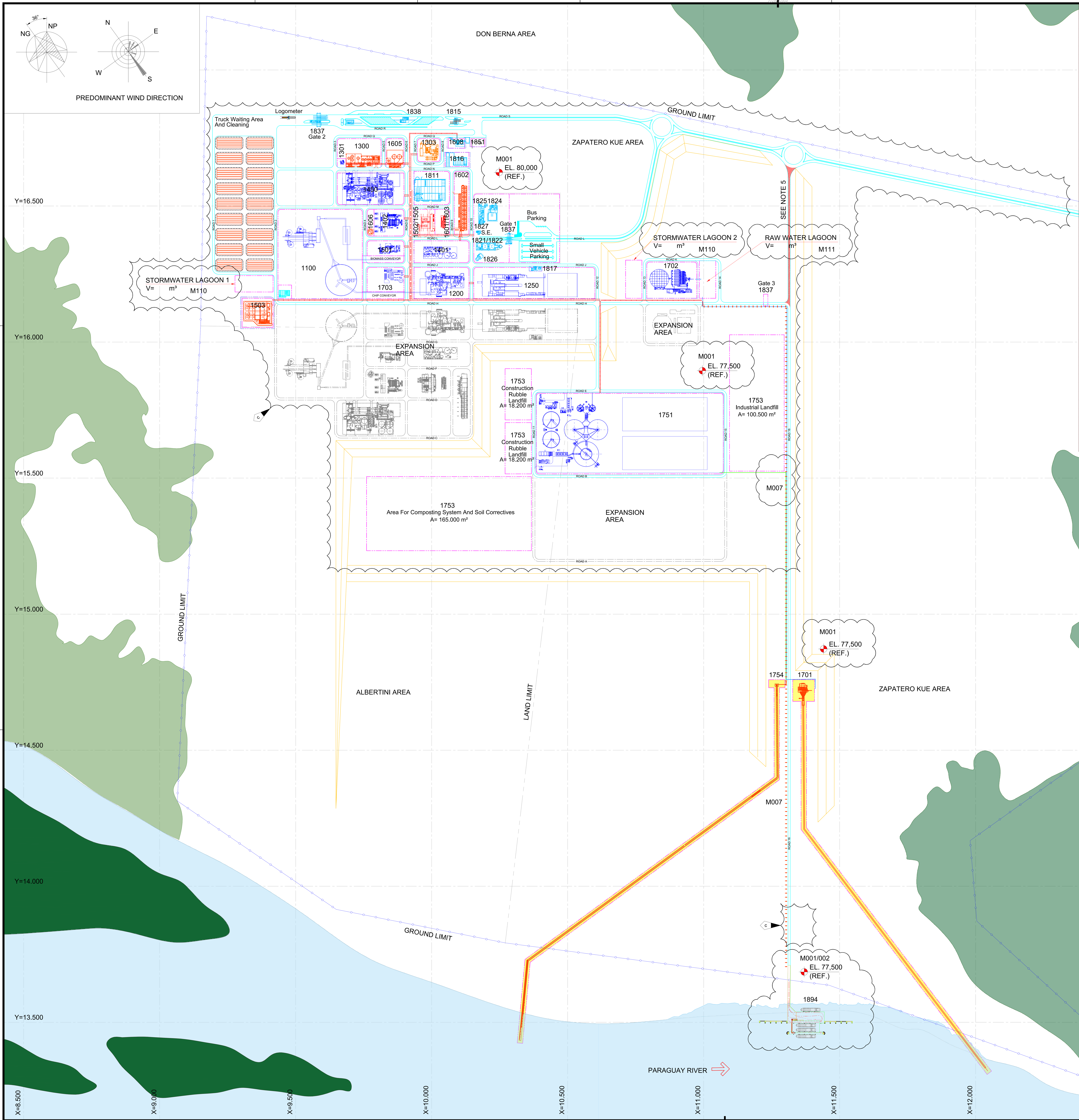
ANXEX I

PROCESS FLOW DIAGRAM

confidential
Forest-debarked wood
Line 1
Line 2
Line 3
Washing
Chipper 1
Chipper 2
Chipper 3
Screening
Chip pile
Chips
Fines
Steam
Bark shreder
Bark + Fines
Biomass pile
COOKING
Blow tank
OXYGEN DELIGNIFICATION
Pre-washing
Screening
Pos-washing
Pre-bleached pulp storage
BLEACHING PLANT
Ep
D
P
Hot water
White water
Storage Tower 1
Storage Tower 2
Circulating water
Mixing tank
Screening
Machine tank
DRYING MACHINE
Sheet cooler
Cutter
Baling
Chemical preparation
Oxygen plant
O_2
Oxygen delignification
bags
Dissolving
Talc
Oxygen delignification
$NaHSO_3$
Sodium bisulphite
Bleaching
NaOH 50%
NaOH 20%
Caustic
Bleaching and other plants
H_2SO_4 98%
Sulphuric acid
Bleaching and other plants
H_2O_2
Bleaching
Absortion tower
$NaClO_3$
ClO_2 Reactor
ClO_2 tanks
Bleaching
Sodium sulfate
Cooling towers
Make-up water
TG 2
TG 1
Steam MP
Steam LP
Condensate to deaerator
MeOH column
Flue gas stack
High pressure steam
DNCG
CNCG Backup 2 Flare
Sootblowing steam
MeOH storage
Condenser
Condensate
CNCG
EVAPORATION
7
6
5
4
3
2
1
Foul cond.
Stripper
Heavy liquor tanks
Weak black liquor tanks
Electrostatic Precipitator
RECOVERY BOILER
CNCG Backup 1 Biomass Boiler
DNCG Backup 1 Biomass Boiler
Fuel oil
Air
Dissolving tank
Mix tank
Biomass Boiler
Purge
RAW WATER TREATMENT
MeOH
Fuel oil
Syngas
Condensate
Electrostatic Precipitator
Lime make-up
Lime Kiln 1
Lime mud filter
DNGC (Causticizing)
Lime mud filter
Electrostatic Precipitator
Lime Kiln 2
Raw green liquor tank
Green liquor filters
Filtered green liquor storage
Slaker
Grits
Causticizers
White liquor filters
Lime mud storage
White liquor tank
Dregs washing
Dregs
Weak white liquor tank
Oxygen
O_2 delignification
White liquor oxidation
Chemicals
Clarifiers
Sand filter
ETAC
Fresh water
Fire fighting water
Potable water
Activated carbon filter
Dewatered primary sludge
Screen
Pumping station
Sludge tank
EFFLUENT TREATMENT
Effluent
Screening
Rain water lagoon
FI
Cond.
TI
pH
Primary clarifiers
Emergency lagoon
Dewatering screw
Dewatered primary sludge
H_2SO_4
NaOH
Neutralization tank
Cooling towers
Sanitary effluent
Aeration tanks
Chemicals
Secondary decanters
Sludge tank
Sludge dewatering system
Dewatered biological sludge
Flocculation
Flotation
Air compressor
Saturation tank
NaOH
Neutralization tank
Sludge tank
Centrifuge
ETA sludge dewatered
PÖYRY
PARACEL
1 500 000 ADt/a

ANNEX II

MILL PROJECT LAYOUT



AREAS

CODE	DESCRIPTION	DESCRIPCIÓN
1100	Wood Handling - I	Manuseio de Madeira - I
1200	Cooking and Fiber Line - I	Cocimiento e Línea de Fibras - I
1250	Pulp Drying	Secado de Pasta Celulosa - I
1300	Chemical Preparation - I	Prep. de Productos Químicos - I
1301	Chorine Dioxide Plant	Planta de Dióxido de Cloro
1303	Oxygen Plant	Planta de Oxígeno
1401	Evaporation	Evaporación
1402	Recovery Boller	Caldera de Recuperación
1450	Causticizing and Lime Kiln	Caustificación e Horno de Cal
1501	Power Boiler	Caldera de Fuerza
1502	Turbogenerator	Turbogeneradores
1503	Main Substation	Subestación Principal
1505	Diesel Generator	Geerador Diésel
1601	Compressed Air System	Sistema de Aire Comprimido
1602	Cooling Tower	Torre de Enfriamento
1603	Chilled Water System	Sistema de Água Fria
1605	Fuel Oil Storage	Depósito de Combutóleo
1606	Stack	Chimenea
1608	LPG System	Sistema de GLP
1701	Water Intake	Captación de Agua
1702	Water Treatment Plant	ETA - Estación de Tratamiento de Agua
1703	Boiler Feedwater	Trat. de Agua de Alimentación de Caldera
1751	Effluent Treatment	ETE - Estación de Tratamiento de Efluentes
1753	Solids Waste Disposal	Atierro
1754	Effluent Discharge Pipeline	Emisario
1811	Maintenance Warehouse And Supplies	Mantenimiento Almacén y Suministros
1815	Gas Station	Gasolinera
1816	Flammable Chemicals and Refractories Storages	Productos Químicos Inflam. y Refractarios Almacenes
1817	Pit Stop	Pit Stop
1821	Offices	Oficinas
1822	Laboratories	Laboratorios
1824	Kitchen / Canteen	Cocina / Cantina
1825	First Aid and Medical Facilities	Primeros Auxilios e Instalaciones Médicas
1826	Central Control Building	Edificio de control central
1827	Dressing Room	Vestidor
1837	Gates Houses, Scales and Fences	Puertas de Entradas, Balanças y Cercas
1838	Trucker Support Building	Edificio de Apoyo para Camioneros
1851	Communication Tower and Equipment Room	Torre de Comunicaciones y Sala de Equipos
1894	Port	Puerto

REVISION TABLE

CODE:
PR -PRELIMINARY
PA -FOR APPROVAL
PI -FOR INFORMATION
PC -FOR QUOTATION
CO-FOR COMMENTS
LE -RELEASED FOR CONSTRUCTION
LD -RELEASE FOR DETAILING
CC -AS BUILT
CA -CANCELED

REV.	DATE	PROJ.	VERIF.	APPROV.	AUTHOR.	CODE	DESCRIPTION
0	03/12/19	jtm	awg	dhy	mnq	PA	INITIAL ISSUE
a	23/01/20	jtm	awg	dhy	mnq	PA	Added area 1851 and changed areas 1701, 1753 and 1754
b	20/02/20	jtm	awg	dhy	mnq	PA	REVISED LAYOUT LEASE
c	27/03/30	jtm	awg	dhy	mnq	PA	CHANGED LAYOUT POSITION

NOTES:

1 - ALL COORDINATES IN METERS (m).
2 - THE COORDINATION SYSTEM USED IS WGS 84, OBTAINED FROM THE SOFTWARE GOOGLE EARTH.
3 - PRELIMINARY DESIGN STUDY, ARRANGEMENT OF THE PROCESS ISLAND IN PROGRESS.
4 - ELEVATIONS INDICATED FOR REFERENCE ONLY, CONFIRMATION OF SURVEY AND STUDY OF THE EARTH IN MOVEMENT BY IMPLEMENTATION.
5 - TEMPORARY ACCESS FOR RECEIVING TORMS BY BARGE FOR WEIGHING AT GATE 2.

LEGEND:

- NEW STREETS
- BATTERY LIMIT, SIDEWALKS AND ACCESS
- GROUND LIMITS AND DEFINITE FENCE
- WATER INTAKE
- EFFLUENT DISCHARGE PIPELINE
- EPC
- BOP
- OVER THE FENCE
- NON PROCESS BUILDING
- FUTURE EXPANSION
- PIPE RACK (BOP)
- PIPE WAY (BOP)
- TEMPORARY ROAD (NOTA 5)

PENDENT ITEM:

M001 - GROUND LEVEL.
M002 - PORT DEFINITION.
~~M003 - EMERGENCY POND DEFINITION.~~
~~M004 - PIPE RACK DEFINITION.~~
~~M005 - FENCE DEFINITION.~~
M006 - ACCESS DEFINITION.
M007 - BASIC ROAD WATER INTAKE AND EFFLUENT DISCHARGE PIPELINE.
~~M008 - ELECTRICAL ROOM DEFINITION.~~
M110 - STORMWATER LAGOON CAPACITY.
M111 - RAW WATER LAGOON CAPACITY.

CONSULTED DOCUMENTS

TITLE	NUMBER	REV.

REFERENCE DOCUMENTS

TITLE	NUMBER

DISTRIBUTION

TO	REVISION 0	a	b	c	d	e	f
PARACEL	E	E	E	E			
POYRY	E	E	E	E			

N- PRINT/PLOT (HARD COPY) E- ELECTRONIC FILE

FOR
APPROVAL

PÖYRY

PARACEL PROJECT
Basic Engineering Services
Concepción - Paraguay

PARACEL

RESP./TITLE/CREA NUMBER | CUSTOMER NUMBER | REV.

TITLE
PARACEL PROJECT - BASIC ENGINEERING SERVICES
General Mill Site Layout
Master Plan - General Layout

SCALE	UNIT	PROJECTION	PÖYRY NUMBER	REV.
1:5000	mm		109001759-001-1000-M05-0001	c

ANNEX III

MATERIAL SAFETY DATA SHEET (MSDS)

Administración: Ruta 1 Km. 24 - Ciudad del Plata
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Tel.: 2347 2035 - Fax: 2347 2127
email: isusa@isusa.com.uy

FICHA DE DATOS DE SEGURIDAD: ACIDO SULFURICO

Concentrado para uso industrial 98,5 % ± 0,5 %

1. Identificación del producto y del proveedor

1.1. Identificación del producto

- Nombre del producto indicado en la etiqueta: Ácido sulfúrico concentrado
- Nombre químico: Ácido sulfúrico
- Fórmula química: H2SO4
- Nº ONU: 1830
- Riesgo principal: 8
- Usos recomendados y restricciones de uso: Fabricación de fertilizantes, detergentes, sulfato de aluminio, sales, explosivos, productos farmacéuticos y numerosos productos químicos. En electrolito para baterías, agente deshidratante y otros diversos usos.

1.2. Identificación de la empresa

- Fabricante: Industria Sulfúrica S.A. (ISUSA)
- Dirección:
  - Planta Ruta 1: Ruta 1 km 24, Ciudad del Plata, Departamento de San José
  - Planta Agraciada - Camino Vecinal Tramo 154 s/n entre Ruta 21 Km 283½ y Ruta 12 Km 20, Localidad de Agraciada, Departamento de Soriano
- País: República Oriental del Uruguay
- Teléfono:
  - Planta Ruta 1 – 2347 2035
  - Planta Agraciada – 098 392 811/22
- Correo Electrónico: isusa@isusa.com.uy
- Teléfono de Emergencia con atención las 24 horas
  - Planta Ruta 1: 2347 2035, 0800 8522
  - Planta Agraciada: 0800 8638

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2. Identificación de peligros

2.1. Clasificación de la sustancia

Corrosivo cutáneo, categoría 1 A.
Sustancia corrosiva para los metales, categoría 1.
Grupo de embalaje II
Número de riesgo: 80

2.2. Elementos de la etiqueta

PELIGRO

PROVOCA GRAVES QUEMADURAS EN LA PIEL Y LESIONES OCULARES

Evite el contacto con los ojos, piel y ropa. Si se produce, lávese con abundante agua por lo menos durante 15 minutos.
No agregue agua al recipiente, el ácido reacciona violentamente con el agua.

2.3. Otros peligros

Es un ácido mineral fuerte que presenta color y olor aceitoso en estado puro, puede presentarse amarillo o marrón en estado impuro. Causa destrucción del tejido corporal y serias quemaduras químicas. Puede descomponerse en altas temperaturas formando gases tóxicos como el dióxido de azufre. No es inflamable pero reacciona violentamente con el agua generando calor y potenciales salpicaduras. Puede carbonizar y posiblemente incendiar materiales combustibles.
En contacto con metales puede desprender hidrógeno, el que forma mezclas explosivas con el aire.

3. Composición e información de los componentes

2.4. <u>Identidad química de la sustancia</u>: Ácido Sulfúrico
2.5. <u>Nombres comunes, sinónimos de la sustancia</u>: Acido de batería, ácido de cámara, ácido fertilizante, aceite de Vitriolo.
2.6. <u>Número CAS y otros identificadores únicos para la sustancia</u>: 7664-93-9
2.7. <u>Impurezas y aditivos estabilizantes que estén clasificados y que contribuyen a la clasificación de la sustancia</u>: No contiene

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4. Medidas de primeros auxilios

Es un producto altamente corrosivo para los tejidos corporales por todas las vías de exposición.
La rapidez en el lavado es esencial para evitar consecuencias mayores. En todos los casos obtener atención médica.
Contacto con la piel: Retirar las ropas contaminadas inmediatamente. Lavar las partes afectadas del cuerpo con abundante agua durante 15 minutos.
Contacto con los ojos: Lavar con agua, inmediatamente durante 15 minutos, levantando ocasionalmente los párpados.
Ingestión: Si la víctima está consciente, administrar grandes cantidades de agua inmediatamente.
No intentar hacer vomitar a la víctima. Trasladar inmediatamente el paciente al hospital.
Inhalación: Llevar al accidentado al aire fresco, mantener abrigado y aplicar respiración artificial si fuera necesario. La administración boca a boca puede exponer al administrador. Transportar a la víctima al hospital inmediatamente.
Otros consejos médicos: después de la exposición, el paciente se mantendrá bajo vigilancia médica durante al menos 48 hs, como prevención a un posible desarrollo de edema pulmonar.

5. Medidas de lucha contra incendios

No es inflamable ni combustible pero sin embargo su acción corrosiva sobre numerosos metales es acompañada por desprendimiento de hidrógeno el cual es fuente de incendio y explosiones. El hidrógeno forma mezclas explosivas con el aire, por lo tanto al abrir un recipiente metálico conteniendo ácido evitar fuentes de ignición.
Cuando entra en contacto con combustible finamente dividido, (ejemplo aserrín o papel) puede provocar su ignición.
Medios de extinción apropiados:
Para fuegos pequeños: usar extintores de polvo. Tener en cuenta que el ácido reacciona con el agua produciendo desprendimiento de calor.
En caso de fuegos mayores: usar agua para refrigerar los recipientes, asegurándose que no entre en contacto con el producto.
Protección a bomberos: usar equipos de respiración autónoma y ropa de protección total.
Sustancias liberadas por el calor o descomposición: óxidos de azufre e hidrogeno.

6. Medidas a tomar en caso de derrames accidentales del producto

6.1. Precauciones personales, equipos de protección y procedimientos de emergencia:

Ponerse el equipo de protección antes de entrar en el área de peligro. Ventilar la zona de derrame o fuga. Use equipo antiácido, mascara completa o pantalla facial, guantes antiácidos, botas de PVC, por dentro del equipo.
Proceder con precaución. Restringir el acceso al área. Mantener el personal sin protección en posición contraria a la dirección del viento en el área de derrame. Evitar el contacto con el producto derramado. Tener en cuenta mientras se implementa la respuesta que el ácido

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es altamente corrosivo y reactivo. El contacto con metales puede producir hidrógeno, gas inflamable y explosivo.

6.2. Precauciones ambientales:

Tomar precauciones para evitar la contaminación de los cursos de agua y drenajes. Informar a la autoridad correspondiente en caso de contaminación de los cursos de agua.

6.3. Métodos y materiales para la contención y limpieza de vertidos:

Contención: Por succión o bombeo a cisternas o contenedores usando equipos apropiados a tales fines.
Puede contenerse construyendo diques o barreras usando arena o tierra. El ácido contenido en la barrera puede filtrase al suelo aumentando la extensión de la contaminación.
Mitigación: Se puede neutralizar, con carbonato de calcio, carbonato de sodio, calizas o dolomita.
Tener en cuenta que la reacción química produce calor, vapores y salpicaduras. Consultar con un técnico calificado sobre las técnicas seguras de contención y mitigación.
Recoger el líquido procedente de la fuga en recipientes herméticos, no absorber en aserrín u otros absorbentes combustibles.

7. Manipulación y almacenamiento

7.1. Precauciones para el manejo seguro:

Proporcionar una ventilación adecuada. Utilizar protección de ojos y manos cuando se manejen pequeñas cantidades. Usar equipo de protección total cuando exista riesgo de salpicaduras o derrames. Cuando se diluye, adicionar siempre el ácido sobre el agua y nunca el agua sobre el ácido. Evitar la inhalación de altas concentraciones de nieblas, en estos casos usar máscara completa con filtros para gases ácidos.

7.2. Condiciones de almacenamiento seguro:

El ácido sulfúrico concentrado para uso industrial se almacena en recipientes y tanques de hierro, acero inoxidable o bidones de plástico apropiados. Es conveniente ubicarlos en locales bien ventilados y al abrigo de la luz del sol. En caso de depósitos exteriores se recomienda pintarlos exteriormente de colores claros. Se debe tener especial atención a que en recipientes metálicos se genera hidrógeno, que forma mezclas explosivas con el aire, por lo que nunca se deben producir chispas en las proximidades de los tanques. En todos los casos se deberá disponer de pisos resistentes a la corrosión y de desagües con una retención para poder neutralizar el ácido proveniente de fugas accidentales. Se deberá disponer en las proximidades un punto de suministro de agua con abundante caudal. Se aconseja la instalación de una ducha de seguridad para casos de accidentes.

7.3. Incompatibilidades con otras sustancias:

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Alejar de los materiales combustibles, agentes reductores, bases fuertes, metales y alimentos y raciones para animales.

8. Control de la exposición y protección personal

8.1. Parámetros de control

Límite de exposición recomendados:

- TLV-TWA: Niebla 0,2 mg/m3(ACGIH 2010).
- TLV-STEL: No disponible (ACGIH 2010).
- OSHA PEL: 1mg/m3
- NIOSH REL: 1mg/m3

8.2. Controles de ingeniería apropiados.

Medidas de precaución y equipos mecánicos: ventilación local asistida. Instalar equipos lava-ojos y duchas de seguridad en cualquier lugar en donde se pueda producir contacto con los ojos y la piel.

8.3. Medidas de protección individual

Protección para ojos y cara: usar pantalla de protección facial.
Protección de la piel: usar equipo antiácido o delantal de PVC, guantes antiácidos, botas de PVC, pantalón por fuera de las botas.
Protección respiratoria: en caso de presencia de niebla ácida se debe usar máscara con cartuchos para gases ácidos.
Medidas de higiene necesarias: no comer, ni beber, ni fumar durante el trabajo.

9. Propiedades físicas y químicas

Aspecto: líquido incoloro a amarillo, viscoso.
Olor: sin olor cuando está frío, si se calienta se desprenden vapores de SO3
Umbral Olfativo: Para niebla de SO3 < 1mg/m3
PH (sin diluir): < 0.1
Punto de fusión y/o congelamiento: 3º C
Punto de ebullición: entre 310 y 335 ºC
Punto de inflamación: No aplica
Tasa de evaporación: No disponible
Inflamabilidad: No aplica
Presión de vapor: < 0,001 mm Hg a 20 ºC; 1 mm Hg a 146 ºC
Densidad de vapor (aire=1): 3,4
Densidad relativa: 1.84 g/ml
Solubilidad: completamente soluble.
Coeficiente de reparto: No aplica
Temperatura de autoinflamación: No aplica
Temperatura de descomposición: Se descompone a 340ºC en SO3 y agua

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Viscosidad: 25 centipoises a 21ºC

10. Estabilidad y reactividad

10.1. Reactividad.

Es extremadamente reactivo con metales, álcalis y muchos productos químicos orgánicos e inorgánicos.
La dilución con agua genera calor excesivo y pueden ocurrir salpicaduras o ebullición. Siempre añada el ácido al agua, NUNCA AGREGUE AGUA AL ACIDO

10.2. Estabilidad química:

Este producto es muy estable bajo condiciones normales de almacenamiento, manipulación y uso.

10.3. Posibilidad de reacciones peligrosas:

De la reacción con metales se desprende hidrógeno, gas combustible y explosivo. Por contacto con cianuros, sulfuros y carburos se pueden desprender gases peligrosos como cianuro de hidrógeno, sulfuro de hidrógeno y acetileno. El contacto con materia orgánica combustible puede causar fuego o explosión.

10.4. Condiciones que deben evitarse:

Debe evitarse las altas temperaturas

10.5. Materiales Incompatibles:

Materiales combustibles, materiales orgánicos, oxidantes, aminas, bases, agua, calor en exceso y metales.

10.6. Productos de descomposición peligrosos:

Dióxido de azufre, trióxido de azufre e hidrógeno.

11. Información toxicológica

11.1. General.

El ácido sulfúrico concentrado ejerce una acción corrosiva fuerte en todos los tejidos, debido a una acción de deshidratación severa. La severidad de una quemadura química es proporcional a la concentración del ácido y a la duración del contacto. Exposiciones prolongadas a soluciones diluidas o niebla ácida pueden llevar a irritación de los ojos y piel, causando conjuntivitis y dermatitis crónica. La inhalación de niebla de ácido sulfúrico puede resultar en irritación del tracto respiratorio que posiblemente puede llevar a espasmo laríngeo. Los asmáticos pueden ser muy sensibles a inhalar niebla de ácido sulfúrico. IARC y la ACGIH han concluido que hay suficiente evidencia que exposiciones ocupacionales a nieblas de ácidos inorgánicos fuertes conteniendo ácido sulfúrico es carcinogénico o potencialmente carcinogénico a los humanos.

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11.2. Efectos agudos.

Contacto con la piel: Provoca quemaduras graves profundas y dolorosas. Las quemaduras extensas pueden tener como resultado el shock y muerte.
Contacto con los ojos: Provoca quemaduras graves profundas y dolorosas
Ingestión: Puede tener como resultado quemaduras graves en boca, garganta, perforación del esófago, estómago, manchas y erosión de dientes, náuseas y vómitos de sangre y tejidos erosionados, y hasta la muerte. No inducir el vómito.
Especies y ruta LD_{50} rata- oral 2140 mg/kg
Inhalación: La niebla ácida puede causar irritación de vías respiratorias. Altas concentraciones pueden causar estornudo, tos, dificultad para respirar y edemas de vías respiratorias, con graves consecuencias.
Especies y ruta LC_{50} rata- inhalatoria 0,375 mg/l (4hr)

11.3. Efectos crónicos.

La exposición prolongada a soluciones diluidas o nieblas puede resultar en irritación a los ojos (conjuntivitis crónica) y producir dermatitis en la piel. La exposición a altas concentraciones de niebla ácida ha causado erosión y decoloración de los dientes anteriores. La International Agency por Research on Cáncer ha concluido que hay suficiente evidencia que la exposición ocupacional a nieblas ácidas inorgánicas fuertes conteniendo ácido sulfúrico son carcinógenos en humanos, resultando en un incremento de incidencia principalmente de cáncer laríngeo. La ACGIH tiene listada la niebla de ácido inorgánico fuerte conteniendo ácido sulfúrico como sospechoso de carcinógeno humano (A2). OSHA no lista la niebla de ácido sulfúrico como carcinógeno.
Mutagénico: mutagenicidad bacteriana: test de Ames negativo
Toxicidad para la reproducción: no teratogénico en experimentos con animales.

12. Información ecotoxicológica

12.1. Toxicidad

Toxicidad en peces (Brachydanio rerio): LC 50 82 mg/l en 24 hs (IUCLID)
Toxicidad en Crustáceos (Daphnia): EC50 29 mg/l en 24 h
(Fuente: Normativa de la CE 91/155/EC)

12.2. Persistencia y degradabilidad:

Los métodos para la determinación de la biodegradabilidad no son aplicables para sustancias inorgánicas. Es improbable que cause efectos perniciosos. Quedaran restos indefinidamente como sulfatos.

12.3. Bioacumulación: Este producto tiene un bajo potencial de bioacumulación.

12.4. Movilidad en el suelo: No se dispone de información

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12.5. Otros efectos adversos

Efecto perjudicial en organismos acuáticos. Efecto perjudicial por desviación del pH. Corrosivo incluso en forma diluida. No produce consumo biológico de oxígeno. Existe peligro para el agua potable en caso de penetración en suelos y/o acuíferos.

13. Consideraciones para la eliminación

13.1. Métodos recomendados para disposición final del producto:

Recuperar todo el ácido posible mediante bombeo para reprocesarlo. No lavar hacia drenajes ni permitir que se alcance cursos naturales de agua.

13.2. Métodos recomendados para disposición final de los residuos:

Los desechos de neutralización se dispondrán de acuerdo con los requerimientos regulatorios. Si se neutraliza con piedra caliza o dolomita o ceniza de soda(carbonato de sodio) se requerirá de buena ventilación debido a que se libera dióxido de carbono.

13.3. Métodos recomendados para disposición final de embalajes contaminados:

Devolver al proveedor.

14. Información para el transporte

13.4. Transporte Carretero

- Número de ONU: 1830
- Nombre según ONU: Ácido Sulfúrico
- Clasificación de riesgo para el transporte: 8
- Grupo de embalaje: II

13.5. Transporte Marítimo - IMDG

- Número de ONU: 1830
- Nombre según ONU: Ácido sulfúrico, la sustancia no está considerada contaminante marino.

13.6. Otros

Según el Código RID, la sustancia está clasificada como C1,
Materias corrosivas sin riesgo subsidiario, de carácter ácido, inorgánicas líquidas.
Según el Código ADN: información no disponible.

13.7. Precauciones especiales para el usuario

En caso de derrame neutralizar con carbonato de calcio, carbonato de sodio, cal, calizas o dolomita.
El ácido sulfúrico, reacciona violentamente con el agua.
Evitar el contacto con el producto, de producirse, lávese con abundante agua.
IMDG (Código Marítimo Internacional de Mercancías Peligrosas)
RID (Reglamentos sobre el transporte internacional de Mercancías peligrosas por ferrocarril)

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ADN (Acuerdo Europeo relativo al transporte internacional de Mercancías peligrosas por vías de navegación interior)

15. Información reglamentaria

Decreto 560/2003, Reglamento Nacional de Transporte de Mercancías Peligrosas por Carretera.
Cantidad exenta para la aplicación del Decreto 560/2003: 333 Kg

16. Otras informaciones/ bibliografía

La presente ficha de datos de seguridad, está realizada de acuerdo con los requisitos del Sistema Globalmente Armonizado

1. The Manufacture of Sulfuric Acid, W. Duecker. 1959
2. MSDS Canadian centre for occupational health and safety (november, 1995)
3. Fiche toxicologique nº 30 Institut Nacional de Securite.
4. MSDS Fisher Scientific.
5. MSDS EFMA.
6. Acuerdo para la facilitación del transporte de mercancías peligrosas en el Mercosur. Ministerio de Transporte y Obras Públicas. Montevideo,2005
7. Hoja de Datos de Seguridad de Teck Cominco Metals . Vancouver. Canadá. Dic. 2009
8. Ficha de datos de seguridad de Asturiana de Zinc S.A. Castrillón, Asturias, España 2010
9. IUCLID. International Uniform Chemical Information Database version 5.2 2010

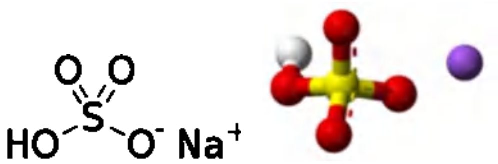
Nota: La información aquí suministrada se basa en nuestros conocimientos actuales sobre el producto, no pretende ser completa y tienen como fin describir al producto con relación a las medidas de seguridad que hay que adoptar. Esta información es una ayuda para que quien la reciba haga sus propias determinaciones para su aplicación particular

Fecha de emisión: Enero 2012
Versión: 02
Sustituye: Versión 01 mayo 2009
M.S.C
M.F.

Hoja de seguridad
Bisulfito de sodio MSDS

Sección 1. Identificación del producto

- **Nombre de la sustancia:** Bisulfito de sodio.
- **Número CAS:** 7631-90-5
- **RTECS**: VZ2000000
- **Fórmula química:** $NaHSO_3$
- **Estructura química:**



- **Masa molar:** 104,07 g/mol
- **Sinónimos:** Sulfito monosódico, ácido sulfuroso, Sódico sulfhídrico.
- **Usos recomendados:** Para disminución del pH y fabricación de joyas.
- **Número de atención de emergencias:** TRANSMEDIC 2280-0999 / 2245-3757 (TM 203 503 Campus Omar Dengo, TM 203 504 Campus Benjamín Núñez) 911 Servicio de emergencia, 2261-2198 Bomberos de Heredia.

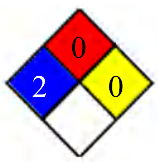
Sección 2. Identificación del peligro o peligros

Descripción de peligros:

Corrosivo 8.1

Información pertinente a los peligros para el hombre y el ambiente:
Sustancia nociva para la salud y peligrosa para el medio ambiente.

Sistemas de clasificación:
-NFPA(escala 0-4):



-HMIS(escala 0-4):

SALUD	2
INFLAMABILIDAD	0
REACTIVIDAD	0

Consejos de prudencia:
- Utilice el equipo de protección indicado para resguardar sus vías respiratorias y la piel.
- Alejar de llamas y fuentes de ignición.

Sección 3. Composición/información sobre los constituyentes

Composición

Número CAS	Componentes peligrosos	% m/m
7631-90-5	Bisulfito de sodio	99.0 %

Sección 4. Primeros auxilios

- **Información general:** Sustancia nociva para la salud, en caso de emergencia buscar atención médica inmediatamente.
- **Contacto ocular:** Enjuague los ojos con agua corriente durante 15 minutos, manteniendo los párpados bien abiertos para eliminar el producto. Si persiste el dolor, consulte con un oftalmólogo.
- **Contacto dérmico:** Después del contacto con la piel, lavar inmediatamente con agua abundante.
- **Inhalación:** Trasladar al aire fresco.
- **Ingestión:** No provocar el vómito sin consejo médico. Enjuague la boca con abundante agua fresca.

Efectos por exposición
- **Contacto ocular:** Puede causar irritación, conjuntivitis química, lagrimeo y dolor.
- **Contacto dérmico**: Puede causar irritación en la piel e hipersensibilidad.
- **Inhalación**: Puede causar irritación en las membranas mucosas.
- **Ingestión:** Puede ser nocivo si se ingiere. Puede causar náuseas, vómitos, diarrea, dolor abdominal dolor, hemorragia gástrica.

Atención médica
- **Tratamiento:** No disponible.
- **Efectos retardados:** No disponible.
- **Antídotos conocidos:** No disponible.

Sección 5. Medidas de lucha contra incendios

- **Agentes extintores:** CO_2, polvo extintor o chorro de agua rociada o espuma de alcohol.
- **Productos peligrosos por combustión:** Produce humos irritantes.
- **Equipo de protección para combatir fuego:** Aparato de respiración autónomo con mascarilla facial completa y traje protector completo.

Sección 6. Medidas que deben tomarse en caso de vertido accidental

- **Precauciones personales, equipo protector y procedimiento de emergencia:** Evacuar o aislar el área de peligro, demarcar las zonas. Restringir el acceso a personas innecesarias y sin la debida protección. Ubicarse a favor del viento. Usar equipo de protección personal.
- **Precauciones relativas al medio ambiente:** No permitir que caiga en fuentes de agua y alcantarillas.
- **Métodos y materiales para la contención y limpieza de vertidos:** Coloque el producto contaminado en un contenedor cerrado, etiquetado y compatible con el producto.

Sección 7. Manipulación y almacenamiento

- **Manipulación de recipientes:** Si se manipulan correctamente, no se requieren medidas especiales. Mantener estrictas normas de higiene, no fumar, beber, ni comer en el sitio de trabajo. Lavarse las manos después de usar el producto.
- **Condiciones de almacenamiento:** Mantener el recipiente cerrado herméticamente y en un lugar fresco.

Sección 8. Controles de exposición/ protección personal

Parámetros de control (valores límite que requieren monitoreo)

TWA	5 mg/m^3
STEL	No disponible

- **Condiciones de ventilación:** Ventilación local y general.
- **Equipo de protección respiratoria:** Usar equipo de seguridad respiratorio cuando el aerosol, vapor, y polvo.
- **Equipo de protección ocular:** Gafas de seguridad.
- **Equipo de protección dérmica:** Usar guantes de carnaza o PVC y delantal, u otra ropa protectora para evitar el contacto con la piel.

Sección 9. Propiedades físicas y químicas

Estado físico	Sólido
Color	Blanco
Olor	Inodoro
Umbral olfativo	No aplica.
pH	No disponible.
Punto de fusión	>300 ºC
Punto de ebullición	No disponible
Punto de inflamación	No aplica
Tasa de evaporación	No aplica
Límites de explosión	No aplica
Presión de vapor a 20°C	23.3 hPa
Densidad relativa de vapor	No aplica

(aire=1)	
Densidad relativa (agua=1)	1.48
Solubilidad en agua	3,5 partes en agua fría.
Solubilidad en otros disolventes	Soluble en 70 partes de alcohol. insoluble en cloruro líquido y amonio.
Coeficiente de reparto n-octanol/agua (Log pow)	No disponible
Temperatura de autoinflamación	No aplica
Temperatura de descomposición	No disponible
Peligro de explosión	No disponible
Viscosidad	No aplica

Sección 10. Estabilidad y reactividad

- **Reactividad:** No disponible.
- **Estabilidad:** Estable bajo condiciones normales.
- **Incompatibilidad:** Agentes oxidantes fuertes.
- **Productos de polimerización:** No ocurrirá.
- **Productos peligrosos de la descomposición:** Óxidos de azufre.

Sección 11. Información toxicológica

- **Toxicidad aguda:** No disponible.
- **Corrosión/irritación cutáneas:** Sí.
- **Lesiones oculares graves/irritación ocular:** Sí.
- **Sensibilización respiratoria o cutánea:** Sí.
- **Mutagenicidad en células germinales:** Mutagénico para bacterias y levaduras.
- **Carcinogenicidad:** No.
- **Toxicidad para la reproducción:** No.
- **Toxicidad sistémica específica de órganos diana-Exposición única:** No disponible.
- **Peligro por aspiración:** Sí.
- **Posibles vías de exposición:** Dermal.
- **Efectos inmediatos:** Irritación.
- **Efectos retardados:** No disponible.
- **Efectos crónicos:** La exposición crónica puede causar náuseas y vómitos, la exposición más importante ocasiona inconsciencia

- **LD/LC50:**

Oral (LD-50)	2 g/Kg (rata)
Dermal (LD-50)	No disponible
Inhalativa (LC-50)	No disponible.

Sección 12. Información ecotoxicológica

- **Toxicidad Acuática:** No disponible.
- **DBO_5=** No aplica.
- **Persistencia y degradabilidad:** Es posible la degradación sin embargo los productos no se espera que sean peligrosos.
- **Potencial de bioacumulación:** No disponible.
- **Movilidad en el suelo:** No disponible.
- **Otros efectos adversos:** No presenta evidencias de carcinogenicidad, mutagenicidad y teratogenicidad según experimentos con animales.

Sección 13. Información relativa a la eliminación de los productos

La eliminación de residuos debe realizarse de acuerdo con su caso Federal, estatal y local. Este producto, si alterada por el uso, se puede disponer de un tratamiento en una permitida instalación o los consejos de su peligrosa locales perder autoridad reguladora. Los residuos de los fuegos extinguidos con este material pueden ser peligrosos.

Sección 14. Información relativa al transporte

- **N° ONU:** 3260
- **Designación oficial de transporte de las Naciones Unidas**: Etiqueta blanca y negro con el número 8 de corrosivo.
- **Riesgos ambientales:** Contaminante para el medio ambiente.
- **Precauciones especiales:** No transporte con agentes oxidantes fuertes ni alimentos.

Sección 15. Información sobre la reglamentación

Regulado por el Reglamento sobre las características y el listado de los desechos peligrosos industriales (Decreto N°27000-MINAE), el Reglamento para el Manejo de los Desechos Peligrosos Industriales (Decreto N° 27001-MINAE), y el Reglamento de transporte terrestre de productos peligrosos (Decreto 27008-MINAE).

Sección 16. Otras informaciones

Frases R:
R22 - Nocivo por ingestión.
R31 - En contacto con ácidos libera gases tóxicos.
R58 - Puede provocar a largo plazo efectos negativos en el medio ambiente

Frases S:
S25 - Evítese el contacto con los ojos.
S46 - En caso de ingestión, acúdase inmediatamente al médico y muéstresele la etiqueta o el envase.
S61 - Evítese su liberación al medio ambiente. Recábense instrucciones específicas de la ficha de datos de seguridad.

Fecha de preparación de la hoja de seguridad: 11 de agosto de 2013.
Versión: No aplica
Modificaciones respecto a versión anterior: 31 de mayo de 2016.

HDS

HOJA de DATOS de SEGURIDAD

1. IDENTIFICACIÓN DEL PRODUCTO Y DEL PROVEEDOR

Producto: **CLORATO DE SODIO, $NaClO_3$,**
Clase 5.1 NU 1495

Fabricante: Eka Chile S. A. Tel. : + 56 41 2129200
Avda. Rocoto 2911 Fax : + 56 41 2929006
Talcahuano

Fonos Emergencia: PLANTA : + 56 41 2129207 / 2129225 / 09 6268359 – 09 3461557

2. COMPOSICIÓN / INGREDIENTES

Nombre Químico (IUPAC)	Contenido	CAS núm.	Núm. CE	HAZCHEM	Clasificación	FrasesR[1)]
Clorato de Sodio	> 99,5%	7775-09-9	231-887-4	1SE	O (oxidante), N (peligroso para el medio ambiente) Xn (nocivo a la salud)	R9-22

[1)] Ver el punto 15.

3. IDENTIFICACIÓN DE LOS RIESGOS

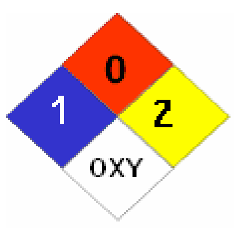
Clasificación : O: R9 Xn: R22 N: R51/53
Efectos para la Salud : Nocivo por ingestión
Efectos sobre el medio ambiente: Dañino para vegetales, pero tóxico para las algas pardas
Otras Propiedades Peligrosas : Oxidante
Peligro de explosión mezclado con productos combustibles.
Los ácidos fuertes reaccionan violentamente con los cloratos produciendo gases tóxicos y explosivos como el cloro y el dióxido de cloro.

Marca en etiqueta NCh 2190

Clasificación de riesgos del producto químico (NFPA)

INFLAMABILIDAD (ROJO)

SALUD (AZUL)



REACTIVIDAD (AMARILLO)

Grado de riesgo
4: Extremo
3: Alto
2: Moderado
1: Leve
0: No significativo

4. MEDIDAS DE PRIMEROS AUXILIOS

Inhalación : Respirar aire puro
Acudir al médico si aparecen síntomas de envenenamiento
Contacto con la piel : Lavar la piel con agua y jabón
Despojarse de la ropa contaminada y lavarla para impedir incendio
Contacto con los ojos : Lavarlos inmediatamente con agua. Acudir al médico si persisten molestias
Ingestión : Lavar la boca y beber inmediatamente un par de vasos de agua o leche. ¡No provocar el vómito!
Acudir al hospital si se ha ingerido algo más que una cantidad insignificante
Hay resto demetahemoglobinemía. No debe tratarse con metiltionina

5. MEDIDAS PARA LUCHAR CONTRA EL FUEGO

Sustancia extintora : Utilizar agua

Sustancia extintora Inadecuada : ¡No utilizar extintores de polvo o nieve carbónica (CO_2)!

Riesgos específicos : En espacios cerrados en los que hay clorato pueden producirse explosiones en caso de incendio Recipientes cerrados que contienen clorato de sodio pueden explotar si se calientan por encima de la temperatura de desintegración (> 250°C)

Métodos específicos : ¡Apagar los incendios con grandes cantidades de agua! ¡No intentar ahogar el fuego con mantas! Hay que alejar inmediatamente los recipientes en las cercanías del foco de calor, o enfriarlos con agua

6. MEDIDAS PARA CONTROLAR DERRAMES O FUGAS

Protección Personal : Cuando hay que tratar derrames de importancia es necesario llevar ropa protectora y otros equipo de protección (ver punto 6). Alejar cualquier material que pueda inflamarse

Protección ambiental : Recoger el clorato contaminado del suelo

No descargar soluciones de líquidos al alcantarillado

Métodos de saneamiento : Cercar con arena o material similar no combustible y recoger todas las impurezas en recipientes de plástico o metal. No utilizar aserrines, turba, cortezas ni otro material que sean combustibles. Lavar con grandes cantidades de agua. Si los vertidos son grandes, llamar a expertos, informar al servicio de salvamento

7. MANIPULACIÓN Y ALMACENAMIENTO

Manipulación : <u>Medidas técnicas</u>

: Utilizar únicamente lubricantes y juntas inertes (sintéticos) para bombas, válvulas y otros equipos donde y cuando se manipula el clorato seco o en solución. Rellenar con lubricantes a intervalos regulares

<u>Consejos para seguridad de manejo</u>

- A intervalos regulares conviene limpiar los equipos eléctricos del polvo de clorato
- Evitar el contacto con los productos químicos y materiales indicados abajo (sustancias incompatibles)
- Mantener los recipientes cerrados cuando no se usan
- Evitar el contacto con la piel y ojos
- No manejar el clorato en las cercanías de productos combustibles y fuentes de calor

<u>Medidas de protección</u>

- Manejar el clorato de modo que se evite la formación de polvo
- Si ha de manejarse de manera que es inevitable la formación de polvo, hay que disponer de un ventilador de extracción
- Recoger el polvo e inutilizarlo

Almacenamiento : <u>Medidas técnicas</u>

Ver más abajo

<u>Condiciones de almacenamiento</u>

- Almacenar el producto en lugar fresco, seco y a prueba de fuego, separado de productos inflamables y fuentes de calor
- No someter el material a fricción ni a golpes
- Guardar el producto apartado de productos comestibles

Sacos Grandes

- Almacenarlos sobre arena, evitar el asfalto.
- La distancia de seguridad entre las pilas de sacos ha de ser como mínimo de 1,5-3.0 m
- Mantener la distancia de seguridad a los edificios

A Granel

- Almacenar el producto en espacios que no contengan materiales combustibles
- Almacenar el material separado de otros productos

Productos incompatibles

El clorato de sodio ha de almacenarse separado de materiales orgánicos, ácidos fuertes, fósforo, azufre, sulfuros, polvos metálicos y sales de amonio

Material de envasado

Usar barriles metálicos o sacos de tipo aprobado (con marca UN)

Los sacos no han de volver a utilizarse

8. CONTROL DE EXPOSICION/PROTECCION ESPECIAL

Medidas técnicas : Extracción en puntos

Equipo y medidas personales de protección :
- En atmósferas polvorientas, usar filtro para respirar
- Guantes pvc, botas pvc, delantales de plástico o goma o mono protector
- Gafas protectoras
- Lavaojos
- Las ropas de trabajo han de lavarse diariamente en agua
- Cambiar inmediatamente la ropa que se haya contaminado con clorato

Medidas especiales : Tiene que haber disponibles duchas de emergencia o bañeras llenas con agua. Los materiales que se hayan impregnado con clorato han de ser inutilizados para que no exista riesgo de que se produzcan incendios incontrolables

ESTA PROHIBIDO FUMAR

9. PROPIEDADES FISICAS Y QUIMICAS

Apariencia y olor	:	Cristales blancos inodoros, sabor amargo y salado
pH en solución	:	Neutro
Punto de fusión	:	248-250 °C
Punto de ebullición		Se desintegra
Desintegración	:	A más de 250-300 °C
Punto de inflamación	:	No aplicable
Zona de explosión	:	Ver punto 10
Densidad, en granel	:	1500 kg/m^3
Solubilidad en agua	:	728 g/l a 20 °C

10. ESTABILIDAD Y REACTIVIDAD

El clorato de sodio es una sustancia fuertemente oxidante que al calentarse desprende fácilmente oxígeno. La desintegración se produce al calentarse a más de 250 °C. Al desintegrarse se forma cloruro de sodio y oxígeno

Circunstancias que hay que evitar: Temperaturas elevadas

Materiales y productos Químicos que hay que evitar :
: Las mezclas de clorato y material orgánico son muy inflamables
: Las mezclas secas pueden inflamarse o explotar mediante la fricción o sometiéndolas a golpes
: Los tejidos, celulosa y cuero contaminados con clorato son fácilmente inflamables

Los ácidos fuertes reaccionan violentamente con el clorato y producen gases tóxicos y explosivos como cloro y dióxido de cloro

11. INFORMACIÓN TOXICOLÓGICA

El clorato de sodio está clasificado como producto nocivo a la salud

Toxicidad aguda : LD_{50} (oral, rata) = 1200 mg/kg.

LD_{LO} (oral, hombre) = 214 mg/kg.

El clorato de sodio tiene efecto oxidante y oxida la hemoglobina de la sangre convirtiéndola en metahemoglobina. Ello conduce a una escasez de oxígeno en los tejidos corporales ya que la metahemoglobina tiene peor capacidad para el transporte del oxígeno

Síntomas

Dolores abdominales, náuseas, vómitos, diarrea, disnea, cianosis, nefritis aguda, anuria, daños renales y hepáticos, convulsiones, coma y muerte. Los primeros síntomas pueden aparecer después de varias horas

Efectos locales : *Inhalación*

La inhalación del polvo causa irritación en las mucosas

Piel y ojos

El clorato de sodio es un irritante ligero

12. INFORMACION ECOTOXICOLOGICA

El clorato daña las plantas, pero es tóxico para las algas pardas. Son especialmente sensibles al clorato las bacterias que participan en la nitrificación, desnitrificación y formación de amoniaco

Movilidad : *Agua*

Permanecer disuelto en el agua

Tierra

Puede percolarse el suelo

Persistencia/degradibilidad : Se degrada lentamente en el suelo en presencia de aire. Degradación más rápida en cloruro sódico y oxígeno en la ausencia de aire (desintegración microbiana)

Acumulación : En las plantas el clorato se convierte en cloruro. Este se acumula en las células hasta concentraciones tóxicas causando la muerte de la planta. No hay pruebas de que se acumule en la célula animal

Ecotoxicidad : Los cloratos son perjudiciales para los organismos acuáticos, pero tóxicos para las algas focáceas (Fucus vesiculosus). Los cloratos producen alteraciones en los microorganismos que hay en sedimentos, por ejemplo, los que intervienen en el ciclo del nitrógeno

Peces 48h LD_{50}. Salmón arco iris (Oncorynchus mykiss) = 2750 mg/l

Crustáceos 24 h LC_{50} pulga de agua (Daphnia magna) = 880 mg/l (clorato de potasio)

Algas IC50 alga azul (fucus vesiculosus) = 0,080 mg/l (estudio de larga duración). Tiene efecto inhibidor del plancton verde (Scenedesmeus) a 7 mg/l

13. CONSIDERACIONES SOBRE DISPOSICION FINAL

Vertidos : El clorato de sodio no debe disponerse ni ser vertido en el alcantarillado. Recogerlo en recipientes de plástico o metal

Envases contaminados : Limpiar los envases vacíos de los restos de clorato. El material combustible puede quemarse en recipientes abiertos bajo condiciones controladas

En general : Consultar a las autoridades locales para obtener información sobre el manejo de los residuos

Dirigirse a Eka Chile si se precisa ayuda técnica, ver punto 16

14. INFORMACION SOBRE EL TRANSPORTE

Terrestre por carretera o ferrocarril : ADR/RID

Clase : 5.1

Núm. UN : 1495

Grupo de envase : II

Etiqueta : 5.1

Vía marítima : IMDG

Clase 5.1

EmS núm. 5.1-06

MFAG 745

Vía aérea : IATA-DGR

Clase 5.1

15. NORMAS VIGENTES

Clasificación y marcas

Clasificación y marcas según la directiva 67/548/EEC, 18 adaptación técnica

Clase de peligrosidad : Oxidante, dañino a la salud

Designación de peligrosidad : O, Xn

Marcas

CLORATO DE SODIO

Frases de riesgo (R9-22-31)

Explosivo si se mezcla con material combustible

Peligroso de ingerir

(Forma un gas tóxico en contacto con lo ácidos) 1)

Frases de seguridad (S(2)-13-17-46)

(Guardar fuera del alcance de los niños) (2)

Guardar separado de productos alimentarios y piensos

Guardar separado de productos inflamables

En caso de ingestión, acudir inmediatamente al médico y mostrarle este envase o etiqueta.

(1) Marcar adicional según Eka Chemicals

(2) Se utiliza únicamente en la marca de productos para el consumo

16. OTRAS INFORMACIONES

Uso recomendado

El uso dominante del clorato de sodio es para la producción de dióxido de cloro, que se utiliza para el blanqueamiento de pasta de papel. Otras aplicaciones son para la producción de clorato de potasio, cloruro de sodio, perclorato de potasio, perclorato de sodio, herbicidas y defoliantes.

No utilizar el clorato de sodio en mezclas para fuegos artificiales de aficionados

Seguir las disposiciones de seguridad en el manejo del clorato de sodio. Su omisión puede ser causa de daños graves personales o materiales

Unidades de protección de Eka Chemicals

ALBY	Dirección	Eka Chemicals AB
Suecia		SE-841 44 Alby
	Fax	+46 69 01 54 35
	Tel.:	+46 69 01 54 00

AMBES	Dirección:	Eka Chimie S. A.
Francia		Z.I. du Bec
		FR-33810 Ambés
	Fax	+33 556 77 05 08
	Tel.	+33 556 77 31 40

OULU	Dirección:	Eka Chemicals OY
Finlandia		P.O. Box 198
		FI-99101 Oulu
	Fax	+358 8 3183 3151
	Tel.:	+358 8 3183 3111

STOCKVIK	Dirección	Eka Chemicals AB
Suecia		Box 13000
		SE-850 13 Sundsvall
	Fax:	+46 60 56 93 82
	Tel.:	+46 60 13 40 00

TALCAHUANO	Dirección:	Eka Chile S.A.
Chile		P.O. Box 167
		Talcahuano
	Fax:	+56 41 2929006
	Tel.:	+56 41 2129200
		+56 41 2129225 / 2129207 / 2129240
		09 6268359 – 09 3461557

Fichas Internacionales de Seguridad Química

DIOXIDO DE CLORO

ICSC: 0127

MINISTERIO DE TRABAJO Y ASUNTOS SOCIALES ESPAÑA

INSTITUTO NACIONAL DE SEGURIDAD E HIGIENE EN EL TRABAJO

DIOXIDO DE CLORO
Peróxido de cloro
Oxido de cloro (IV)
ClO_2
Masa molecular: 67.5

Nº CAS 10049-04-4
Nº RTECS FO3000000
Nº ICSC 0127

TIPOS DE PELIGRO/ EXPOSICION	PELIGROS/ SINTOMAS AGUDOS	PREVENCION	PRIMEROS AUXILIOS/ LUCHA CONTRA INCENDIOS
INCENDIO	No combustible pero facilita la combustión de otras sustancias. Muchas reacciones pueden producir incendio o explosión.	NO poner en contacto con combustibles.	En caso de incendio en el entorno: agua en grandes cantidades, agua pulverizada.
EXPLOSION	Riesgo de incendio y explosión en presencia de chispas, impactos, luz solar, calor o al entrar en contacto con sustancias combustibles.	Sistema cerrado, ventilación, equipo eléctrico y de alumbrado a prueba de explosiones. No exponer a fricción o choque.	En caso de incendio: mantener fríos los bidones y demás instalaciones rociando con agua. Combatir el incendio desde un lugar protegido.
EXPOSICION		¡EVITAR TODO CONTACTO!	¡CONSULTAR AL MEDICO EN TODOS LOS CASOS!
• **INHALACION**	Corrosivo. Tos, dificultad respiratoria, jadeo, dolor de garganta, náuseas. (Síntomas no inmediatos: véanse Notas).	Ventilación, extracción localizada o protección respiratoria. Sistema cerrado y ventilación.	Aire limpio, reposo, posición de semiincorporado, respiración artificial si estuviera indicada y proporcionar asistencia médica.
• **PIEL**	Corrosivo. Enrojecimiento, quemaduras cutáneas graves, dolor.	Guantes protectores y traje de protección.	Aclarar con agua abundante, después quitar la ropa contaminada y aclarar de nuevo y proporcionar asistencia médica.
• **OJOS**	Corrosivo. Enrojecimiento, dolor, visión borrosa.	Gafas ajustadas de seguridad o protección ocular combinada con la protección respiratoria.	Enjuagar con agua abundante durante varios minutos (quitar las lentes de contacto si puede hacerse con facilidad) y proporcionar asistencia médica.
• **INGESTION**			

DERRAMAS Y FUGAS	ALMACENAMIENTO	ENVASADO Y ETIQUETADO
Evacuar la zona de peligro. Consultar a un experto. Ventilar. Eliminar gas con agua pulverizada. (Protección personal adicional: traje de protección completa incluyendo equipo autónomo de repiración).	Separado de sustancias combustibles y reductoras. Mantener en lugar fresco. Ventilación a ras del suelo.	

VEASE AL DORSO INFORMACION IMPORTANTE

ICSC: 0127

Fichas Internacionales de Seguridad Química

DIOXIDO DE CLORO

ICSC: 0127

DATOS IMPORTANTES

ESTADO FISICO; ASPECTO
Gas entre rojo y amarillo, de olor acre.

PELIGROS FISICOS
El gas es más denso que el aire.

PELIGROS QUIMICOS
Puede descomponerse con explosión por choque, fricción o sacudida. Puede explotar por calentamiento intenso. La sustancia es un oxidante fuerte y reacciona violentamente con sustancias combustibles y reductores. Reacciona violentamente con mercurio, fósforo, azufre etc, originando peligro de fuego y explosión. Reacciona con el agua produciendo cloruro de hidrógeno y ácido clórico.

LIMITES DE EXPOSICION
TLV (como TWA): 0.1 ppm; 0.28 mg/m^3 (ACGIH 1993-1994).
TLV (como STEL): 0.3 ppm; 0.83 mg/m^3 (piel) (ACGIH 1993-1994).
MAK: 0.1 ppm; 0.3 mg/m^3 (1992).

VIAS DE EXPOSICION
La sustancia se puede absorber por inhalación y por ingestión.

RIESGO DE INHALACION
Al producirse una pérdida de gas se alcanza muy rápidamente una concentración nociva de éste en el aire.

EFECTOS DE EXPOSICION DE CORTA DURACION
Lacrimógeno. La sustancia es corrosiva de los ojos, la piel y el tracto respiratorio. La inhalación del gas puede originar edema pulmonar (véanse Notas). La exposición por encima del OEL puede producir la muerte. Los efectos pueden aparecer de forma no inmediata. Se recomienda vigilancia médica.

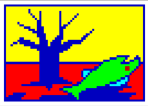
EFECTOS DE EXPOSICION PROLONGADA O REPETIDA
La sustancia puede afectar el pulmón, dando lugar a bronquitis crónica. La sustancia puede causar erosiones dentales.

PROPIEDADES FISICAS

Punto de ebullición: 11°C
Punto de fusión: -59°C
Densidad relativa (agua = 1): 1.6 a 0°C (líquido)
Solubilidad en agua, g/100 ml a 20°C: 0.8
Presión de vapor, kPa a 20°C: 101
Densidad relativa de vapor (aire = 1): 2.3
Límites de explosividad, % en volumen en el aire: >10

DATOS AMBIENTALES

Esta sustancia puede ser peligrosa para el ambiente; debería prestarse atención especial a los organismos acuáticos.



N O T A S

Está indicado examen médico periódico dependiendo del grado de exposición. Los síntomas del edema pulmonar no se ponen de manifiesto, a menudo, hasta pasadas algunas horas y se agravan por el esfuerzo físico. Reposo y vigilancia médica son por ello, imprescindibles. Debe considerarse la inmediata administración de un aerosol adecuado por un médico o persona por él autorizada. Enjuagar la ropa contaminada con agua abundante (peligro de incendio).

INFORMACION ADICIONAL

FISQ: 3-104 DIOXIDO DE CLORO

ICSC: 0127 **DIOXIDO DE CLORO**

NOTA LEGAL IMPORTANTE:
Ni la CCE ni la IPCS ni sus representantes son responsables del posible uso de esta información. Esta ficha contiene la opinión colectiva del Comité Internacional de Expertos del IPCS y es independiente de requisitos legales. La versión española incluye el etiquetado asignado por la clasificación europea, actualizado a la vigésima adaptación de la Directiva 67/548/CEE traspuesta a la legislación española por el Real Decreto 363/95 (BOE 5.6.95).

Fichas Internacionales de Seguridad Química

METANOL	ICSC: 0057
	Abril 2000

Alcohol metílico	Carbinol

CAS:	**67-56-1**	**CH_4O / CH_3OH**
RTECS:	**PC1400000**	**Masa molecular: 32.0**
NU:	**1230**	
CE Índice Anexo I:	**603-001-00-X**	
CE / EINECS:	**200-659-6**	

TIPO DE PELIGRO / EXPOSICIÓN	PELIGROS AGUDOS / SÍNTOMAS	PREVENCIÓN	PRIMEROS AUXILIOS / LUCHA CONTRA INCENDIOS
INCENDIO	Altamente inflamable. Ver Notas.	Evitar las llamas, NO producir chispas y NO fumar. NO poner en contacto con oxidantes.	Polvo, espuma resistente al alcohol, agua en grandes cantidades, dióxido de carbono.
EXPLOSIÓN	Las mezclas vapor/aire son explosivas.	Sistema cerrado, ventilación, equipo eléctrico y de alumbrado a prueba de explosión. NO utilizar aire comprimido para llenar, vaciar o manipular. Utilícense herramientas manuales no generadoras de chispas.	En caso de incendio: mantener fríos los bidones y demás instalaciones rociando con agua.

EXPOSICIÓN		¡EVITAR LA EXPOSICION DE ADOLESCENTES Y NIÑOS!	
Inhalación	Tos. Vértigo. Dolor de cabeza. Náuseas. Debilidad. Alteraciones de la vista.	Ventilación. Extracción localizada o protección respiratoria.	Aire limpio, reposo. Proporcionar asistencia médica.
Piel	¡PUEDE ABSORBERSE! Piel seca. Enrojecimiento.	Guantes de protección. Traje de protección.	Quitar las ropas contaminadas. Aclarar con agua abundante o ducharse. Proporcionar asistencia médica.
Ojos	Enrojecimiento. Dolor.	Gafas ajustadas de seguridad, o protección ocular combinada con la protección respiratoria.	Enjuagar con agua abundante durante varios minutos (quitar las lentes de contacto si puede hacerse con facilidad), después proporcionar asistencia médica.
Ingestión	Dolor abdominal. Jadeo. Vómitos. Convulsiones. Pérdida del conocimiento (para mayor información, véase Inhalación).	No comer, ni beber, ni fumar durante el trabajo. Lavarse las manos antes de comer.	Provocar el vómito (¡UNICAMENTE EN PERSONAS CONSCIENTES!). Proporcionar asistencia médica.

DERRAMES Y FUGAS	ENVASADO Y ETIQUETADO
Evacuar la zona de peligro. Ventilar. Recoger el líquido procedente de la fuga en recipientes precintables. Eliminar el residuo con agua abundante. Eliminar vapor con agua pulverizada. Traje de protección química, incluyendo equipo autónomo de respiración.	No transportar con alimentos y piensos. **Clasificación UE** Símbolo: F, T R: 11-23/24/25-39/23/24/25; S: (1/2-)7-16-36/37-45 **Clasificación NU** Clasificación de Peligros NU: 3 Riesgos Subsidiarios de las NU: 6.1; Grupo de Envasado NU: II
RESPUESTA DE EMERGENCIA	**ALMACENAMIENTO**
Ficha de emergencia de transporte (Transport Emergency Card): TEC (R)-30S1230. Código NFPA: H 1; F 3; R 0;	A prueba de incendio. Separado de oxidantes fuertes, alimentos y piensos. Mantener en lugar fresco.

IPCS
International
Programme on
Chemical Safety

VÉASE INFORMACIÓN IMPORTANTE AL DORSO

Fichas Internacionales de Seguridad Química

METANOL	ICSC: 0057

DATOS IMPORTANTES

ESTADO FÍSICO; ASPECTO:
Líquido incoloro, de olor característico.

PELIGROS FÍSICOS:
El vapor se mezcla bien con el aire, formándose fácilmente mezclas explosivas.

PELIGROS QUÍMICOS:
Reacciona violentamente con oxidantes, originando peligro de incendio y explosión.

LÍMITES DE EXPOSICIÓN:
TLV: 200 ppm como TWA, 250 ppm como STEL; (piel); BEI establecido (ACGIH 2004).
MAK: Riesgo para el embarazo: grupo (DFG 2004).
LEP UE: 200 ppm; 260 mg/m³ como TWA (piel) como TWA (UE 2006).

VÍAS DE EXPOSICIÓN:
La sustancia se puede absorber por inhalación, a través de la piel y por ingestión.

RIESGO DE INHALACIÓN:
Por evaporación de esta sustancia a 20°C se puede alcanzar bastante rápidamente una concentración nociva en el aire.

EFECTOS DE EXPOSICIÓN DE CORTA DURACIÓN:
La sustancia irrita los ojos la piel y el tracto respiratorio. La sustancia puede afectar al sistema nervioso central, dando lugar a pérdida del conocimiento. La exposición puede producir ceguera y muerte. Los efectos pueden aparecer de forma no inmediata.

EFECTOS DE EXPOSICIÓN PROLONGADA O REPETIDA:
El contacto prolongado o repetido con la piel puede producir dermatitis. La sustancia puede afectar sistema nervioso central, dando lugar a dolores de cabeza persistentes y alteraciones de la visión.

PROPIEDADES FÍSICAS

Punto de ebullición: 65°C
Punto de fusión: -98°C
Densidad relativa (agua = 1): 0.79
Solubilidad en agua: miscible
Presión de vapor, kPa a 20°C: 12.3
Densidad relativa de vapor (aire = 1): 1.1

Densidad relativa de la mezcla vapor/aire a 20°C (aire = 1): 1.01
Punto de inflamación: 12°C c.c.
Temperatura de autoignición: 464°C
Límites de explosividad, % en volumen en el aire: 5.5-44
Coeficiente de reparto octanol/agua como log Pow: -0.82/-0.66

DATOS AMBIENTALES

NOTAS

Arde con llama azulada. Está indicado examen médico periódico dependiendo del grado de exposición. Esta ficha ha sido parcialmente actualizada en octubre de 2006: ver Límites de exposición.

INFORMACIÓN ADICIONAL

Límites de exposición profesional (INSHT 2011):

VLA-ED: 200 ppm; 266 mg/m^3

Notas: vía dérmica.

VLB: 15 mg/L en orina. Notas F, I.

Nota legal	Esta ficha contiene la opinión colectiva del Comité Internacional de Expertos del IPCS y es independiente de requisitos legales. Su posible uso no es responsabilidad de la CE, el IPCS, sus representantes o el INSHT, autor de la versión española.

Ficha de Informação de Segurança de Produto Químico - FISPQ

Data: 23/06/2017 **Nº FISPQ:** BR0306 **Versão:** 7 **Anula e substitui versão:** todas anteriores

1 - IDENTIFICAÇÃO DO PRODUTO E DA EMPRESA

Nome do produto: OC-3A

Código interno de identificação: BR0306

Principais usos recomendados para a substância ou mistura: Utilizado para geração de energia térmica em fornos e caldeiras.

Nome da empresa: PETROBRAS DISTRIBUIDORA S.A.

Endereço: Rua Correia Vasques 250
20211-140 - Cidade Nova - Rio de Janeiro (RJ).

Telefone: 0800 728 9001

Telefone para emergências: 08000 24 44 33

2 - IDENTIFICAÇÃO DE PERIGOS

Classificação de perigo do produto:

Líquidos inflamáveis – Categoria 4

Corrosivo/irritante à pele – Categoria 3

Carcinogenicidade – Categoria 2

Toxicidade sistêmica ao órgão-alvo após única exposição – Categoria 3

Sistema de classificação utilizado: Norma ABNT-NBR 14725-2:2009 – versão corrigida 2:2010.
Sistema Globalmente Harmonizado para a Classificação e Rotulagem de Produtos Químicos, ONU.

Outros perigos que não resultam em uma classificação: O produto não possui outros perigos.

ELEMENTOS APROPRIADOS DA ROTULAGEM

Pictogramas:

Palavra de advertência: ATENÇÃO

Frase de perigo:

Líquido combustível.

Provoca irritação moderada à pele.

Suspeito de provocar câncer.

Pode provocar irritação das vias respiratórias.

Pode provocar sonolência ou vertigem.

Pode ser nocivo se ingerido e penetrar nas vias respiratórias.

Frase de precaução:

Evite inalar vapores e névoas.

Use luvas de proteção, roupa de proteção, proteção ocular e proteção facial.

EM CASO DE INALAÇÃO: Remova a pessoa para local ventilado e a mantenha em repouso numa posição que não dificulte a respiração.

EM CASO DE exposição ou suspeita de exposição: Consulte um médico.

Em caso de irritação cutânea: Consulte um médico.

Em caso de incêndio: Para a extinção utilize pó químico, espuma resistente a álcool, dióxido de carbono (CO2) e neblina de água.

3 - COMPOSIÇÃO E INFORMAÇÃO SOBRE OS INGREDIENTES

>>>SUBSTÂNCIA DE PETRÓLEO

Nome químico ou comum nome técnico: Óleo combustível residual.

Grupo de substância de petróleo: Membros desta categoria formam um grupo abrangendo diversos hidrocarbonetos com uma ampla faixa de pesos moleculares, números de carbonos (C7 a C50) e pontos de ebulição (121 a 600 ºC). Os hidrocarbonetos de petróleo contêm enxofre, nitrogênio, oxigênio e compostos organometálicos

Sinônimo: Óleo Combustível residual.

Número de Registro CAS: 68476-33-5

Impurezas que contribuam para o perigo:

Componente	Concentração (%)	CAS
Compostos nitrogenados	-	NA
Compostos sulfurados	-	NA
Metais pesados	-	NA

* Concentração de enxofre total: máx. 1% (p/p) – ASTM D4294

NA: Não aplicável.

4 - MEDIDAS DE PRIMEIROS SOCORROS

Inalação:

Remova a vítima para local arejado e mantenha-a em repouso. Monitore a função respiratória. Se a vítima estiver respirando com dificuldade, forneça oxigênio. Se necessário aplique respiração artificial. Procure atenção médica. Leve esta FISPQ.

Contato com a pele:

Remova as roupas e sapatos contaminados. Lave a pele exposta com grande quantidade de água, por pelo menos 20 minutos. Procure atenção médica. Leve esta FISPQ.

Contato com os olhos:

Lave com água corrente por pelo menos 20 minutos, mantendo as pálpebras abertas. Retire lentes de contato quando for o caso. Procure atenção médica imediatamente. Leve esta FISPQ.

Ingestão:

Lave a boca da vítima com água em abundância. NÃO INDUZA O VÔMITO. Procure atenção médica. Leve esta FISPQ.

Notas para médico:

Evite contato com o produto ao socorrer a vítima. Mantenha a vítima em repouso e aquecida. Não forneça nada pela boca a uma pessoa inconsciente. O tratamento sintomático deve compreender, sobretudo, medidas de suporte como correção de distúrbios hidroeletrolíticos, metabólicos, além de assistência respiratória.

5 - MEDIDAS DE COMBATE A INCÊNDIO

Meios de extinção:

Apropriados: Pó químico, espuma resistente a álcool, dióxido de carbono (CO2) e neblina de água.

Não recomendados: Jatos d'água. Água diretamente sobre o líquido em chamas.

Perigos específicos da mistura ou substância:

A combustão do produto químico ou de sua embalagem pode formar gases irritantes e tóxicos como monóxido, dióxido de carbono e sulfeto de hidrogênio. Muito perigoso quando exposto a calor excessivo ou outras fontes de ignição como: faíscas, chamas abertas ou chamas de fósforos e cigarros,operações de solda, lâmpadas-piloto e motores elétricos. Pode acumular carga estática por fluxo ou agitação. Os vapores do líquido aquecido podem incendiar-se por descarga estática. Os vapores são mais densos que o ar e tendem a se acumular em áreas baixas ou

	confinadas, como bueiros, porões, etc. Podem deslocar-se por grandes distâncias provocando retrocesso da chama ou novos focos de incêndio tanto em ambientes abertos como confinados. Os contêineres podem explodir se aquecidos.
Medidas de proteção da equipe de combate a incêndio	Equipamento de proteção respiratória do tipo autônomo (SCBA) com pressão positiva e vestuário protetor completo. Em locais fechados, utilize equipamento de segurança com sistema de ar autônomo. Contêineres e tanques envolvidos noincêndio devem ser resfriados com jatos d'água.

6 - MEDIDAS DE CONTROLE PARA DERRAMAMENTO OU VAZAMENTO

Precauções pessoais

Para o pessoal que não faz parte dos serviços de emergência:	Produto combustível. Remova todas as fontes de ignição.Impeça fagulhas ou chamas. Não fume. Não toque nos recipientes danificados ou no material derramado sem o uso devestimentas adequadas. Evite inalação, contato com os olhos e com a pele. Utilize equipamento de proteção individual conforme descrito na Seção 8.
Para pessoal de serviço de emergência:	Utilizar EPI completo, com óculos de segurança contra respingos, luvas de proteção de PVC, vestuário protetor adequado.
Precauções ao meio ambiente:	Evite que o produto derramado atinja cursos d'água e rede de esgotos.
Métodos e materiais para contenção e limpeza:	Colete o produto derramado e coloque em recipientes próprios. Adsorva o produto remanescente, com areia seca, terra, vermiculite, ou qualquer outro material inerte. Coloque omaterial adsorvido em recipientes apropriados e remova-os paralocal seguro.
Diferenças na ação de grandes e pequenos vazamentos:	Não há distinção entre as ações de grandes e pequenos vazamentos para este produto.

7 - MANUSEIO E ARMAZENAMENTO

MEDIDAS TÉCNICAS APROPRIADAS PARA O MANUSEIO

Precauções para manuseio seguro:	Manuseie o produto em local ventilado ou com sistema geral de exaustão local. Evite formação de vapores ou névoas. Evite contato com materiais incompatíveis. Não fume. Evite inalação e o contato com a pele, olhos e roupas. Evite respirar vapores/névoas do produto. Utilize equipamento de proteção individual ao manusear o produto, descritos na Seção 8.
Medidas de higiene:	Não coma, beba ou fume durante o manuseio do produto. Lave bem as mãos antes de comer, beber, fumar ou ir ao banheiro. Roupas contaminadas devem ser trocadas e lavadas antes de sua reutilização.

Condições de armazenamento seguro, incluindo qualquer incompatibilidade

Prevenção de incêndio e explosão: Mantenha afastado do calor, faísca, chama aberta e superfícies quentes. — Não fume. Mantenha o recipiente hermeticamente fechado. Aterre o vaso contentor e o receptor do produto durante transferências. Utilize apenas ferramentas antifaiscante. Evite o acúmulo de cargas eletrostáticas. Utilize equipamento elétrico, de ventilação e de iluminação à prova de explosão.

Condições adequadas: Mantenha o produto em local fresco, seco e bem ventilado, distante de fontes de calor e ignição. Armazenar em tanque de teto fixo, em local bem ventilado, na temperatura ambiente e sob pressão atmosférica. O local de armazenamento deve conter bacia de contenção para reter o produto, em caso de vazamento. O local de armazenamento deve ter piso impermeável, isento de materiais combustíveis e com dique de contenção para reter em caso de vazamento.

Materiais para embalagens: Não especificado.

8 - CONTROLE DE EXPOSIÇÃO E PROTEÇÃO INDIVIDUAL

Parâmetros de controle

Limite de exposição ocupacional:

Ingredientes	TLV – TWA (ACGIH 2012)
Óleo combustível	5,0 $mg/m^{3.}$

Indicadores biológicos: Não estabelecidos.

Medida de controle de engenharia: Promova ventilação mecânica e sistema de exaustão direta para o meio exterior. Estas medidas auxiliam na redução da exposição ao produto. É recomendado tornar disponíveis chuveiros de emergência e lava olhos na área de trabalho.Manter as concentrações da substância ou mistura no ar abaixo dos limites de exposição ocupacional indicados.

Equipamento de proteção pessoal

Proteção dos olhos/face: Óculos de proteção com proteção facial contra respingos.

Proteção da pele e do corpo: Luvas de proteção de PVC. Vestuário protetor adequado.

Proteção respiratória: Recomenda-se a utilização de respirador com filtro para vapores orgânicos para exposições médias acima da metade do TLV-TWA. Nos casos em que a exposição exceda 3 vezes o valor TLV-TWA, utilize respirador do tipo autônomo (SCBA) com suprimento de ar, de peça facial inteira, operado em modo de pressão positiva. Siga orientação do Programa de Prevenção Respiratória (PPR),
3ª ed. São Paulo: Fundacentro, 2002.

Perigos térmicos: Não apresenta perigos térmicos.

9 - PROPRIEDADES FÍSICO-QUÍMICAS

Aspecto (estado físico, forma e cor)::	Líquido viscoso e escuro.
Odor e limite de odor:	Característico de hidrocarbonetos.
Ph:	Não aplicável.
Ponto de fusão/ponto de congelamento:	< 30ºC
Ponto de ebulição inicial e faixa de temperatura de ebulição:	121 – 600ºC
Ponto de fulgor:	66ºC; Método: vaso fechado.
Taxa de evaporação:	Muito lenta.
Inflamabilidade : (sólido; gás):	Não aplicável.
Limite inferior/superior de inflamabilidade ou explosividade:	Superior: 6% Inferior: 1%
Pressão de vapor:	0,02 – 0,791 kPa a 120°C 0,063 – 0,861 kPa a 150°C
Densidade de vapor:	Não disponível.
Densidade relativa:	Não disponível
Solubilidade:	Insolúvel em água. Solúvel em solventes orgânicos.
Coeficiente de partição – n-octanol/água:	Log kow: 3,9 – 6,0 (dado estimado).
Temperatura de auto-ignição:	250 – 537ºC
Temperatura de decomposição:	Não disponível.
Viscosidade:	2300 cSt a 60ºC (Método MB-293).
Outras informações:	Densidade: 1,026

10 - ESTABILIDADE E REATIVIDADE

Estabilidade e reatividade:	Estável sob condições usuais de manuseio e armazenamento. Não sofre polimerização.
Possibilidade de reações perigosas:	Não são conhecidas reações perigosas com relação ao produto
Condições a serem evitadas	Temperaturas elevadas. Fontes de ignição. Contato com materiais incompatíveis.
Materiais incompatíveis	Agentes oxidantes fortes, como peróxidos, cloratos e nitratos.
Produtos perigosos da decomposição:	Em combustão libera hidrocarbonetos poli-aromáticos na forma de partículas e vapores. Quando aquecido pode liberar sulfeto de hidrogênio.

11 - INFORMAÇÕES TOXICOLÓGICAS

Toxicidade aguda:	Produto não classificado como tóxico agudo. Informações referentes ao: - Óleo combustível: DL50 (oral, ratos): > 5000 mg/kg DL50 (dérmica, ratos): > 3000 mg/kg
Corrosão/irritação da pele:	Causa irritação moderada à pele com vermelhidão e dor no local atingido.
Lesões oculares graves/ irritação ocular:	Pode causar leve irritação ocular com vermelhidão e lacrimejamento.
Sensibilização respiratória ou à pele:	Não é esperado que o produto provoque sensibilização respiratória ou à pele.
Mutagenicidade em células germinativas:	Resultado positivo para ensaio de troca de cromátides-irmãs. Resultado positivo em teste de Ames (Salmonella typhimurium – in vitro). Porém, sem relevância para acarretar em uma classificação.
Carcinogenicidade:	Suspeito carcinógeno humano.
Toxicidade à reprodução:	Não é esperado que o produto apresente toxicidade à reprodução
Toxicidade para órgãos-alvo específicos – exposição única:	Como depressor do sistema nervoso central pode causar efeitos narcóticos como dores de cabeça, tontura, náuseas e sonolência. Pode causar irritação das vias aéreas superiores com tosse, dor de garganta e falta de ar. Pode causar confusão mental e perda da consciência em casos de exposição à altas concentrações.
Toxicidade para órgãos-alvo específicos – exposição repetida:	A exposição repetida e prolongada pode causar dermatite por Ressecamento.
Perigo por aspiração:	Pode causar pneumonia química se aspirado.

12 - INFORMAÇÕES ECOLÓGICAS

Efeitos ambientais, comportamentos e impactos do produto

Ecotoxicidade:	Não é esperado que o produto apresente perigo para organismos aquáticos.
Persistência e degradabilidade:	É esperada baixa degradação e alta persistência.
Potencial bioacumulativo:	É esperado potencial de bioacumulação em organismos aquáticos. Log kow: 3,9 – 6,0 (dado estimado).
Mobilidade no solo:	Não determinada.
Outros efeitos adversos:	Em caso de grandes derramamentos, devido à complexidade do produto, este poderá apresentar comportamentos distintos tais como adsorção ao sedimento e formação de película na superfície, podendo resultar em impacto ao meio ambiente.

13 - CONSIDERAÇÕES SOBRE TRATAMENTO E DISPOSIÇÃO

Métodos recomendados para tratamento e disposição aplicados ao

Produto:	O tratamento e a disposição devem ser avaliados especificamente para cada produto. Devem ser consultadaslegislações federais, estaduais e municipais, dentre estas: Resolução CONAMA 005/1993, Lei n°12.305, de 02 de agosto de 2010 (Política Nacional de Resíduos Sólidos).
Restos de produtos:	Manter restos do produto em suas embalagens originais, fechadas e dentro de tambores metálicos, devidamente fechados, de acordo com a legislação aplicável. O descarte deve ser realizado conforme o estabelecido para o produto, recomendando-se as rotas de processamento em cimenteiras e a incineração.
Embalagem usada:	Nunca reutilize embalagens vazias, pois elas podem conter restos do produto e devem ser mantidas fechadas e encaminhadas para serem destruídas em local apropriado. Neste caso, recomenda-se envio para rotas de recuperação dos tambores ou incineração.

14 - INFORMAÇÕES SOBRE TRANSPORTE

Regulamentações nacionais e internacionais

Terrestre:	Decreto nº 96.044, de 18 de maio de 1988: Aprova o regulamento para o transporte rodoviário de produtos perigosos e dá outras providências. Agência Nacional de transportes terrestres (ANTT): Resolução Nº. 5232/16.
Hidroviário:	DPC – Diretoria de Portos e Costas (Transporte em águas brasileiras) Normas de Autoridade Marítima (NORMAM) NORMAM 01/DPC: Embarcações Empregadas na Navegação em Mar Aberto. NORMAM 02/DPC: Embarcações Empregadas na Navegação Interior. IMO – “International Maritime Organization” (Organização Marítima

	Internacional) International Maritime Dangerous Goods Code (IMDG Code) – Incorporating Amendment 34-08;2008 Edition.
Aéreo:	DAC -Departamento de Aviação Civil: IAC 153-1001. Instrução de Aviação Civil – Normas para o transporte de artigos perigosos em aeronaves civis. IATA – “ International Air Transport Association” (Associação Nacional de Transporte Aéreo) Dangerous Goods Regulation (DGR) - 51
Número ONU:	3256
Nome apropriado para embarque:	LÍQUIDO A TEMPERATURA ELEVADA, INFLAMÁVEL, N.E. (Óleo combustível), com PFg superior a 60,5ºC, a temperatura igual ou superior ao PFg
Classe e subclasse de risco principal e subsidiário:	3
Número de risco:	30
Grupo de embalagem:	III

15 - REGULAMENTAÇÕES

Regulamentações:

Regulamentações: Decreto Federal nº 2.657, de 3 de julho de 1998
Norma ABNT-NBR 14725:2012.
Portaria MTE nº 704 de 28 de maio de 2015 – Altera a Norma Regulamentadora nº 26

16 - OUTRAS INFORMAÇÕES

Informações importantes:

Esta FISPQ foi elaborada baseada nos conhecimentos atuais do produto químico e fornece informações quanto à proteção, à segurança, à saúde e ao meio ambiente.

Adverte-se que o manuseio de qualquer substância química requer o conhecimento prévio de seus perigos pelo usuário. Cabe à empresa usuária do produto promover o treinamento de seus empregados e contratados quanto aos possíveis riscos advindos do produto.

Siglas:

ACGIH - American Conference of Governmental Industrial Hygienists
CAS - Chemical Abstracts Service
DL50 - Dose letal 50%
STEL – Short Term Exposure Level
TLV - Threshold Limit Value
TWA - Time Weighted Average

Bibliografia:

ECB] EUROPEAN CHEMICALS BUREAU. Diretiva 67/548/EEC (substâncias) e Diretiva 1999/45/EC (preparações). Disponível em: http://ecb.jrc.it/. Acesso em: outubro de 2010.
[EPI-USEPA] ESTIMATION PROGRAMS INTERFACE Suite - United States Environmental Protection Agency. Software.
[HSDB] HAZARDOUS SUBSTANCES DATA BANK. Disponível em: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB. Acesso em: outubro de 2010.
[IARC] INTERNATIONAL AGENCY FOR RESEARCH ON CANCER. Disponível em: http://monographs.iarc.fr/ENG/Classification/index.php. Acesso em: outubro de 2010.
[IPCS] INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY – INCHEM. Disponível em: http://www.inchem.org/. Acesso em: outubro de 2010.
[IPIECA] INTERNATIONAL PETROLEUM INDUSTRY ENVIRONMENTAL CONSERVATION ASSOCIATION. Guidance on the application of Globally Harmonized System (GHS) criteria to petroleum substances. Version 1. June 17th 2010.
Disponível em: http://www.ipieca.org/system/files/publications/ghs_guidance_17_june_2010.pdf. Acesso em: outubro de 2010.
[IUCLID] INTERNATIONAL UNIFORM CHEMICAL INFORMATION DATABASE. [s.l.]: European chemical Bureau. Disponível em: http://ecb.jrc.ec.europa.eu. Access in: outubro de 2010.
[NIOSH] NATIONAL INSTITUTE OF OCCUPATIONAL AND SAFETY. International Chemical Safety Cards. Disponível em: http://www.cdc.gov/niosh/. Acesso em: outubro de 2010.
[NITE-GHS JAPAN] NATIONAL INSTITUTE OF TECHNOLOGY AND EVALUATION. Disponível em: http://www.safe.nite.go.jp/english/ghs_index.html. Acesso em: outubro de 2010.
[PETROLEUM HPV] PETROLEUM HIGH PRODUCTION VOLUME. Disponível em: http://www.petroleumhpv.org/pages/petroleumsubstances.html. Acesso em: outubro de 2010.
[REACH] REGISTRATION, EVALUATION, AUTHORIZATION AND RESTRICTION OF CHEMICALS. Commission Regulation (EC) No 1272/2008 of 16 December 2008 amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorization and Restriction of Chemicals.
[SIRETOX/INTERTOX] SISTEMA DE INFORMAÇÕES SOBRE RISCOS DE EXPOSIÇÃO QUÍMICA. Disponível em: http://www.intertox.com.br. Acesso em: outubro de 2010.
[TOXNET] TOXICOLOGY DATA NETWORKING. ChemIDplus Lite. Disponível em: http://chem.sis.nlm.nih.gov/. Acesso em: outubro de 2010.

Ficha de Informação de Produto Químico

IDENTIFICAÇÃO

Help

Número ONU	Nome do produto	Rótulo de risco
1202	ÓLEO DIESEL	

Número de risco	Classe / Subclasse
30	3

Sinônimos
ÓLEO COMBUSTÍVEL 1 - D ; ÓLEO COMBUSTÍVEL 2 - D

Aparência
LÍQUIDO OLEOSO ; MARROM AMARELADO ; ODOR DE ÓLEO COMBUSTÍVEL OU LUBRIFICANTE ; FLUTUA NA ÁGUA

Fórmula molecular	Família química
NÃO PERTINENTE	HIDROCARBONETO (MISTURA)

Fabricantes
Para informações atualizadas recomenda-se a consulta às seguintes instituições ou referências:
ABIQUIM - Associação Brasileira da Indústria Química: Fone 0800-118270
ANDEF - Associação Nacional de Defesa Vegetal: Fone (11) 3081-5033
Revista Química e Derivados - Guia geral de produtos químicos, Editora QD: Fone (11) 3826-6899
Programa Agrofit - Ministério da Agricultura

MEDIDAS DE SEGURANÇA

Help

Medidas preventivas imediatas
EVITAR CONTATO COM O LÍQUIDO. CHAMAR OS BOMBEIROS. PARAR O VAZAMENTO, SE POSSÍVEL. ISOLAR E REMOVER O MATERIAL DERRAMADO.

Equipamentos de Proteção Individual (EPI)
USAR LUVAS, BOTAS E ROUPAS DE PROTEÇÃO.

RISCOS AO FOGO

Help

Ações a serem tomadas quando o produto entra em combustão
COMBUSTÍVEL. EXTINGUIR COM PÓ QUÍMICO SECO, ESPUMA OU DIÓXIDO DE CARBONO. ESFRIAR OS RECIPIENTES EXPOSTOS, COM ÁGUA.

Comportamento do produto no fogo
NÃO PERTINENTE.

Produtos perigosos da reação de combustão
NÃO PERTINENTE.

Agentes de extinção que não podem ser usados
A ÁGUA PODE SER INEFICAZ.

Limites de inflamabilidade no ar
Limite Superior: 6,0 vol %
Limite Inferior: 1,3%

Ponto de fulgor
38ºC (VASO FECHADO)

Temperatura de ignição
(OBS. 1)

Taxa de queima
4 mm/min

Taxa de evaporação (éter=1)
DADO NÃO DISPONÍVEL

NFPA (National Fire Protection Association)

Perigo de Saúde (Azul): 0
Inflamabilidade (Vermelho): 2
Reatividade (Amarelo): 0

PROPRIEDADES FÍSICO-QUÍMICAS E AMBIENTAIS

Help

Peso molecular NÃO PERTINENTE	Ponto de ebulição (°C) 288 A 338	Ponto de fusão (°C) - 18 A - 34
Temperatura crítica (°C) NÃO PERTINENTE	Pressão crítica (atm) NÃO PERTINENTE	Densidade relativa do vapor NÃO PERTINENTE
Densidade relativa do líquido (ou sólido) 0,841 A 16 °C (LÍQUIDO)	Pressão de vapor 2,17 mm Hg A 21,1 °C	Calor latente de vaporização (cal/g) NÃO PERTINENTE
Calor de combustão (cal/g) - 10.200	Viscosidade (cP) DADO NÃO DISPONÍVEL	
Solubilidade na água INSOLÚVEL	pH NÃO PERT.	
Reatividade química com água NÃO REAGE.		
Reatividade química com materiais comuns NÃO REAGE.		
Polimerização NÃO OCORRE.		
Reatividade química com outros materiais DADO NÃO DISPONÍVEL.		
Degradabilidade DADO NÃO DISPONÍVEL.		
Potencial de concentração na cadeia alimentar NENHUM.		
Demanda bioquímica de oxigênio (DBO) DADO NÃO DISPONÍVEL.		
Neutralização e disposição final DADO NÃO DISPONÍVEL.		

INFORMAÇÕES ECOTOXICOLÓGICAS

Help

Toxicidade - limites e padrões L.P.O.: DADO NÃO DISPONÍVEL P.P.: NÃO ESTABELECIDO IDLH: DADO NÃO DISPONÍVEL LT: Brasil - Valor Médio 48h: DADO NÃO DISPONÍVEL LT: Brasil - Valor Teto: DADO NÃO DISPONÍVEL LT: EUA - TWA: 100 mg/m³ LT: EUA - STEL: NÃO ESTABELECIDO
Toxicidade ao homem e animais superiores (vertebrados) M.D.T.: DADO NÃO DISPONÍVEL M.C.T.: DADO NÃO DISPONÍVEL
Toxicidade: Espécie: RATO
Toxicidade: Espécie: CAMUNDONGO
Toxicidade: Espécie: OUTROS
Toxicidade aos organismos aquáticos: PEIXES : Espécie
Toxicidade aos organismos aquáticos: CRUSTÁCEOS : Espécie
Toxicidade aos organismos aquáticos: ALGAS : Espécie
Toxicidade a outros organismos: BACTÉRIAS

Toxicidade a outros organismos: MUTAGENICIDADE
Toxicidade a outros organismos: OUTROS

Informações sobre intoxicação humana		
Tipo de contato	Síndrome tóxica	Tratamento
Tipo de contato LÍQUIDO	Síndrome tóxica IRRITANTE PARA A PELE. IRRITANTE PARA OS OLHOS. PREJUDICIAL, SE INGERIDO.	Tratamento REMOVER ROUPAS E SAPATOS CONTAMINADOS E ENXAGUAR COM MUITA ÁGUA. MANTER AS PÁLPEBRAS ABERTAS E ENXAGUAR COM MUITA ÁGUA. NÃO PROVOCAR O VÔMITO.

DADOS GERAIS Help

Temperatura e armazenamento AMBIENTE.
Ventilação para transporte ABERTA.
Estabilidade durante o transporte ESTÁVEL.
Usos COMBUSTÍVEL PARA MOTORES DIESEL E INSTALAÇÃO DE AQUECIMENTO EM PEQUENO PORTE.
Grau de pureza DE ACORDO COM NORMA "ASTM".
Radioatividade NÃO TEM.
Método de coleta MÉTODO 12.
Código NAS (National Academy of Sciences) NÃO LISTADO

OBSERVAÇÕES Help

1) TEMPERATURA DE IGNIÇÃO : 1- D = 176,8 °C A 329,7 °C 2 -D = 254,6 °C A 285,2 °C POTENCIAL DE IONIZAÇÃO (PI) = DADO NÃO DISPONÍVEL

NOVA CONSULTA

FICHA DE DATOS DE SEGURIDAD

Versión 1.27 — Numero de FDS 300000000110
Fecha de revisión 02.05.2017 — Fecha 03.11.2018
Sustituye a la versión: 1.26

SECCIÓN 1: Identificación de la sustancia o la mezcla y de la sociedad o la empresa

1.1. Identificador del producto
: Oxígeno

nº CAS : 7782-44-7

fórmula química : O_2

Número de registro en REACH: Figura en la lista del Anexo IV / V de REACH, exento de solicitud de registro.

1.2. Usos pertinentes identificados de la sustancia o de la mezcla y usos desaconsejados

Uso de la sustancia o mezcla : Industrial en general

Restricciones de uso : Sin datos disponibles.

1.3. Datos del proveedor de la ficha de datos de seguridad
: S.E. de Carburos Metálicos, S.A.
Av. de la Fama, 1.
08940 Cornellà de Llobregat
(Barcelona)
www.carburos.com

Dirección de correo electrónico – Información técnica : GASTECH@airproducts.com

Teléfono : +34 (93)2902600

1.4. Teléfono de
: + 34 932 902 600
Servicio de Información Toxicológica (Instituto Nacional de Toxicología

emergencia y Ciencias Forenses) +34 91 562 04 20

SECCIÓN 2: Identificación de los peligros

2.1. Clasificación de la sustancia o de la mezcla

Gases oxidantes - Categoría 1 H270:Puede provocar o agravar un incendio; comburente.
Gases a presión - Gas comprimido. H280:Contiene gas a presión; peligro de explosión en caso de calentamiento.

2.2. Elementos de la etiqueta

Pictogramas/símbolos de riesgos

Palabras de advertencia Peligro

Declaraciones de riesgo:

H270:Puede provocar o agravar un incendio; comburente.
H280:Contiene gas a presión; peligro de explosión en caso de calentamiento.

Declaraciones de precaución:

Prevención	:	P220:Mantener lejos de la ropa y otros materiales combustibles. P244:Mantener las válvulas y los accesorios limpios de aceite y grasa.
Respuesta	:	P370+P376 :En caso de incendio: Detener la fuga, si no hay peligro en hacerlo.
Almacenamiento	:	P403:Almacenar en un lugar bien ventilado.

2.3. Otros peligros

Gas oxidante a alta presión.
Acelera la combustión vigorosamente.
Mantener lejos de aceites, lubricantes y materiales combustibles.
Puede reaccionar violentamente con materias combustibles.

SECCIÓN 3: Composición/información sobre los componentes

3.1. Sustancias

Componentes	EINECS / ELINCS Nombre	CAS Nombre	Concentración (Proporción de volumen)
oxigeno	231-956-9	7782-44-7	100 %

Componentes	Clasificación (CLP)	Registro REACH #
oxigeno	Ox. Gas 1 ;H270 Press. Gas (Comp.) ;H280	*1

*1:Figura en la lista del Anexo IV / V de REACH, exento de solicitud de registro.
*2:No exige su registro. Sustancias fabricadas o importadas < 1 t/a.
*3:No ha expirado el plazo límite de solicitud de registro.

Consulte la sección 16 para conocer el texto completo de cada indicación de peligro (H) relevante.

La concentración es nominal. Para la composición exacta del producto, referirse a las especificaciones técnicas.

3.2. Mezclas : No aplicable.

SECCIÓN 4: Primeros auxilios

4.1. Descripción de los primeros auxilios

Consejo generales : Retirar a la víctima a un área no contaminada llevando colocado el equipo de respiración autónoma. Mantener a la víctima caliente y en reposa. Llamar al doctor. Aplicar la respiración artificial si se para la respiración.

Contacto con los ojos	:	EN CASO DE exposición manifiesta o presunta: Consultar a un médico.
Contacto con la piel	:	No se esperan efectos adversos de este producto. EN CASO DE exposición manifiesta o presunta: Consultar a un médico.
Ingestión	:	La ingestión no está considerada como una vía potencial de exposición.
Inhalación	:	Consultar a un médico después de una exposición importante. Salir al aire libre. Si la respiración es dificultosa o se detiene, proporcione respiración asistida. Se puede suministrar oxígeno suplementario. Si se detiene el corazón, el personal capacitado debe comenzar de inmediato la resucitación cardio-pulmonar.

4.2. Principales síntomas y efectos, agudos y retardados

Síntomas : Sin datos disponibles.

4.3. Indicación de toda atención médica y de los tratamientos especiales que deban dispensarse inmediatamente

Tratamiento : En caso de exposición manifiesta o presunta: consulte a un médico.

SECCIÓN 5: Medidas de lucha contra incendios

5.1. Medios de extinción

Medios de extinción adecuados	:	Se pueden usar todos los medios de extinción conocidos.
Medios de extinción que no deben utilizarse por razones de seguridad	:	Sin datos disponibles.

5.2. Peligros específicos derivados de la sustancia o la mezcla

: Ante la exposición al calor intenso o fuego, el cilindro se vaciará rápidamente y/o se romperá violentamente. Oxidante. Mantiene la combustión vigorosamente. Puede reaccionar violentamente con los materiales combustibles. Algunos materiales no inflamables en el aire, pueden ser inflamables con la presencia de un oxidante. Alejarse del envase y enfriarlo con agua desde un lugar protegido. Mantener los cilindros adyacentes fríos mediante pulverización de gran cantidad de agua hasta que el fuego se apague. Si es posible, detener el caudal de producto.

5.3. Recomendaciones para el personal de lucha contra incendios : Si es necesario, llevar aparato respiratorio autónomo para la lucha contra el fuego. Vestimenta y equipo de protección standard (aparato de respiración autónoma) para bomberos. Standard EN 137-mascara de cara completa que incluya un aparato de respiración autónomo de aire comprimido en circuito abierto. EN 469: Vestimenta protectora para bomberos.EN 659: Guantes de protección para bomberos.

Información adicional : Algunos materiales incombustibles en el aire, se encenderán en una atmósfera rica en oxígeno (más de 23<(>,<)>5%). La ropa resistente al fuego puede encenderse y no proteger en atmósferas ricas en oxígeno.

SECCIÓN 6: Medidas en caso de vertido accidental

6.1. Precauciones personales, equipo de protección y procedimientos de emergencia : La ropa expuesta a altas concentraciones puede retener el oxígeno durante 30 minutos o más, y potencialmente existe peligro de incendio. Mantener lejos de fuentes de ignición. Evacuar el personal a zonas seguras. Utilizar equipos de respiración autónoma cuando entren en el área a menos que esté probado que la atmósfera es segura. Ventilar la zona.

6.2. Precauciones relativas al medio ambiente : No descargar dentro de ningún lugar donde su acumulación pudiera ser peligrosa. Impedir nuevos escapes o derrames de forma segura.

6.3. Métodos y material de contención y de limpieza : Ventilar la zona.

Consejos adicionales : Si es posible, detener el caudal de producto. Aumentar la ventilación en el área de liberación del gas y controlar las concentraciones. Si la fuga tiene lugar en el cilindro o en su válvula, llamar al número de emergencia. Si la fuga tiene lugar en la instalación del usuario, cerrar la válvula del cilindro, ventear la presión con seguridad y purgar el cilindro con gas inerte antes de intentar repararlo.

6.4. Referencia a otras secciones : Si desea más información, consulte las secciones 8 y 13

SECCIÓN 7: Manipulación y almacenamiento

7.1. Precauciones para una manipulación segura

Todos los indicadores, válvulas, reguladores, tubos y equipo usados en servicio de oxígeno deben ser limpiados para el servicio de oxígeno. El oxígeno no debe ser usado como sustituto del aire comprimido. Nunca usar el chorro del oxígeno para depurar, especialmente la ropa, porque aumenta la posibilidad de incendio. Los gases comprimidos o líquidos criogénicos sólo deben ser manipulados por personas con experiencia y debidamente capacitadas. Proteger los cilindros contra daños físicos; no tirar, no rodar, ni dejar caer. La temperatura en las áreas de almacenamiento no debe exceder los 50ºC. Antes de usar el producto, identificarlo leyendo la etiqueta. Antes del uso del producto se deben conocer y entender sus características así como los peligros relacionados con las mismas. En caso de que existan dudas sobre los procedimientos del uso correcto de un gas concreto, ponerse en contacto con el proveedor. No quitar ni emborronar las etiquetas entregadas por el proveedor para la identificación del contenido de los cilindros. Para la manipulación de cilindros se deben usar, también para distancias cortas, carretillas destinadas al transporte de cilindros. No quitar el protector de seguridad de la válvula hasta que el cilindro no esté sujeto a la pared, mesa de trabajo o plataforma, y listo para su uso. Para quitar las protecciones demasiado apretadas u oxidadas usar una llave inglesa ajustable. Antes de conectar el envase comprobar la adecuación de todo el sistema de gas, especialmente los indicadores de presión y las propiedades de los materiales. Antes de conectar el envase para su uso, asegurar que se ha protegido contra la aspiración de retorno del sistema al envase. Asegurar que todo el sistema de gas es compatible con las indicaciones de presión y con los materiales de construcción. Asegurarse antes del uso de que no existan fugas en el sistema de gas Usar los equipos de regulación y de presión adecuados en todos los envases cuando el gas es transferido a sistemas con una presión menor que la del envase. No insertar nunca un objeto (p.ej. llave, destornillador, palanca, etc.) a las aberturas del protector de la válvula. Tales acciones pueden deteriorar la válvula y causar una fuga. Si el usuario ve cualquier problema durante la manipulación de la válvula del cilindro, debe interrumpir su uso y ponerse en contacto con el proveedor. Cerrar la válvula del envase después de cada uso y cuando esté vacío, incluso si está conectado al equipo. Nunca intente reparar o modificar las válvulas de un envase o las válvulas de seguridad. Debe de comunicarse inmediatamente al proveedor el deterioro de cualquier válvula. No usar envases como rodillos o soportes, o para cualquier otro propósito que no sea contener el gas, tal como ha sido suministrado. Nunca crear un arco voltaico en un cilindro de gas comprimido o hacer que el cilindro forme parte de un circuito eléctrico. No fumar durante la manipulación de productos o cilindros Nunca re-comprimir el gas o la mezcla de gases sin consultarlo previamente con el proveedor. Nunca intente transferir gases de un cilindro / envase a otro. Usar siempre válvulas anti-retorno en las tuberías. Al devolver el cilindro instalar el tapón protector de la válvula o tapón protector de fugas. Nunca permitir el contacto de aceite, lubrificante u otra sustancia combustible con válvulas o envases que contengan oxígeno u otros oxidantes. No usar válvulas de apertura rápida (p.ej: válvulas de bola). Abrir la válvula lentamente para evitar los golpes de ariete. Nunca someter todo el sistema a presión al mismo tiempo. Usar sólo con equipo limpiado para el servicio de oxígeno e indicado para cilindros a presión. Nunca usar fuego directo o calentadores eléctricos para aumentar la presión en el envase. Los envases no deben ser sometidos a temperaturas superiores a los 50ºC (122ºF).

7.2. Condiciones de almacenamiento seguro, incluidas posibles incompatibilidades

Los envases deben ser almacenados en un lugar especialmente construido y bien ventilado, preferiblemente al aire libre. Se deben almacenar los envases llenos de tal manera que los más antiguos sean usados en primer lugar. Los envases almacenados deben ser controlados periódicamente en cuanto a su estado general y fugas. Tener en cuenta todas las leyes y requisitos locales sobre el almacenamiento de envases. Proteger los envases almacenados al aire libre contra la corrosión y las condiciones atmosféricas extremas. Los envases no deben ser almacenados en condiciones que puedan acelerar la corrosión. Los envases deben ser almacenados en posición vertical y asegurados para prevenir las caídas. Las válvulas de los contenedores deben estar bien cerradas y donde sea necesario, las salidas de las válvulas deben ser protegidas con tapones. Los protectores de las válvulas o tapones deben estar en su sitio. Mantener los envases herméticamente cerrados en un lugar fresco y bien ventilado. Los envases deben ser almacenados en lugares libres de riesgo de incendio y lejos de fuentes del calor e ignición. Los cilindros llenos se deben separar de los vacíos. No permitir que la temperatura de almacenamiento alcance los 50ºC (122 °F). Colocar señales "Se prohíbe fumar y usar el fuego abierto" en las áreas de almacenamiento. Devolver los envases con puntualidad

Medidas técnicas/Precauciones

Los recipientes deben ser separados en el área de almacenamiento según las distintas categorías (p.e.: inflamable, tóxico, etc.) y conforme a la reglamentación local.

7.3. Usos específicos finales

Consulte la sección 1 o la hoja de datos de seguridad ampliada, si corresponde.

SECCIÓN 8: Controles de exposición/protección individual

8.1. Parámetros de control

Si corresponde, consulte la sección ampliada de la hoja de datos de seguridad para obtener más información acerca de la materia prima aprobada (CSA).

8.2. Controles de la exposición

Disposiciones de ingeniería

Asegúrese una ventilación apropiada.

Equipos de Protección personal

Protección respiratoria	:	No se precisa en el uso normal. Para respirar en atmósfera deficiente de oxígeno debe usarse un equipo de respiración autónomo o una línea de aire con presión positiva y máscara. Los usuarios de los equipos de respiración autónomos deben ser entrenados.
Protección de las manos	:	Usar guantes de trabajo al manejar envases de gases. Los guantes deben estar limpios y sin aceite o lubricante. Standard EN 388 - guantes que protegen contra riesgos mecánicos.
Protección para los ojos y la cara	:	Se aconseja el uso de gafas de protección durante la manipulación de cilindros. Standard EN 166- Protección para el ojo.
Protección de la piel y del cuerpo	:	Durante la manipulación de cilindros se aconseja el uso de zapatos de protección. Standard EN ISO 20345 - Equipos de protección personal-zapatos de seguridad.
Instrucciones especiales de protección e higiene	:	Asegurarse de una ventilación adecuada, especialmente en locales cerrados.
Controles de la exposición medioambiental	:	Si corresponde, consulte la sección ampliada de la hoja de datos de seguridad para obtener más información acerca de la materia prima aprobada (CSA).

SECCIÓN 9: Propiedades físicas y químicas

9.1. Información sobre propiedades físicas y químicas básicas

(a/b) estado físico/color	:	Gas comprimido. Gas incoloro

(c) Olor	:	Sin olor que advierta de sus propiedades
(d) Densidad	:	0,0013 g/cm3 (0,081 lb/ft3) a 21 °C (70 °F) Nota: (como vapor)
(e) Densidad relativa	:	1,1 (agua = 1)
(f) Punto de fusión / punto de congelación	:	-362 °F (-219 °C)
(g) Temperatura de ebullición/rango	:	-297 °F (-183 °C)
(h) Presión de vapor	:	No aplicable.
(i) Solubilidad en agua	:	0,039 g/l
(j) Coeficiente de reparto: n-octanol/agua [log Kow]	:	No es aplicable a gases inorganicos.
(k) pH	:	No es aplicable a gases ni a mezcla de gases.
(l) Viscosidad	:	No se dispone de datos fiables.
(m) características de las partículas	:	No es aplicable a gases ni a mezcla de gases.
(n) Límites superior y inferior de explosión / inflamabilidad	:	No inflamable.
(o) Punto de inflamación	:	No es aplicable a gases ni a mezcla de gases.
(p) Temperatura de autoignición	:	No inflamable.
(q) Temperatura de descomposición	:	No aplicable.

9.2. Otros datos

Peligro de explosión	:	No aplicable.
Propiedades oxidantes	:	Ci =1
Peso molecular	:	32 g/mol
Límite crítico de olores	:	La superación de limites por el olor es subjetiva e inadecuado para advertir del riesgo de sobrecarga.
Indicé de evaporación	:	No es aplicable a gases ni a mezcla de gases.
Inflamabilidad (sólido, gas)	:	Consulte la clasificación del producto en la Sección 2
volumen específico	:	0,7540 m3/kg (12,08 ft3/lb) a 21 °C (70 °F)
Densidad relativa del vapor	:	1,105 (aire = 1) Más pesado que el aire

SECCIÓN 10: Estabilidad y reactividad

10.1. Reactividad	:	Sin riesgo de reactividad salvo lo expresado en la sub-sección mas adelante.
10.2. Estabilidad química	:	Estable en condiciones normales.
10.3. Posibilidad de reacciones peligrosas	:	Oxida violentamente materiales orgánicos.
10.4. Condiciones que deben evitarse	:	Nunca por debajo de las condiciones de manejo y almacenamiento (ver sección 7).
10.5. Materiales incompatibles	:	Materiales inflamables. Materiales orgánicos. Evitar aceite, grasas y otras sustancias inflamables

10.6. Productos de descomposición peligrosos	:	Sin datos disponibles.

SECCIÓN 11: Información toxicológica

11.1. Información sobre los efectos toxicológicos

Vías de entrada probables

Efectos en los ojos	:	En caso de contacto directo con los ojos, busque asistencia médica.
Efectos en la piel	:	No se esperan efectos adversos de este producto.
Efectos debido a la inhalación	:	La respiración con oxígeno 75% o superior en la atmósfera durante más de unas horas puede taponar la nariz, tos, dolores de garganta, tórax y dificultades en la respiración. Inhalación del oxígeno puro comprimido puede causar lesiones de pulmón y trastornos del sistema nervioso.
Efectos debido a la ingestión	:	La ingestión no está considerada como una vía potencial de exposición.
Síntomas	:	Sin datos disponibles.

Toxicidad aguda

Toxicidad oral aguda	:	No hay datos disponibles sobre este producto.
Toxicidad aguda por inhalación	:	No hay datos disponibles sobre este producto.
Toxicidad dérmica aguda	:	No hay datos disponibles sobre este producto.
Corrosión o irritación de la piel	:	Sin datos disponibles.
Irritación o daños oculares severos	:	Sin datos disponibles.
Sensibilización.	:	Sin datos disponibles.

Toxicidad crónica o efectos debidos a la exposición a largo plazo

Carcinogenicidad	: Sin datos disponibles.
Toxicidad reproductiva	: No hay datos disponibles sobre este producto.
Mutagenicidad en células germinales	: No hay datos disponibles sobre este producto.
Toxicidad sistémica específica de órganos diana (exposición única)	: Sin datos disponibles.
Toxicidad sistémica específica de órganos diana (exposición repetida)	: Los nacidos permaturamente expuestos a concentraciones altas a oxígeno pueden sufrir lesión de retina, que puede progresar hasta sudesprendimiento y ceguera. La lesión de retina puede también aparecer en adultos expuestos al oxígeno 100% durante períodos prolongados (de 24 a 48 horas).A dos o más atmósferas aparece toxicidad en el sistema nervioso central (CNS). Los síntomas incluyen náuseas, vomitos, mareos o vértigo, agarrotamiento de los músculos, cambios de visión, y pérdida de sentido y ataques generalizados. A tres atmósferas, la toxicidad del CNS afecta en menos de dos horas, y a seis atmósferas en solo algunos minutos.
Peligro de aspiración	: Sin datos disponibles.

SECCIÓN 12: Información ecológica

12.1. Toxicidad

Toxicidad acuática	: No hay datos disponibles sobre este producto.
Toxicidad para otros organismos	: No hay datos disponibles sobre este producto.

12.2. Persistencia y degradabilidad

Sin datos disponibles.

12.3. Potencial de bioacumulación

Consulte la sección 9 "Coeficiente de partición (n-octanol/agua)".

12.4. Movilidad en el suelo

Debido a su alta volatilidad, es poco probable que el producto cause contaminación del suelo.

12.5. Resultados de la valoración PBT y mPmB

Si corresponde, consulte la sección ampliada de la hoja de datos de seguridad para obtener más información acerca de la materia prima aprobada (CSA).

12.6. Otros efectos adversos

Este producto no causa daños ecológicos.

Efectos sobre la capa de ozono

Potencial factor reductor de la capa de ozono	:	Sin datos disponibles.
Factor de calentamiento global	:	Sin datos disponibles.

SECCIÓN 13: Consideraciones relativas a la eliminación

13.1. Métodos para el tratamiento de residuos	:	Devolver el producto no usado al proveedor en el cilindro original. Contactar con el proveedor si es necesaria información y asesoramiento. Referirse al código de prácticas de EIGA Doc. 30 "Disposal of Gases" accesible en http://www.eiga.org para mayor información sobre métodos adecuados de vertidos. Lista de residuos peligrosos: 16 05 04: Contenedores de gases a presión (incluido halones) que contienen sustancias peligrosas.
Envases contaminados	:	Devolver el cilindro al proveedor.

SECCIÓN 14: Información relativa al transporte

ADR

No. ONU/ID	:	UN1072
Denominación adecuada de envío	:	OXIGENO COMPRIMIDO
Clase o división	:	2
Código de restricción en túneles	:	(E)
Etiqueta(s)	:	2.2 (5.1)
ADR/RID Peligro ID nº	:	25
Contaminante marino	:	No

IATA

No. ONU/ID	:	UN1072
Denominación adecuada de envío	:	Oxygen, compressed
Clase o división	:	2.2
Etiqueta(s)	:	2.2 (5.1)
Contaminante marino	:	No

IMDG

No. ONU/ID	:	UN1072
Denominación adecuada de envío	:	OXYGEN, COMPRESSED
Clase o división	:	2.2
Etiqueta(s)	:	2.2 (5.1)
Contaminante marino	:	No
Grupo de segregación:	:	None

RID

No. ONU/ID	:	UN1072
Denominación adecuada de envío	:	OXIGENO COMPRIMIDO
Clase o división	:	2
Etiqueta(s)	:	2.2 (5.1)

Contaminante marino : No

Transporte a granel con arreglo al anexo II del Convenio MARPOL y del Código IBC
Si desea la información completa para el transporte, comuníquese con un representante de atención al cliente.
Información Adicional
Evitar el transporte en los vehículos donde el espacio de la carga no esté separado del compartimiento del conductor. Asegurar que el conductor está enterado de los riesgos potenciales de la carga y que conoce que hacer en caso de un accidente o de una emergencia. La información de transporte no ha sido elaborada para incluir todos los datos reglamentarios específicos correspondientes a este material. Si desea la información completa para el transporte, comuníquese con un representante de atención al cliente.

SECCIÓN 15: Información reglamentaria

15.1. Reglamentación y legislación en materia de seguridad, salud y medio ambiente específicas para la sustancia o la mezcla

País	Listado de regulaciones	Notificación
EE.UU.	TSCA	Incluido en inventario.
EU	EINECS	Incluido en inventario.
Canadá	DSL	Incluido en inventario.
Australia	AICS	Incluido en inventario.
Corea del Sur	ECL	Incluido en inventario.
China	SEPA	Incluido en inventario.
Filipinas	PICCS	Incluido en inventario.
Japón	ENCS	Incluido en inventario.

Otros regulaciones
REGLAMENTO (CE) nº 1907/2006 DEL PARLAMENTO EUROPEO Y DEL CONSEJO de 18 de diciembre de 2006 relativo al registro, la evaluación, la autorización y la restricción de las sustancias y preparados químicos (REACH), por el que se crea la Agencia Europea de Sustancias y Preparados Químicos, se modifica la Directiva 1999/45/CE y se derogan el Reglamento (CEE) nº 793/93 del Consejo y el Reglamento (CE) nº 1488/94 de la Comisión así como la Directiva 76/769/CEE del Consejo y las Directivas 91/155/CEE, 93/67/CEE, 93/105/CE y 2000/21/CE de la Comisión.

REGLAMENTO (UE) 2015/830 DE LA COMISIÓN de 28 de mayo de 2015 por el que se modifica el Reglamento (CE) no 1907/2006 del Parlamento Europeo y del Consejo, relativo al registro, la evaluación, la autorización y la restricción de las sustancias y mezclas químicas (REACH).

REGLAMENTO (CE) No 1272/2008 DEL PARLAMENTO EUROPEO Y DEL CONSEJO de 16 de diciembre de 2008 sobre clasificación, etiquetado y envasado de sustancias y mezclas, y por el que se modifican y derogan las Directivas 67/548/CEE y 1999/45/CE y se modifica el Reglamento (CE) no 1907/2006.

Acuerdo europeo sobre transporte internacional de mercancías peligrosas por carretera (ADR), celebrado en Ginebra el 30 de septiembre de 1957, en su versión enmendada.

Real Decreto 97/2014, de 14 de febrero (BOE núm. 50, de 27 de febrero de 2014), por el que se regulan las operaciones de transporte de mercancías peligrosas por carretera en territorio español.

Real Decreto 840/2015, de 21 de septiembre (BOE núm. 251, de 20 de octubre de 2015), por el que se aprueban medidas de control de los riesgos inherentes a los accidentes graves en los que intervengan sustancias peligrosas.

REAL DECRETO 374/2001, de 6 de abril (BOE núm. 104, de 1 de mayo de 2001), sobre la protección de la salud y seguridad de los trabajadores contra los riesgos relacionados con los agentes químicos durante el trabajo.

Real Decreto 782/1998, de 30 de abril (BOE núm. 104, de 1 de mayo de 1998), por el que se aprueba el Reglamento para el desarrollo y ejecución de la Ley 11/1997, de 24 de abril, de Envases y Residuos de Envases.

DECRETO 2414/1961, de 30 de noviembre (BOE núm. 292, de 7 de diciembre de 1961), por el que se aprueba el Reglamento de Actividades Molestas, Insalubres, Nocivas y Peligrosas.

Orden de 9 de marzo de 1971 (BOE núm. 64, de 16 de marzo de 1971), por la que se aprueba la Ordenanza General de Seguridad e Higiene en el

Trabajo.

15.2. Evaluación de la seguridad química

Un CSA (Análisis de Seguridad Química) no debe de realizarse para este producto.

SECCIÓN 16: Otra información

Asegurar que se cumplen todas las regulaciones nacionales/locales.

Declaraciones de riesgo:
H270 Puede provocar o agravar un incendio; comburente.
H280 Contiene gas a presión; peligro de explosión en caso de calentamiento.

Indicación del método:
Gases oxidantes Categoría 1 Puede provocar o agravar un incendio; comburente. Método de cálculo

Gases a presión Gas comprimido. Contiene gas a presión; peligro de explosión en caso de calentamiento. Método de cálculo

Abreviaturas y acrónimos:
ATE - Estimación de Toxicidad Aguda
CLP - Reglamento (CE) nº 1272/2008 sobre clasificación, etiquetado y envasado
REACH - Registro, evaluación, autorización y restricción de las sustancias y preparados químicos Reglamento (CE) nº 1907/2006
EINECS - Catálogo Europeo de Sustancias Químicas Comercializadas
ELINCS - Lista europea de sustancias químicas notificadas
CAS# - No. CAS (Chemical Abstracts Service)
PPE - equipos de protección personal
Kow - coeficiente de reparto octanol-agua
DNEL - nivel sin efecto derivado
LC50 - concentración letal para el 50 % de una población de pruebas
LD50 - dosis letal para el 50 % de una población de pruebas (dosis letal media)
NOEC - concentración sin efecto observado
PNEC - concentración prevista sin efecto
RMM - medida de gestión del riesgo
OEL - valor límite de exposición profesional

PBT - sustancia persistente, bioacumulativa y tóxica
vPvB - muy persistente y muy bioacumulable
STOT - toxicidad específica en determinados órganos
CSA - valoración de la seguridad química
EN - norma europea
UN - Organización de las Naciones Unidas
ADR - Acuerdo europeo relativo al transporte internacional de mercancías peligrosas por carretera
IATA - Asociación Internacional de Transporte Aéreo
IMDG - Código marítimo internacional para el transporte de mercancías peligrosas
RID - Reglamento relativo al transporte internacional de mercancías peligrosas por ferrocarril
WGK - clase de peligro para el agua

Principales referencias bibliográficas y fuentes de datos:
ECHA - Directriz sobre la compilación de fichas de datos de seguridad
ECHA - Documento de orientación sobre la aplicación de los criterios del CLP
La base de datos de ARIEL

Indicación de cambios : Teléfono de emergencia (24h)
9. PROPIEDADES FISICAS Y QUIMICAS
10. ESTABILIDAD Y REACTIVIDAD
15. INFORMACIÓN REGLAMENTARIA

Preparado por : Departamento EH&S Global, Air Products and Chemicals, Inc.

Para información adicional, por favor, visite nuestra página web de Tutela de Producto en la dirección http://www.airproducts.com/productstewardship/

Esta Ficha de Datos de Seguridad ha sido elaborada de acuerdo con las Directivas Europeas aplicables y es de aplicación en todos los países que han traspuesto las Directivas a leyes nacionales. REGLAMENTO (UE) 2015/830 DE LA COMISIÓN de 28 de mayo de 2015 por el que se modifica el Reglamento (CE) no 1907/2006 del Parlamento Europeo y del Consejo, relativo al registro, la evaluación, la autorización y la restricción de las sustancias y mezclas químicas (REACH).

Los detalles dados en este documento se cree son correctos en el momento de su publicación. Aunque se ha tomado el cuidado apropiado en la preparación de este documento, no se puede aceptar ninguna responsabilidad por lesión o daños resultantes de su uso.

HOJA DE DATOS DE SEGURIDAD

Peróxido de Hidrógeno 50% estándar

SDS #: 7722-84-1-50-10
Fecha de revisión: 2015-05-08
Formato: NA
Versión: 1

1. IDENTIFICACIÓN DE PRODUCTO Y EMPRESA

Identificación del producto

Nombre del Producto: Peróxido de Hidrógeno al 50% estándar.

Otras formas de identificación
CAS No: 7722-84-1

Uso Recomendado del químico y restricciones de uso:

Uso recomendado: Blanqueo industrial, tratamiento, reducción de la contaminación y reacciones generales de oxidación.

Restricciones de uso: Use como se recomienda en la etiqueta.

Fabricante/Distribuidor:

PeroxyChem, LLC
2005 Market Street
Suit 3200
Philadelphia, PA 19103
Teléfono:+1 267/422-2400 (Información General)
sdsinfo@peroxychem.com

PeroxyChem-México
Av. Industria #9, Col. Industrial Cerro Gordo C.P. 55420
Teléfono: 56-99-08-14 (Información General)

Teléfonos de Emergencia

Por fuga, fuego o derrame o emergencia por accidentes llamar a
01 800 /424 93000 (CHEMTREC-USA)
1 703/527 3887 (CHEMTREC- Collect-otros paises)
1 613/ 996-6666 (CANUTEC – Canada)
1 303/ 389-1409 (Medical –US-llamada por cobrar)
01 800 00 214 00 (SETIQ- MEXICO)
55-59-15-88 (SETIQ- MEXICO)
24 hrs del día/365 días del año.

1 281 / 474-8750 (Bayport, Planta en Texas)
1 250 / 561-4221 (Prince George, BC, Planta en Canada)
52-55-56-99-08-00 ext. 0807, 0806, 1335
(Centro de Distribución, México)
(Información Lunes a Viernes 8:30 a17:30 hrs)

2. IDENTIFICACION DE RIESGOS

Clasificación

Regulación OSHA

Este material es considerado peligroso por la OSHA Estandar de Comunicación de Riesgo (29 CFR 1910. 1200).

Toxicidad Aguda-Oral	Categoría 4
Toxicidad Aguda- Inhalación (Vapores)	Categoría 4
Corrosión a la piel / Irritación	Categoría 1, Sub-Categoría B
Daño serio a los ojos/ Irritación a los ojos	Categoría 1
Toxicidad específica en órgano blanco (exposición única)	Categoría 3
Líquidos oxidantes	Categoría 2

Elementos de las etiquetas de SGA Sistema Globalmente Armonizado (GHS), incluyendo las declaraciones de precaución

Consejos de prudencia

Peligro

Indicaciones de Peligro
H314-Causa severas quemaduras en piel y daños en los ojos.
H302-Nocivo por ingestión.
H332-Nocivo por inhalación.
H335-Puede irritar las vías respiratorias.
H272-Puede intensificar un incendio; es oxidante.

Consejos de Prudencia - Prevención
P271-Usar solamente en exteriores o en áreas bien ventiladas.
P260-No respire los vapores, niebla o rocío.
P280-Usar guantes de protección/ropa de protección/protección ocular/careta de protección.
P210-Mantenerse lejos de las fuentes de calor/chispas/llamas abiertas/superficies calientes.- No fumar.
P220-Mantener o almacenar alejado de la ropa o materiales inflamables/combustibles.
P221-Tomar todas las precauciones necesarias posibles para no mezclarse con combustibles /inflamables.

Consejos de Prudencia - Respuesta
P305+P351+P338-Si el contacto es con los ojos: Enjuague cuidadosamente con agua durante varios minutos. Quitar lentes de contacto si están presentes y es fácil retirarlos. Continuar enjuagando.
P310-Llame inmediatamente a un centro de toxicología o a un médico.
P303+P361+P353- Si el contacto es en la piel o en el cabello: Quítese inmediatamente la ropa contaminada, enjuagar la piel con abundante agua/ ducharse.
P363-Lavar perfectamente la ropa contaminada antes de usarse nuevamente.
P304+P340-En caso de inhalación, alejar a la persona al aire libre y mantenerla en una posición que le facilite la respiración.
P312- Si no se siente bien, llamar a un centro de toxicología o a un médico.
P301+P330+P331- En caso de ingestión: Enjuagar la boca, no inducir el vómito.
P310- Llame inmediatamente a un centro de toxicología o a un médico.
P370+P378- En caso de incendio: Utilizar agua para la extinción.

Otros Peligros que no contribuyen en la clasificación.
No fueron identificados

Otra información
Mantener el contenedor en un lugar fresco fuera del sol directo. Almacenar sólo en contenedores ventilados. No almacenar en tarimas de madera. No devuelva el material no utilizado a su envase original. Evitar la contaminación ya que podría causar la descomposición y la generación de oxígeno que puede resultar en alta presión y la posible ruptura del contenedor-. Los porrones vacíos se deben enjuagar tres veces con agua antes de desechar.

3. COMPOSICION/INFORMACIÓN SOBRE LOS COMPONENTES

Fórmula HO-OH

Nombre Químico	CAS-No.	% en Peso
Peróxido de hidrógeno	7722-84-1	50
Agua	7732-18-5	50

Limites de exposición ocupacional, en caso de existir, se presentan en la sección 8.

4. MEDIDAS DE PRIMEROS AUXILIOS

Contacto con los ojos Enjuague inmediatamente con abundante agua por al menos 15 minutos, levantando tanto el parpado superior como inferior. Remueva lentes de contacto después de los primeros 5 minutos de enjuague, después siga enjuagando. Consulte a un médico u oftalmólogo inmediatamente.

Contacto con la piel Quítese la ropa contaminada. Enjuague la piel inmediatamente con abundante agua, lave durante 15 a 20 minutos. Consulte a un médico inmediatamente.

Inhalación Traslade al lesionado donde reciba aire fresco. Si la persona no está respirando, llame al médico y/o ambulancia, entonces dé respiración, preferiblemente de boca a boca si es posible. Acuda al médico para tratamiento adicional.

Ingestión Enjuague la boca con agua. No induzca el vómito. Si la persona está consciente, dele 2 vasos de agua. Consiga atención médica inmediata. No administrar nada por la boca de una persona que se encuentra inconsciente.

Los síntomas más importantes y efectos agudos y retardados El peróxido de hidrógeno irrita el sistema respiratorio y, si se inhala, puede causar inflamación y edema pulmonar. Los efectos pueden no ser inmediatos. Síntomas de sobreexposición son tos, dolor de garganta, vértigo. En caso de ingestión accidental, la necrosis puede ser consecuencia de las quemaduras de membrana mucosa (boca, esófago y estómago). La liberación rápida de oxígeno puede causar hinchazón de estómago y hemorragias e incluso lesiones mortales a órganos si una gran cantidad se ha ingerido. En caso de contacto con la piel, puede causar quemaduras, eritema (enrojecimiento de la piel), ampollas o incluso necrosis.

Indicación de atención médica inmediata y tratamientos especiales en caso necesario El Peróxido de Hidrógeno en estas concentraciones es un fuerte oxidante. El contacto directo con los ojos posiblemente cause daño en las corneas especialmente si no se enjuaga inmediatamente. Se recomienda una cuidadosa evaluación oftalmológica y la posibilidad de terapia local corticosteroide debe ser considerada. Debido a la probabilidad de los efectos corrosivos en el tracto gastrointestinal después de la ingestión, y a la escasa probabilidad de efectos sistémicos, intentar una evacuación estomacal vía inducción del vómito o lavado gastrointestinal debe ser evitado. Existe una posibilidad remota de que una sonda nasogástrica u orogástrica pueda ser requerido para la reducción de distensión severa (grave) debido a la formación de gas.

5. MEDIDAS PARA COMBATIR INCENDIOS

Medios adecuados de extinción. Agua. No use otra substancia.

Riesgos específicos que se deriven del químico. En contenedores cerrados sin ventilación existe el riesgo de ruptura debido al incremento de presión derivado de su descomposición. El contacto con material combustible puede causar fuego.

Riesgos de los productos de combustión. Como producto de la descomposición se libera oxígeno el cual puede intensificar el fuego.

Datos de explosión:

Sensibilidad a impacto mecánico: No sensible

Sensibilidad a descarga estática: No sensible

Equipo de protección y precauciones para bomberos: Use agua en spray para enfriar las superficies expuestas a fuego y para proteger al personal. Mueva los contenedores del área de fuego si puedes hacerlo sin riesgo. Como en cualquier incendio, use aparatos de respiración autónoma y equipo de protección completo.

6. MEDIDAS EN CASO DE LIBERACIÓN ACCIDENTAL

Precauciones personales Evite el contacto con la piel, ojos y vestimenta. Use equipo de protección personal. Aisle y delimite el área del derrame. Mantenga a las personas alejadas del derrame y a las personas necesarias para el combate de la emergencia, manténgalas corriente arriba de la dirección del viento en relación del derrame o fuga. Elimine todas las fuentes de ignición y remueva los materiales combustibles.

Otros Material combustible expuesto al peróxido de hidrógeno deberá ser inmediatamente sumergido en agua o enjuagado con grandes cantidades de agua para asegurar que todo el peróxido de hidrógeno es removido. El peróxido de hidrógeno residual que es permitido se seque (por evaporación del peróxido de hidrógeno puede concentrarse) en materiales orgánicos como papel, telas, algodón, piel madera o otros combustibles puede causar que el material se encienda y resulte en fuego.

Precauciones medioambientales Ver sección 12 para información ecotoxicológica adicional

Métodos de contención. Use diques para colectar grandes derrames. Detenga la fuga y contenga los derrames si puede hacerse en forma segura, posteriormente diluya con abundante agua. Para derrames pequeños, diluir con grandes cantidades de agua.

Métodos de limpieza Enjuague el área hasta anegar con agua. El peróxido de hidrógeno puede descomponerse adicionado metabisulfito de sodio o sulfito de sodio después de haber diluído hasta cerca del 5%.

7. MANIPUACIÓN Y ALMACENAMIENTO

Manipulación Úselo únicamente en áreas bien ventiladas. Mantenga / almacene fuera del alcance de de materiales combustibles / vestimenta. Nunca regrese el peróxido de hidrógeno no usado al contenedor original. Su contaminación puede causar descomposición y generación de gas oxígeno el cual puede resultar en altas presiones y en posible ruptura del envase o recipiente que lo contiene. Los porrones vacíos deben ser enjuagados tres veces con agua antes de desecharse o disponerse. Los utensilios usados para manipular el peróxido de hidrógeno únicamente deben ser hechos con vidrio, acero inoxidable, aluminio o plástico. Tuberías y equipos deberán ser pasivados antes del primer uso. El peróxido de hidrógeno deberá ser almacenado solamente en contenedores ventilados y transferidos solamente en forma autorizada.

Almacenamiento Mantenga los contenedores en áreas frescas fuera de la luz solar directa y lejos de combustibles. Provea de ventilación mecánica en forma general o local para ventilación y así evitar la liberación de vapor o niebla en el medio ambiente de trabajo. Los contenedores deben ser venteados. Almacene en el contenedor original solamente. El lugar de almacenamiento debe estar hecho de materiales no combustibles con pisos impermeables. En caso de liberación, el derrame debe dirigirse a un área segura. Los contenedores deberán ser inspeccionados en forma visual en forma regular para detectar anormalidades como (porrones contraídos, inflados, incremento en temperatura, etc.)

Productos incompatibles Materiales combustibles, aleaciones de cobre, acero galvanizado. Fuertes agentes reductores, metales pesados. Hierro, contacto con metales, iones metálicos, álcalis, agentes reductores y material orgánico (como alcoholes o terpenos). Puede producir descomposición térmica auto acelerada.

8. CONTROL DE DE EXPOSICIÓN / PROTECCIÓN PERSONAL

Parámetros de control

Límite de exposición Parámetros de control en el centro de trabajo

Nombre Químico	**ACGIH TLV**	**OSHA PEL**	**NIOSH**	**México**
Peróxido de Hidrógeno 7722-84-1	TWA:1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3	IDLH: 75 ppm TWA: 1 ppm TWA: 1.4 mg/m^3	México: TWA 1 ppm México: TWA: 1.5 mg/m^3 México: STEL 2 ppm México: STEL 3 mg/m^3
Nombre Químico	**British Columbia**	**Quebec**	**Ontario TWAEV**	**Alberta**
Peróxido de Hidrógeno 7722-84-1	TWA: 1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3	TWA: 1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3

TWA= (Time-Weighted Average) concentración promedio de exposición en una jornada de 8 horas.

STEL= (Short therm exposure limit) limite de exposición a corto plazo.

Controles de ingeniería adecuados

Controles adecuados de ingeniería	Asegure que las estaciones de lava ojos y regaderas de emergencia están cerca del lugar de trabajo. Asegure ventilación adecuada.

Medidas de protección individual, como equipo de protección personal

Protección ocular y facial	Use goggles y careta hecha de policarbonato, acetato, policarbonato/acetato, PETG o termoplástico.
Protección de piel y de cuerpo	Para protección del cuerpo use ropa impermeable, un traje hecho de caucho SBR, PVC, (revestimiento exterior de PVC con sustrato de polyester), Gore-tex (polyester, trilaminado con Gore-tex), o un traje especializado HAZMAT contra salpicaduras o traje protector (nivel A, B o C). Para protección de pies use botas apropiadas hechas de NBR, PVC, Poliuretano o Neopreno. Zapatones hechos de látex PVC, así como botas de bombero o botas especializadas HAZMAT. No use alguna otra bota o zapatón hecho de nylon o mezclas de nylon. No use algodón, lana o piel porque esos materiales reaccionan rápidamente con concentraciones altas de peróxido de hidrógeno. Sumerja completamente en agua ropa u otros materiales contaminados con peróxido de hidrógeno antes de secarse. Si se deja secar el peróxido de hidrógeno residual en materiales orgánicos como papel, telas, algodón, piel madera u otros combustibles pueden causar que el material se encienda y resulte en fuego.
Protección de manos	Para protección de manos, utilice guantes aprobados hechos de nitrilo, PVC, o Neopreno. No use algodón, lana o piel porque esos materiales reaccionan RAPIDAMENTE con concentraciones altas de peróxido de hidrógeno. Enjuague vigorosamente el exterior de los guantes antes de retirarlos. Inspeccionelos por fuga regularmente.
Protección respiratoria	Si se esperan concentraciones por arriba de 10 ppm, use NIOSH/DHHS aprobados, aparato de respiración autónoma (SCBA) u otro respirador con aire suministrado (ASR) aprobado (ejemplo: un respirador de cara completo con línea de aire (ALR)). NO use ninguna forma de purificador de aire (APR) o mascaras para polvo, especialmente aquellos que contengan agentes oxidables como carbón activado.
Medidas de higiene	Evite respirar vapores rocío o gas. Agua limpia debe estar disponible para lavar en caso de contaminación de piel u ojos.
Información general	Soluciones de ingeniería para protección deben ser implementadas y en uso antes de considerar al equipo de protección personal.

9. PROPIEDADES FISICAS Y QUIMICAS

Información en base a propiedades físicas y químicas

Apariencia:	Claro, incoloro
Estado Físico:	Líquido
Color:	Incoloro
Olor:	Inodoro
Olor límite:	No aplica
pH:	<= 3.0
Punto de fusión/Punto de Congelamiento	-52 °C
Punto de ebullición:	114°C
Flash point:	No inflamable
Taza de evaporación:	> 1 (N-Butil Acetato =1)
Inflamabilidad (sólido, gas)	No inflamable
Inflamabilidad límite en aire	No aplica
Límite superior de inflamabilidad:	
Límite inferior de inflamabilidad:	
Presión de vapor:	18 mmHg @ 30°C
Densidad de vapor:	Información no disponible
Densidad	1.2 g/cm^3 @20°C
Gravedad específica:	1.2
Solubilidad en agua:	Completamente Soluble.

Coeficiente de partición:	log Kow=-1.5 @ 20 °C
Temperatura de auto ignición:	No combustible.
Temperatura de descomposición:	100°C (adiabático)
Viscosidad cinemática:	1.17 cp @ 20°C
Viscosidad dinámica:	Información no disponible.
Propiedades explosivas:	Información no disponible.
Propiedades oxidantes:	Fuertemente oxidante
Peso Molécular:	34
Bulk density	No aplica

10. ESTABILIDAD Y REACTIVIDAD

Reactividad	Agente reactivo y oxidante
Estabilidad química	Estable bajo condiciones normales. Se descompone con calor. Estable bajo las condiciones recomendadas de almacenamiento
Posibles reacciones de riesgo	El contacto con sustancias orgánicas puede causar fuego o explosión, el contacto con metales, iones metálicos, álcalis, agentes reductores y materia orgánica (como alcoholes o terpenos) pueden producir descomposición térmica auto-acelerada
Riesgo de polimerización	No ocurre
Condiciones a evitar	Calor excesivo; contaminación; exposición a rayos UV; variaciones de pH.
Materiales incompatibles	Los materiales combustibles. Aleaciones de cobre, hierro galvanizado. Agentes fuertemente reductores. Los metales pesados hierro. Las aleaciones de cobre. El contacto con metales, iones metálicos, álcalis, agentes reductores y materia orgánica (como como alcoholes o terpenos) pueden producir la descomposición térmica de auto-acelerada.
Productos de descomposición peligrosa:	Oxígeno el cual mantiene la combustión. Producirá sobrepresión en el equipo que lo contenga.

11. INFORMACIÓN TOXICOLOGICA

Información del producto

LD 50 Oral	50% solución: LD50 > 225 mg/kg bw (rata) 35% solución: LD50 1193 mg/kg bw (rata) 70% solución: LD50 1026 mg/kg bw (rata)
LD 50 Piel	35% solución: LD50 > 2000 mg/kg bw (conejo) 70% solución: LD50 9200 mg/kg bw (conejo)
LC 50 Inhalación	50% solución: LC50 > 170 mg/m^3 (rata) (4 horas) Vapores de peróxido de hidrogeno: LC0 9400 mg/m^3 (ratón) (5 a 15 min) Vapores de peróxido de hidrógeno: LC50 > 2160 mg/m^3 (ratón)
Daños serios a los ojos / irritación a los ojos	Corrosivo. Riesgo de serio daño a los ojos
Corrosión a la piel / irritación	Corrosivo a la piel. Causa de severas quemaduras.
Sensibilización	No causa sensibilización en animales de laboratorio.

Efectos e información toxicológica

Síntomas	Vapores, rocío o aerosoles de peróxido de hidrógeno puede causar irritación en las vías respiratorias superiores, inflamación de la nariz, ronquera, dificultad para respirar y una sensación de quemazón, opresión en el pecho. Prolongada exposición a vapores concentrados o a soluciones diluidas puede causar irritación y temporal decoloración de piel y cabello. Exposición a vapor, rocío, o aerosol puede causar ardor, dolor y lagrimeo de ojos.

Efectos inmediatos y retardados así como efectos crónicos por la exposición a corto y largo plazo.

Carcinogenicidad — Este producto contiene peróxido de hidrógeno. La agencia internacional para la investigación de cáncer (IARC) ha concluido que es inadecuada la evidencia para carcinogenicidad de peróxido de hidrógeno en humanos, pero limitada evidencia en animales experimentales (grupo 3-no clasificable en cuanto a su carcinogenicidad en humanos). La Conferencia Americana de Higienistas Industriales del Gobierno (ACGIH) ’un carcinógeno confirmado en animales con desconocida relevancia en humanos’ (A3).

Nombre del químico	**ACGIH**	**IARC**	**NTP**	**OSHA**
Peróxido de hidrógeno 7722-84-1	A3	3		

Mutagenicidad — Este producto no está reconocido como mutagenico por las agencias de investigación. Pruebas In vivo no muestran efectos mutagénicos.

Toxicidad reproductiva — Este producto no está reconocido como tóxico para la reproducción por agencias de investigación. No es tóxico a la reproducción en estudios en animales.

Toxicidad sistémica específica del órgano blanco-Exposición única — Puede causar irritación respiratoria

Toxicidad sistémica específica del órgano blanco -Exposición repetida — No clasificado

Efecto en órgano blanco — Ojos, sistema respiratorio y piel.

Riesgo de aspiración — Riesgo de aspiración: puede causar daño al pulmón si se ingiere.

12. INFORMACIÓN ECOTOXICOLOGICA

Ecotoxicidad
Efectos ecotoxicológicos

Peróxido de hidrógeno (7722-84-1)				
Ingrediente activo	Duración	Especies	Valor	Unidades
Peróxido de Hidrógeno	96 h LC50	Fish Pimephales promelas	16.4	mg/L
Peróxido de Hidrógeno	72 h LC50	Fish Leuciscus idus	35	mg/L
Peróxido de Hidrógeno	48 h EC50	Daphnia pulex	2.4	mg/L
Peróxido de Hidrógeno	24 h EC50	Daphnia magna	7.7	mg/L
Peróxido de Hidrógeno	72 h EC 50	Algae Skeletonema costatum	1.38	mg/L
Peróxido de Hidrógeno	21 d NOS	Daphnia magna	0.63	mg/L

Persistencia y degradabilidad — El peróxido de hidrógeno en ambiente acuático es sujeto a varios procesos de reducción u oxidación y se descompone en agua y oxígeno. La vida media del peróxido de hidrógeno en agua fresca esta en un rango de 8 horas a 20 días, en aire de 10 a 20 horas, y en suelos de min. a hrs. Dependiendo de su actividad microbiológica y contaminación de metales.

Bioacumulación — El material puede tener algún potencial bioacumulable pero probablemente se degradará en más medioambientes antes de que la acumulación pueda ocurrir.

Movilidad — Probablemente sea móvil en el medio ambiente debido a su solubilidad en el agua pero problablemente se degradará con el tiempo.

Otros efectos adversos — Se descompone en oxígeno y agua. No hay efectos adversos.

13. INFORMACIÓN RELATIVA A LA ELIMINACIÓN DEL PRODUCTO

Métodos de disposición de residuos	Disponga de acuerdo con las regulaciones locales. Puede disponerse como agua residual si está en cumplimiento con regulaciones locales
US EPA Número de desecho	D001 D003
Empaques contaminados	Disponga de acuerdo con regulaciones locales Porrones- vaciarlos tan vigorosamente como sea posible, enjuague tres veces antes de disponer. Evite contaminación; las impurezas aceleran la descomposición. Nunca regrese producto al envase original.

14. INFORMACIÓN DE TRANSPORTACIÓN.

DOT

Número ONU	UN 2014
Nombre correcto de embarque	Peróxido de hidrógeno, solución acuosa
Clase de riesgo	5.1
Sub-Clase	8
Grupo de empaque	II

TDG

Número ONU	UN 2014
Nombre correcto de embarque	Peróxido de hidrogeno, solución acuosa
Clase de riesgo	5.1
Sub-Clase	8
Grupo de embarque	II

ICAO/IATA

Peroxido de hidrógeno mayor de 40% es prohibido en avión de carga o de pasajero. La regulación aérea permite el embarque de peróxido de hidrógeno (<= 40%) en contenedores sin venteo en avión de carga solamente, así como para aviones de pasajeros y de carga. SIN EMBARGO, todos los contenedores de peróxido de hidrógeno son venteados y entonces, los envíos aéreos de peróxido de hidrógeno no están permitidos. Las regulaciones de IATA establecen que sustancias que contengan envases de sustancias oxidantes con venteo no son permitidas para transportación por aire.

IMDG/IMO

Número ONU	UN 2014
Nombre correcto de embarque	Peróxido de hidrógeno, solución acuosa
Clase de riesgo	5.1
Sub-Clase	8
Grupo de empaque	II

OTRA INFORMACIÓN

Proteja de daño físico. Mantenga los porrones en posición vertical con la tapa hacia arriba. Los porrones no deben ser estibados en tránsito. No almacene porrones en tarimas de madera.

15. INFORMACIÓN REGULATORIA

U.S. Regulaciones Federales

<u>SARA 313</u>
La sección 313 del título III del SARA de 1986. Este producto no contiene ningún químico que sea sujeto a requerimientos de reporte del Acta y Titulo 40 del Código de Regulaciones Federales, parte 372.

<u>SARA 311/312 Categorías de Riesgo</u>

Riesgo agudo a la salud	Si
Riesgo crónico a la salud	No
Riesgo de fuego	Si
Riesgo por repentina liberación de presión	No
Riesgo de reactividad	No

<u>Ley de agua limpia</u>
Este producto no contiene ninguna sustancia regulada como promotor de contaminación a la ley de agua limpia (40 CFR 122.21 y 40 CFR 122.42)

<u>CERCLA</u>

Nombre químico	Sustancias peligrosas RQs	Sustancias extremadamente riesgosas RQs	SARA RQ
Peróxido de hidrógeno 7722-84-1		1000 lb	

Peróxido de hidrógeno RQ es para concentraciones mayores a 52% solamente

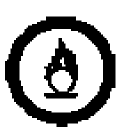
<u>Inventarios internacionales</u>

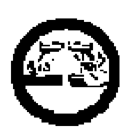
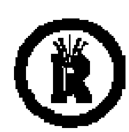
Compo-nente	TSCA (EUA)	DSL (Canadá)	EINECS/ELINCS (Europa)	ENCS (Japón)	China (IECSC)	KECL (Korea)	PICCS (Filipinas)	AICS (Australia)	NZloC (Nueva Zelanda)
Peroxido de hidrógeno 7722-84-1 (50)	X	X	X	X	X	X	X	X	X

México-Grado Riesgo serio, Grado 3

CANADÁ

WHMIS Clase del riesgo.
C- Materiales oxidantes
D1B Materiales tóxicos
E – Material corrosivo
F – Material peligrosamente reactivo



16-. OTRA INFORMACIÓN

NFPA	**RIESGO A LA SALUD** 3	**FLAMABILIDAD** 0	**REACTIVIDAD** 1	**RIESGO ESPECIAL** OX
HMIS	**RIESGO A LA SALUD** 3	**FLAMABILIDAD** 0	**RIESGO FISICO** 1	**PROTECCION PERSONAL** H

NFPA/HMIS Clasificación de Leyendas. Severo= 4, Serio=3, Moderado =2, Ligero=1, Mínimo=0
Riesgo especial: OX= Oxidante
Protección = H (Goggles de seguridad, guantes, delantal, el uso de aire suministrado o SCBA es requerido en lugar de un respirador de cartuchos para vapores)

Código de Fuego: Oxidante: Clase 2- Líquido.

Fecha de revisión: 2015-05-08
Nota de revisión: Revisión inicial

Acrónimos

TWA: (Time-Weighted Average) concentración promedio de exposición en una jornada de 8 horas.

STEL: (Short therm exposure limit) limite de exposición a corto plazo.

NFPA: National Fire Protection Association. Asociación Nacional de Protección contra Incendios (USA). Clasificación de riesgos creada por la NFPA para atención de emergencias.

HMIS: Hazardous Material Information System. Clasificación de riesgos creada para presentar riesgos a la salud.

PeroxyChem, considera que la información y recomendaciones presentadas aquí (incluyendo los datos, indicaciones y los enunciados) son exactos en la fecha actual. NO SE OFRECEN GARANTIAS SOBRE LA IDONEIDAD PARA CUALQUIER PROPOSITO PARTICULAR, NI GARANTIA DE COMERCIALIZACION O CUALQUIER OTRA, EXPRESA O IMPLICITA, RELATIVA A LA INFORMACIÓN BRINDADA AQUÍ. La información proporcionada aquí está relacionada solamente con el producto específico mencionado y puede no ser aplicable cuando se utilice este producto en combinación con cualquier otro material o en algún proceso. Adicionalmente, debido a que las condiciones y métodos de uso están fuera del control de PeroxyChem, rechazamos expresamente toda responsabilidad legal en relación con los resultados que se obtengan o que se deriven del uso de los productos o del uso de ésta información.

Preparado por:

PeroxyChem

Fin de la hoja de seguridad.

1- IDENTIFICACIÓN DEL PRODUCTO	
Identificador SGA del producto:	SODA CAUSTICA LÍQUIDA
Otros medios de identificación:	No aplicable.
Uso recomendado del producto químico y restricciones:	Fabricación de celulosa, aluminio, hilados de rayón, jabón y detergentes e intermedios químicos, utilizados también por la industria siderúrgica y metalúrgica, aditivos alimentarios, mercerización de productos textiles, regeneración de resinas de intercambio iónico y corrección de pH en varios procesos industriales.
Datos sobre el proveedor:	Unipar Carbocloro S/A
Dirección:	Avenida Presidente Juscelino Kubitschek, 1.327 – 22º andar São Paulo/SP - Brasil
Número de teléfono:	(+55) (11) 3704-4200
Número de teléfono para emergencias:	(+55) (13) 3362-8022 (+55) 0800-118270 (PróQuímica Abiquim)

2- IDENTIFICACIÓN DEL PELIGRO O PELIGROS	
Clasificación de la sustancia o mezcla:	Sustancias y mezclas corrosivas para los metales – Categoría 1 Toxicidad aguda por vía cutánea – Categoría 5 Corrosión/irritación cutáneas – Categoría 1B Lesiones oculares graves/irritación ocular – Categoría 1 Toxicidad sistémica específica de órganos diana (exposición única) – Categoría 3 Peligros para el medio ambiente acuático – peligro a corto plazo (agudo) – Categoría 3
Sistema de clasificación adoptado:	Sistema Globalmente Armonizado de Clasificación y Etiquetado de Productos Químicos (SGA), Naciones Unidas.

Elementos de las etiquetas del SGA	
Pictogramas:	
Palabra de advertencia:	PELIGRO
Indicación o indicaciones de peligro:	H290 Puede ser corrosiva para los metales. H313 Puede ser nocivo en contacto con la piel. H314 Provoca graves quemaduras en la piel y lesiones oculares. H335 Puede irritar las vías respiratorias. H402 Nocivo para los organismos acuáticos.
Consejos de prudencia:	**PREVENCIÓN:** P234 Conservar únicamente en el embalaje original. P260 No respirar nieblas y vapores. P261 Evitar respirar nieblas y vapores. P264 Lavarse las manos cuidadosamente después de la manipulación. P271 Utilizar sólo al aire libre o en un lugar bien ventilado. P273 No dispersar en el medio ambiente. P280 Usar guantes, ropa de protección, equipo de protección para los ojos o la cara. **INTERVENCIÓN:** P301 + P330 + P331 EN CASO DE INGESTIÓN: Enjuagar la boca. NO provocar el vómito. P303 + P361 + P353 EN CASO DE CONTACTO CON LA PIEL (o el pelo): Quitar inmediatamente toda la ropa contaminada. Enjuagar la piel con agua o ducharse. P304 + P340 EN CASO DE INHALACIÓN: Transportar a la persona al aire libre y mantenerla en una posición que le facilite la respiración.

	P305 + P351 + P338 EN CASO DE CONTACTO CON LOS OJOS: Enjuagar con agua cuidadosamente durante varios minutos. Quitar las lentes de contacto cuando estén presentes y pueda hacerse con facilidad. Proseguir con el lavado. P310 Llamar inmediatamente a un CENTRO DE TOXICOLOGÍA o a un médico. P312 Llamar un CENTRO DE TOXICOLOGÍA o a un médico si la persona se encuentra mal. P321 Tratamiento específico. P363 Lavar la ropa contaminada antes de volverla a usar. P390 Absorber el vertido para prevenir daños materiales. **ALMACENAMIENTO:** P403 + P233 Almacenar en un lugar bien ventilado. Mantener el recipiente herméticamente cerrado. P405 Guardar bajo llave. P406 Almacenar en un recipiente resistente a la corrosión o con revestimiento interior resistente. **ELIMINACIÓN:** P501 Eliminar el contenido y el recipiente conforme a la reglamentación local.
Otros peligros que no conducen a una clasificación:	El producto no tiene otros peligros.

3- COMPOSICIÓN/INFORMACIÓN SOBRE LOS COMPONENTES

MEZCLA

Componentes que contribuyen al peligro:

Componentes	Concentración (%)	Numero CAS
Hidróxido de Sodio	49,0 – 51,5	1310-73-2

4- PRIMEROS AUXILIOS	
Vía de exposición	
Inhalación:	Llevar a la víctima al exterior y mantenerla en reposo en una posición confortable para respirar. Si se siente mal, llame a un CENTRO DE TOXICOLOGÍA o un médico. Lleve esta FDS.
Contacto con la piel:	Quitar inmediatamente toda la ropa contaminada. Enjuagar la piel con agua y ducharse. Llamar inmediatamente a un CENTRO DE TOXICOLOGÍA o a un médico. Lleve esta FDS.
Contacto con los ojos:	Enjuague bien con agua durante varios minutos. En caso de lentes de contacto, quitarlas, si es fácil. Continúe enjuagando. Llamar inmediatamente a un CENTRO DE TOXICOLOGÍA o a un médico. Lleve esta FDS.
Ingestión:	No inducir el vómito. No dar nada por la boca a una persona inconsciente. Enjuagar la boca de la víctima con agua en abundancia. Si ocurre vómito espontáneo, proporcione agua adicional y mantenga a la víctima en aire fresco. Si no se siente bien, llame a un CENTRO DE TOXICOLÓGÍA o un médico. Lleve esta FDS.
Síntomas/efectos más importantes, agudos o retardados:	Puede ser nocivo en contacto con la piel. Provoca graves quemaduras en la piel con ampollas, descamación y dolor, y lesiones oculares con ardor, lagrimeo y dolor. Puede causar irritación respiratoria con tos y estornudos.
Indicación de la necesidad de recibir atención médica inmediata y, en su caso, de tratamiento especial:	Evite contacto con el producto para socorrer a la víctima. Si es necesario, el tratamiento sintomático debe incluir principalmente medidas de apoyo tales como la corrección de las alteraciones electrolíticas, metabólicas y cuidados respiratorios. En caso de contacto con la piel no frotar la zona afectada.

5- MEDIDAS DE LUCHA CONTRA INCENDIOS	
Medios de extinción:	Apropiados: Compatible con polvo químico, dióxido de carbono (CO_2) y niebla de agua. No apropiados: Chorro de agua directamente.

Peligros específicos del producto químico:	El producto no es inflamable. La combustión del producto químico o recipientes pueden formar gases y humos tóxicos e irritantes, tales como monóxido de carbono y dióxido de carbono.
Medidas especiales que deben tomar los equipos de lucha contra incendios:	Equipo de protección respiratoria tipo autónomo (SCBA) con presión positiva y ropa de protección completa. Rociar con agua los recipientes implicados en el incendio para mantenerlos fríos.

6- MEDIDAS QUE DEBEN TOMARSE EN CASO DE VERTIDO ACCIDENTAL	
Precauciones personales, equipo protector y procedimiento de emergencia	
Para el personal que no forma parte de los servicios de emergencia:	Aislar preventivamente las fuentes de ignición. Evacuar el área dentro de un radio de al menos 50 metros. Mantenga a las personas no autorizadas fuera de la zona. Detenga la fuga si puede hacerlo sin riesgo. No fume. No toque en los recipientes dañados o material derramado sin el uso de ropa adecuada. Evite la exposición al producto. No exponerse a la sustancia sin utilizar equipo de protección personal recomendado en la sección 8.
Para el personal de los servicios de emergencia:	Use equipo completo de protección con gafas de seguridad contra salpicaduras, guantes de seguridad, delantal de PVC, vestimenta de protección anti-ácido (PVC u otro material equivalente), botas de PVC. El material utilizado debe ser impermeable. En caso de fuga, donde la exposición es grande, se recomienda el uso de máscara de protección respiratoria (semifacial) con un filtro contra vapores y nieblas o una máscara facial completa con una línea de aire o un aparato de respiración autónomo.
Precauciones relativas al medio ambiente	Evitar que el material derramado llegue a los cursos de agua o sistemas de alcantarillados.
Métodos y materiales para la contención y limpieza de vertidos	No permita que entre agua en los recipientes. Use barreras naturales o de contención de derrames. Recoger el producto derramado y colocar en contenedores apropiados. Se adsorbe el producto restante con arena seca, tierra, vermiculita u otro material inerte. Coloque el material adsorbido en los contenedores apropiados y trasladarlos a un lugar seguro. Para su eliminación, proceda de acuerdo con la Sección 13 de esta FDS.

7- MANIPULACIÓN Y ALMACENAMIENTO	
Precauciones que se deben tomar para garantizar una manipulación segura	
Precauciones para una manipulación segura de la sustancia o mezcla:	Úselo en un área bien ventilada o con el sistema de la ventilación/escape local. Evitar la formación de vapores y nieblas. Evite la exposición al producto. Evite el contacto con materiales incompatibles. Use el equipo de protección personal como se describe en la Sección 8.
Higiene en general:	Lavarse las manos y la cara completamente después de manipular y antes de comer, beber, fumar o ir al baño. La ropa contaminada debe cambiarse y lavarse antes de volver a usarla. Quite la ropa contaminada y el equipo de protección antes de entrar en áreas de alimentación.
Condiciones de almacenamiento seguro, incluidas cualesquiera incompatibilidades	
Prevención de incendio y atmósferas explosivas:	No se espera que el producto presente un riesgo de incendio o explosión.
Condiciones adecuadas:	Almacenar en un lugar bien ventilado, lejos de la luz solar. Mantenga el recipiente cerrado. Mantener almacenado a temperatura ambiente. No es necesario añadir estabilizantes y antioxidantes para asegurar la durabilidad del producto. Este producto puede reaccionar peligrosamente con algunos materiales incompatibles como se describe en la Sección 10.
Materiales de embalaje:	Recomendado: Tanques de acero al carbono o acero inoxidable, horizontal o vertical, cuando su temperatura es inferior a 60ºC. No se recomienda: Metales (aluminio, zinc, estaño y sus aleaciones).

8- CONTROLES DE EXPOSICIÓN/PROTECCIÓN PERSONAL		
Parámetros de control		
Límite(s) de exposición ocupacional:	**Nombre químico o común**	**TLV – C (ACGIH, 2016)**
	Hidróxido de Sodio	2 mg/m^3

Límite biológicos:	No establecidos.
Otros límites y valores	IDLH (NIOSH, 2010): 10 mg/m³
Controles técnicos apropiados:	Promover la ventilación mecánica directa y el sistema de escape al ambiente exterior. Estas medidas ayudan a reducir la exposición al producto. Mantener las concentraciones de aire por debajo de las normas de exposición ocupacionales.
Medidas de protección individual, como equipo de protección personal (EPP)	
Protección de los ojos/la cara:	Gafas de seguridad contra salpicaduras.
Protección de la piel:	Guantes de seguridad, delantal de PVC o de caucho, ropa anti-ácido protectora (PVC u otro material equivalente), botas de caucho o PVC. El material utilizado debe ser impermeable.
Protección de las vías respiratorias:	En caso de fuga, donde la exposición es grande, se recomienda el uso de máscara de protección respiratoria (semifacial) con un filtro contra vapores y nieblas o una máscara facial completa con una línea de aire o un aparato de respiración autónomo.
Peligros térmicos	No es necesario utilizar EPP específicos, ya que el producto no presenta peligros térmicos.

9- PROPIEDADES FÍSICAS Y QUÍMICAS	
Estado físico:	Líquido.
Color:	Transparente a turba blanquecina.
Olor:	Inodoro.
Punto de fusión/punto de congelación:	No disponible (Ausencia de información).
Punto de ebullición o punto de ebullición inicial e intervalo de ebullición:	140°C (Información sobre la solución de NaOH al 50% en peso)
Inflamabilidad:	No aplicable.

Límites inferior y superior de explosión/inflamabilidad:	No disponible (Ausencia de información).
Punto de inflamación:	No disponible (Ausencia de información).
Temperatura de ignición espontánea:	No disponible (Ausencia de información).
Temperatura de descomposición:	No disponible (Ausencia de información).
pH:	14,0 (solución al 0,5%)
Viscosidad cinemática:	No disponible (Ausencia de información).
Solubilidad:	Miscible con agua. Soluble en alcoholes (etanol, metanol y glicerol). Insoluble en acetona y éter.
Coeficiente de reparto n-octanol/agua (valor logarítmico):	No disponible (Ausencia de información).
Presión de vapor:	13 mmHg a 60°C (Información relativa a la solución de NaOH al 50% en peso)
Densidad y/o densidad relativa:	1,5280 g/cm^3 - 1,5506 g/cm^3 a 15,5ºC (el intervalo es igual a una concentración de alcalinidad total entre 49% y 51% de NaOH)
Densidad de vapor relativa:	No disponible (Ausencia de información).
Características de las partículas:	No aplicable.
Otras informaciones:	No aplicable.

10- ESTABILIDAD Y REACTIVIDAD	
Reactividad:	No se espera reactividad en condiciones normales de temperatura y presión.
Estabilidad química:	Producto es estable en condiciones normales de temperatura y presión.

Posibilidad de reacciones peligrosas:	Reacciona violentamente con ácidos, aldehídos, metales y otros productos orgánicos. Reacciona con aluminio, zinc, estaño y cobre, que pueden causar la corrosión y la generación de hidrógeno, que pueden formar mezclas explosivas con el aire. Posibilidad de reacción exotérmica cuando se diluye en agua, alcohol y glicerol.
Condiciones que deben evitarse:	Temperaturas elevadas y el contacto con materiales incompatibles.
Materiales incompatibles:	Aluminio, zinc, estaño, cobre, ácidos, aldehídos, productos orgánicos y agua.
Productos de descomposición peligrosos:	No son conocidos materiales productos de descomposición peligrosos.

11- INFORMACIÓN TOXICOLÓGICA	
Toxicidad aguda:	Puede ser nocivo en contacto con la piel. Basándose en los datos disponibles, no cumple los criterios de clasificación por vía oral e inhalatoria. ETAmezcla (Estimación de la Toxicidad Aguda) ETAmezcla (cutánea): 2621,359 mg/kg Información relativa al: - Hidróxido de Sodio: DL_{50} (cutánea, ratas): 1350 mg/kg
Corrosión/irritación cutáneas:	Provoca quemaduras graves en la piel con ampollas, descamación y dolor.
Lesiones oculares graves /irritación ocular:	Provoca lesiones oculares con ardor, lagrimeo y dolor.
Sensibilización respiratoria o cutánea:	Basándose en los datos disponibles, no cumple los criterios de clasificación.
Mutagenicidad en células germinales:	Basándose en los datos disponibles, no cumple los criterios de clasificación.

Carcinogenicidad:	Basándose en los datos disponibles, no cumple los criterios de clasificación.
Toxicidad para la reproducción:	Basándose en los datos disponibles, no cumple los criterios de clasificación.
Toxicidad sistémica específica de órganos diana - Exposición única:	Puede causar irritación respiratoria con tos y estornudos. La ingestión del producto en dosis altas puede causar perforaciones en los tejidos de la boca, garganta, esófago y estómago.
Toxicidad sistémica específica de órganos diana - Exposiciones repetidas:	Basándose en los datos disponibles, no cumple los criterios de clasificación.
Peligro por aspiración:	Basándose en los datos disponibles, no cumple los criterios de clasificación.

12- INFORMACIÓN ECOTOXICOLÓGICA	
Toxicidad:	Nocivo para los organismos acuáticos. Información relativa al: <u>- Hidróxido de Sodio:</u> CE_{50} (*Ceriodaphnia dubia*, 48h): 40,38 mg/L
Persistencia y degradabilidad:	Debido a la ausencia de datos, se espera que el producto presente persistencia y no sea rápidamente degradable.
Potencial de bioacumulación:	Debido a la ausencia de datos, no se espera que el producto presente potencial bioacumulativo en los organismos acuáticos.
Movilidad en el suelo:	No determinada.
Otros efectos adversos:	Debido al carácter básico del producto, puede causar cambios en los compartimentos ambientales, causando daños a los organismos.

13- INFORMACIÓN RELATIVA A LA ELIMINACIÓN DE LOS PRODUCTOS
Métodos de eliminación
Debe eliminarse como residuo peligroso de acuerdo con las regulaciones locales. El tratamiento y eliminación deberán ser evaluadas específicamente para cada producto. Mantenga el resto del producto en su envase original y debidamente cerradas. La eliminación debe realizarse según lo previsto para el producto. No reutilizar los envases vacíos. Ellos pueden contener restos del producto y debe ser cerrado y enviado para su disposición apropiada como se requiere para el producto.

14- INFORMACIÓN RELATIVA AL TRANSPORTE	
Reglamentaciones internacionales	
Carretera:	ONU – Organización de las Naciones Unidas Recomendaciones Relativas al Transporte de Mercancías Peligrosas. Reglamentación Modelo.
Número ONU:	1824
Designación oficial de transporte de las Naciones Unidas:	HIDRÓXIDO SÓDICO EN SOLUCIÓN
Clase(s) relativas al transporte:	8
Grupo de embalaje:	II
Ferrocarril:	*Convention concerning International Carriage by Rail (COTIF)* *Appendix C - Regulations concerning the International Carriage of Dangerous Goods by Rail - RID*
Número ONU:	1824
Designación oficial de transporte de las Naciones Unidas:	SODIUM HYDROXIDE SOLUTION

Clase(s) relativas al transporte:	8
Grupo de embalaje:	II
Mar:	*IMO – International Maritime Organization* *International Maritime Dangerous Goods Code (IMDG Code)*
Número ONU:	1824
Designación oficial de transporte de las Naciones Unidas:	SODIUM HYDROXIDE SOLUTION
Clase(s) relativas al transporte:	8
Grupo de embalaje:	II
Contaminante marino:	El producto no se considera un contaminante marino.
EmS:	F-A, S-B
Aire:	*IATA - International Air Transport Association* *Dangerous Goods Regulation (DGR)*
Número ONU:	1824
Designación oficial de transporte de las Naciones Unidas:	SODIUM HYDROXIDE SOLUTION
Clase(s) relativas al transporte:	8
Grupo de embalaje:	II
Riesgos ambientales:	El producto no se considera peligroso para el medio ambiente.
Precauciones especiales:	No hay necesidad de precauciones especiales.

Transporte a granel con arreglo al Convenio MARPOL 73/78, Anexo II, y del Código IBC:	Reglamentaciones consultadas: - *International Maritime Organization. MARPOL: Articles, protocols, annexes, unified interpretations of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, consolidated edition. IMO, London, 2006.* - *International Maritime Organization. IBC code: International code for the construction and equipment of shipping carrying dangerous chemicals in bulk: With Standards and guidelines relevant to the code. IMO, London, 2007.*

15- INFORMACIÓN SOBRE LA REGLAMENTACIÓN

Convention concerning Safety in the use of Chemicals at Work (Convention 170) - International Labour Organization, 1990.

16- OTRAS INFORMACIONES

Esta FDS ha sido elaborada sobre la base de los conocimientos actuales sobre el manejo adecuado del producto y en condiciones normales de uso, en conformidad con la aplicación especificada en el envase. Cualquier otro uso del producto que implica su combinación con otros materiales, y el uso de diversas formas de las que se indican, son responsabilidad del usuario. Advierte de que el manejo de cualquier sustancia química requiere el conocimiento previo de sus peligros para el usuario. En el lugar de trabajo es para el producto de la empresa usuaria promueve la formación de sus empleados acerca de los posibles riesgos derivados de la exposición a la sustancia química.

FDS elaborada en Julio, 2017.

Control de cambios:

Versión	Fecha de publicación	Cambios
00	26/07/2017	Elaboración

Abreviaturas:

ACGIH - *American Conference of Governmental Industrial Hygienists*

CAS - *Chemical Abstracts Service*

C – *Ceiling*

CE_{50} - Concentración efectiva 50%

DL_{50} – Dosis letal 50%

IDLH – *Immediately Dangerous to Life or Health*

NA – No aplicable

NIOSH – *National Institute of Occupational Safety and Health*

PVC - Policloruro de vinilo

SCBA – *Self-Contained Breathing Apparatus*

TLV - *Threshold Limit Value*

Referencias bibliográficas:

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIALS HYGIENISTS. TLVs® and BEIs®: Baseados na “Documentação” dos Limites de Exposição Ocupacional (TLVs®) para Substâncias Químicas e Agentes Físicos & Índices Biológicos de Exposição (BEIs®). Tradução Associação Brasileira de Higienistas Ocupacionais. São Paulo, 2016.

NIOSH - NATIONAL INSTITUTE OF OCCUPATIONAL AND SAFETY. International Chemical Safety Cards. Disponible en: <http://www.cdc.gov/niosh/>. Acceso en: julio 2017.

Sistema Globalmente Armonizado de Clasificación y Etiquetado de Productos Químicos (SGA). 6. Rev. Ed. Nueva York: Naciones Unidas, 2015.

UNIPAR CARBOCLORO S/A. FISPQ - Ficha de Informações de Segurança de Produtos Químicos: SODA CÁUSTICA Líquida. Revisión 13. Brasil. Julio, 2017.

ANNEX IV

PRELIMINARY HAZARD ANALYSIS SHEET (APP)

APP – PRELIMINARY RISK ANALYSIS							
Area: Wood Yard							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
1	Ignition in the chip silo or biomass pile	• External ignition source	• Fire • Personal accident • Material damages • Air quality modification • Liquid effluent generation from firefighting system	**C**	**II**	**Mn**	• Area will be provided of firefighting system • Fire will be duly controlled inside Wood Yard area
2	Hydraulic unit oil leakage	• Rupture at oil hydraulic unit system, due to: ✓ Mechanical impact ✓ Mechanical failure	• Modification of soil and groundwater quality • Change in surface water quality	**D**	**II**	**M**	• The areas of the hydraulic units shall be provided with containing walls • Providing rainwater pollution protection systems
3	Leakage of leachate of chip pile	• Rupture of the floor of the storage area or containment system	• Modification of soil, groundwater or surface water quality	**B**	**II**	**D**	• Drainage of the pile should be sent to the effluent treatment system • Installation of groundwater monitoring wells • Frequent visual inspection of the area, which will allow quick corrective action, minimizing impact in case of floor rupture

Frequency: A – Very Unlikely, B – Unlikely, C – Remote, D – Likely, E – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: D – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Cooking, Brown pulp washing and Delignification							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
4	Ignition in the chip silo	• External ignition source	• Fire; • Personal accident • Material damages • Air quality modification	**B**	**II**	**D**	• Firefighting system will be installed
5	Liquor Leakage of liquor (white and / or black)	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump, tank)	• Personal accident • Loss of product • Alteration of soil and groundwater quality • Alteration of surface water quality.	**D**	**II**	**M**	• The area will be surrounded by retaining wall • Equipment and piping with liquor will be made of stainless steel
6	Leakage of pulp	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump, tank)	• Personal accident • Loss of product • Alteration of surface water quality	**D**	**II**	**M**	• The area will be surrounded by retaining wall

Frequency: A – Very Unlikely, B – Unlikely, C – Remote, D – Likely, E – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: D – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Cooking, Brown pulp washing and Delignification							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
7	Leakage (fugitive emissions) of concentrated non condensable gases (CNCG)	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump, tank) • Failure of process settings	• Personal accident • Air quality modification	**D**	**II**	**M**	• CNCG generating sources shall be provided with a safety system consisting of lighting arresters and rupture discs for protection against explosions and accidental emissions to the atmosphere • The piping of rupture disc shall be provided with a pressure sensor so that in the event of a ruptured disc, the ON-OFF valve is immediately closed, blocking the sources and avoiding CNCG emission into the atmosphere • Each source will have the emission of CNCG monitored (flow, temperature and pressure) • CNCG collection lines will be individualized for better operational control • Non-condensable gases will be collected and incinerated in the recovery boiler • Fugitive emissions have a low flow rate, which limits their dispersion around the site

APP – PRELIMINARY RISK ANALYSIS

Area: Cooking, Brown pulp washing and Delignification

Item	Risk	Possible Causes	Possible Effects	Grade			Remarks and/or Recommendations
				Freq.	Sever.	Risk	
8	Explosion of digester	• Overpressure	• Fireball • Materials damage • Alteration of air and soil quality	B	II	D	The design and operation of the Digester is based on the strictest safety criteria in order to prevent accidents and explosions, such as: • High level of instrumentation to allow monitoring of all process variables • Preventive maintenance in relation to the corrosion protection of the digester walls in the occasions of the general stoppings • Redundancy in interlocks at critical safety and process points • In addition, both the operation process and the project preparation phase are based on the full compliance with the safety requirements imposed by Regulatory Norm 13: Boilers and Pressure Vessels (NR-13)

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Bleaching plant							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
9	Chlorine dioxide leakage	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump, tank)	• Personal accident • Loss of product • Alteration of soil and groundwater quality • Alteration of surface water quality.	**C**	**III**	**M**	• The area will have retaining walls around it, and yet, there will be closed channels with a gas collection system • The equipment with chlorine dioxide will be titanium
10	Leakage of chemicals (sulfuric acid, sodium hydroxide, hydrogen peroxide)	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump, tank)	• Personal accident • Loss of product • Alteration of soil and groundwater quality • Alteration of surface water quality.	**C**	**II**	**Mn**	• The area will be surrounded by retaining wall

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Drying Machine and Packing							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
11	Leakage of pulp from bleached pulp towers	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump, tank)	• Personal accident • Loss of product • Alteration of soil quality • Alteration of surface water quality	**C**	**II**	**Mn**	• The area will be surrounded by retaining wall
12	Hydraulic unit oil leakage	• Rupture at oil hydraulic unit system, due to: ✓ Mechanical impact ✓ Mechanical failure.	• Alteration of soil and groundwater quality • Alteration of surface water quality	**D**	**II**	**M**	• The areas of the hydraulic units shall be provided with containing walls
13	Ignition of pulp bales	• External ignition source	• Fire • Materials damage • Personal accident • Alteration of air quality	**C**	**II**	**Mn**	• Storage area of the pulp bales shall be provided with a firefighting system • The fire will be properly controlled within the area, there being no propagation

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Evaporation Plant							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
14	Leakage (fugitive emissions) of concentrated non condensable gases (CNCG)	• Failure on process settings.	• Alteration of air quality.	**D**	**II**	**M**	• CNCG generating sources shall be provided with a safety system consisting of flame arresters and rupture discs for protection against explosions and accidental emissions to the atmosphere • The piping of rupture disc shall be provided with a pressure sensor so that in the event of a ruptured disc, the ON-OFF valve is immediately closed, blocking the sources and avoiding CNCG emission into the atmosphere • Each source will have the emission of CNCG monitored (flow, temperature and pressure) • CNCG collection lines will be individualized for better operational control • Non-condensable gases will be collected and incinerated in the recovery boiler • Fugitive emissions have a low Flow rate, which limits their dispersion around the site

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

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<tr><th colspan="8">APP – PRELIMINARY RISK ANALYSIS</th></tr>
<tr><td colspan="8">Area: Evaporation Plant</td></tr>
<tr><th rowspan="2">Item</th><th rowspan="2">Risk</th><th rowspan="2">Possible Causes</th><th rowspan="2">Possible Effects</th><th colspan="3">Grade</th><th rowspan="2">Remarks and/or Recommendations</th></tr>
<tr><th>Freq.</th><th>Sever.</th><th>Risk</th></tr>
<tr><td>15</td><td>Leakage of black liquor</td><td>• Rupture or hole in piping due to:
✓ Corrosion
✓ Mechanical failure
✓ Operational failure
✓ Mechanical impact
• Rupture or failure of components (valve, pump, tank)</td><td>• Personal accident
• Loss of product</td><td>D</td><td>II</td><td>M</td><td>• Chemical recovery areas will have containment walls</td></tr>
<tr><td>16</td><td>Leakage of contaminated condensate</td><td>• Rupture or hole in piping due to:
✓ Corrosion
✓ Mechanical failure
✓ Operational failure
✓ Mechanical impact
• Rupture or failure of components (valve, pump, tank)</td><td>• Personal accident
• Loss of product
• Alteration of air quality</td><td>C</td><td>III</td><td>M</td><td>• Evaporation area will have a containment wall in all its surroundings
• Implementation of high and very high level alarms with stop interlocking and deflection of condensate flows
• Implantation of redundancy (additional safety) of interlocking to high level in parallel with level switch</td></tr>
<tr><td colspan="8">Frequency: A – Very Unlikely, B – Unlikely, C – Remote, D – Likely, E – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: D – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical</td></tr>
</table>

APP – PRELIMINARY RISK ANALYSIS							
Area: Evaporation Plant							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
17	Leakage of low or uncontaminated condensate	• Rupture or hole in piping due to: ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump, tank)	• Personal accident • Loss of product • Alteration of air quality	**D**	**II**	**M**	• Chemical recovery areas will have containment walls in its surroundings
18	Leakage of concentrated non condensable gases (CNCG) after the condenser	• Rupture or hole in piping due to: ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump, tank)	• Formation of toxic jet • Personal accident • Alteration of air quality	**D**	**III**	**S**	• Concentrated non-condensable gases (CNCG) will be collected and incinerated in the recovery boiler

APP – PRELIMINARY RISK ANALYSIS

Area: Evaporation Plant

Item	Risk	Possible Causes	Possible Effects	Grade – Freq.	Grade – Sever.	Grade – Risk	Remarks and/or Recommendations
19	Leakage of process methanol to incineration points	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump)	• Formation of puddle which can cause ignition: ✓ Fire in the puddle ✓ Flashfire; ✓ Explosion. • Personal accident • Alteration of air quality	**C**	**III**	**M**	• Piping shall be enveloped • The area will be surrounded by retaining wall
20	Explosion of process methanol storage tank	• Lightning strike over the storage tank • Operational failures in maintenance services (welding) • Failure of the inertization system of the storage tank	• Explosion • Material damage • Personal accident • Alteration of air quality	**C**	**III**	**M**	• Tank will be equipped with Atmospheric Discharge Protection System • Welding services must be performed by highly qualified professionals • Tank inertization should be uninterrupted monitored until the end of maintenance

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

<table>
<tr><th colspan="9">APP – PRELIMINARY RISK ANALYSIS</th></tr>
<tr><td colspan="9">Area: Recovery Boiler</td></tr>
<tr><th rowspan="2">Item</th><th rowspan="2">Risk</th><th rowspan="2">Possible Causes</th><th rowspan="2">Possible Effects</th><th colspan="3">Grade</th><th rowspan="2">Remarks and/or Recommendations</th></tr>
<tr><th>Freq.</th><th>Sever.</th><th>Risk</th></tr>
<tr><td>21</td><td>Explosion of recovery boiler</td><td>• Rupture or hole in piping due to:
✓ Corrosion
✓ Mechanical failure
✓ Operational failure
• Injection of weak liquor (contains lots of water)
• Drag water with the gases
• Failure on recovery boiler protection system</td><td>• Materials damage
• Personal accident</td><td>B</td><td>III</td><td>Mn</td><td>The design and operation of the Recovery Boiler are based on the strictest safety criteria in order to prevent accidents and explosions, which are described below:
• Alternative water supply through turbine driven pump
• Black liquor feed system with redundant refractometers for fuel moisture metering
• Redundant smelt spreaders per nozzles
• Emergency water tank located in the boiler to guarantee the cooling of the nozzles in the event of a lack of electrical energy in the mill
• Dissolving tank provided with a relief system (emergency damper) to relieve possible overpressure
• Emergency dedicated drainage system totally independent of the main control system (DCS)
• Application of special materials in critical areas of the furnace such as curves, air vents, corners
• Application of special materials in critical areas in superheaters
• Adoption of chloride and potassium purge system to maintain black liquor concentrations at levels that guarantee low corrosivity
• BMS (Burner Management Systems) independent of the DCS configured in dedicated PLC with redundancy
• High level of instrumentation to monitor all process variables
• Redundancy in critical safety interlocks
In addition to the above design criteria, the Recovery Boiler design will follow all recommendations of the Black Liquor Recovery Boiler Advisory Committee, a US entity formed in 1961 that establishes procedures and recommendations to increase the safety of recovery boilers, from concept, design, operation phase and maintenance.
The sudden expansion of water will produce an increase in pressure that will deform the boiler structure but without causing an explosion. This type of incident, considering that the furnace will operate at basically atmospheric pressure there is relief at the same time producing serious damage to the boiler but without projection of an explosion. There will be an edge of the boiler called "zip corner", in which there will be rupture and the consequent relief of pressure will occur by it, due to the greater fragility of this part.</td></tr>
</table>

APP – PRELIMINARY RISK ANALYSIS							
Area: Recovery Boiler							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
22	Explosion of electrostatic precipitator	• Excess of carbon monoxide (CO) due to process failure.	• Materials damage • Personal accident	**B**	**II**	**D**	• Pipes with gases that will follow to the precipitator will have a carbon monoxide (CO) detector, which in case of presence of this, will automatically and instantly turn off the precipitator, i.e. the system will be interlocked
23	Explosion of the dissolving tank	• Operational failure causing nozzle clogging • Failure of tank protection system	• Materials damage • Personal accident • Alteration of air quality	**B**	**II**	**D**	• Design, operation, and safety requirements of the dissolving tank follow the recommendations of the Black Liquor Recovery Boiler Committee • Project provides TV camera to monitor the flow of product in the nozzles. In the event of an explosion, the local is restricted to the recovery boiler area, i.e. it is confined • The premises adopted in danger of boiler explosion (water expansion) are valid in this case as well

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Causticizing and Lime Kiln							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
24	Leakage of fuel oil in lime kiln feeding	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve)	• Formation of puddle with possibility of ignition • Alteration of air quality	**D**	**II**	**M**	• The area will be surrounded by retaining wall • Instrumentation / automation system may be interlocked if the operating parameters (pressure, temperature, pressure) change
25	Methanol leakage in lime kiln feeding	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve)	• Formation of puddle with possibility of ignition: ✓ Fire in the puddle ✓ Flashfire ✓ Explosion ✓ Alteration of air quality	**D**	**III**	**S**	• The area will be surrounded by retaining wall • Implementation of signaling systems at the most impactable points • The instrumentation/automation system shall be provided with an interlocking system in the event of changes in operating parameters (pressure, temperature, flow)
26	Explosion of electrostatic precipitator (lime kiln)	• Excess of carbon monoxide (CO) due to process failure	• Materials damage • Personal accident	**B**	**II**	**D**	• Pipes with gases that will follow to the precipitator will have a carbon monoxide (CO) detector, which in case of presence of this, will automatically and instantly turn off the precipitator, i.e. the system will be interlocked

APP – PRELIMINARY RISK ANALYSIS							
Area: Causticizing and Lime Kiln							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
27	Leakage of liquor	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump)	• Personal accident • Loss of product	**D**	**II**	**M**	• Chemical recovery areas will have containment walls around them
28	Contaminated condensate leakage	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump)	• Personal accident • Loss of product	**D**	**II**	**M**	• Chemical recovery areas will have containment walls around them

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Biomass Boiler							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
29	Ignition on biomass silo	• External ignition source	• Fire • Personal accident	**B**	**II**	**D**	• Biomass silo is equipped with a fire-fighting system • Fire will be properly controlled within the area of the Biomass Boiler
30	Explosion of the biomass boiler	• Rupture or hole in the pipe • Failure on boiler protection system	• Materials damage • Personal accident	**B**	**III**	**Mn**	• The design and operation of the Biomass Boiler are based on the strictest safety criteria in order to prevent accidents and explosions, which are described below: ✓ Highly automated and instrumented biomass feed control system with online balance of stable and safe fuel mass for combustion ✓ Adoption of biomass feed through rotary valves to prevent flame return to storage silos ✓ Refractory coating oven to prevent erosion of water pipes in turbulence areas ✓ Application of special materials in critical areas in secondary superheaters (hotter zones) and tertiary superheaters (complete) ✓ BMS (Burner Management Systems) independent of the DCS configured in dedicated PLC with redundancy ✓ High level of instrumentation to allow monitoring of process variables ✓ Redundancy in critical safety interlocks

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Biomass Boiler							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
31	Explosion of electrostatic precipitator	• Excess of carbon monoxide (CO) due to process failure	• Local materials damage • Personal accident	**B**	**II**	**D**	• Pipes with gases that will follow to the precipitator will have a carbon monoxide (CO) detector, which in case of presence of this, will automatically and instantly turn off the precipitator, i.e. the system will be interlocked

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS

Area: Utilities – WTP, BFWT and ETP

Item	Risk	Possible Causes	Possible Effects	Grade Freq.	Grade Sever.	Grade Risk	Remarks and/or Recommendations
32	Leakage of chemicals in WTP, BFWT and ETP	• Rupture or failure of components (valve) • Rupture or hole in the line due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact	• Personal accident • Loss of product • Alteration of soil quality	**D**	**II**	**M**	• The areas of chemical unloading and storage will have containment systems
33	Leakage of lagoons and tanks at the ETP	• Mechanical impact • Rupture or perforation of the waterproofing litter	• Change in soil and groundwater quality	**B**	**II**	**D**	• Where applicable, the tanks shall be constructed of concrete. If excavated, they will have protection with compacted clay and HDPE membrane, as well as having a leakage detection system

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS

Area: Chemicals – Sulphuric Acid (H_2SO_4) Storage

Item	Risk	Possible Causes	Possible Effects	Grade Freq.	Grade Sever.	Grade Risk	Remarks and/or Recommendations
34	Leakage of H_2SO_4 from truck unloading to consumption	• Hose rupture • Hose disconnection • Rupture or hole in the line due to: ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Rupture or failure of components (valve, pump).	• Personal accident • Loss of product • Alteration of soil quality	**D**	**II**	**M**	• Product unloading of the truck will be done in an area with containment, and any effluents sent for treatment • Equipment and lines with sulfuric acid will be stainless steel
35	Unwanted product formation	• Shipping of sulfuric acid to another chemical tank due to operational failure	• For the sodium hydroxide tank: pressure increase in the tank with possibility of tank rupture • For hydrogen peroxide tank: possibility of tank rupture	**A**	**II**	**D**	• Unloading of sulfuric acid will be done by properly trained personnel, with verification of the type of product transported versus the destination tank • Daily schedule of product delivery schedules should be confronted. No product out of this daily list will be received • Density and composition of the product will be controlled prior to unloading

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Chemicals – Sodium Bisulphite ($NaHSO_3$) Storage							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
36	$NaHSO_3$ solution leakage	• Hose rupture • Disconnecting the hose • Rupture or failure of components (valve, pump) • Rupture or hole in the line due to: ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact	• Small-scale SO_2 detachment • Personal accident • Change in soil quality	**D**	**II**	**M**	• Preparation and storage areas will have containment

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Chemicals – Methanol Storage							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
37	Methanol leakage from reception to chlorine dioxide plant	• Hose rupture • Disconnecting the hose • Rupture or failure of components (valve, pump) • Rupture or hole in the line due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact	• Formation of a puddle with the possibility of causing an ignition: ✓ Fire in the puddle ✓ Flashfire ✓ Explosion • Personal accident • Change in air quality	**D**	**III**	**S**	• The truck's product will be unloaded in a containment area, and eventual effluents are sent for treatment
38	Ignition of the methanol vapor phase in the storage tank	• Lightning drop on the storage tank • Operational failures in maintenance services (welding) • Storage tank inertization system failure	• Explosion; • Material damage; • Change in air quality.	**C**	**III**	**M**	• The tank must be equipped with Atmospheric Discharge Protection System • Welding services must be performed by highly qualified professionals. A special order (written) will be required to perform welding work at risk points • The inertization of the tank must be monitored uninterrupted until the end of maintenance

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Chemicals – Hydrogen Peroxide (H_2O_2)							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
39	Leakage of H_2O_2 from truck unloading to consumption on fiber line	• Hose rupture • Disconnecting the hose • Rupture or failure of components (valve, pump) • Rupture or hole in the line due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact	• Personal accident • Loss of product • Alteration of air quality	**D**	**II**	**M**	• Product unloading of the truck will be done in an area with containment, and any effluents sent for treatment • H_2O_2 storage tank will be equipped with a containment basin
40	Decomposition of H_2O_2	• Product heating (by external fire) • Return of the product due to operational failure • Instrumentation failure • Presence of contaminant in dilution water	• Possibility of tank explosion • Change in air quality	**C**	**II**	**Mn**	• A double-closing system and a flow meter indicating the reverse flow will be installed • Measure the conductivity of the water to be used in the dilution of hydrogen peroxide
41	Explosion of H_2O_2 storage tank	• Product contamination • Product heating (external fire)	• Material damage • Change in air quality	**B**	**II**	**D**	• Instrumentation / automation system may be provided with interlocking in case of changes in operating parameters (pressure, temperature, flow) • The storage tanks should have a pressure relief system, with alarm indication in case of high pressure

APP – PRELIMINARY RISK ANALYSIS							
Area: Chemicals – Hydrogen Peroxide (H_2O_2)							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
42	Unwanted product formation	• Shipping of H_2O_2 to another chemical tank due to operational failure	• For the sodium hydroxide tank: pressure increase in the tank with possibility of tank rupture • For sulfuric acid tank: possibility of tank rupture	**A**	**II**	**D**	• Unloading of hydrogen peroxide will be done by properly trained personnel, with verification of the type of product transported versus the destination tank • The daily schedule of product delivery schedules should be confronted. No product out of this daily list will be received / unloaded • The density and composition of the product will be controlled prior to unloading • The odor will be controlled in the discharge of the product

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Chemicals – Sodium Hydroxide (NaOH)							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
43	Leakage of NaOH from truck unloading to the pump	• Hose rupture • Disconnecting the hose • Rupture or failure of components (valve, pump) • Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact	• Personal accident • Loss of product • Alteration of air quality	**D**	**II**	**M**	• Product unloading of the truck will be done in an area with containment, and any effluents sent for treatment
44	Unwanted product formation	• Shipping of sodium hydroxide to another chemical tank due to operational failure	• For the hydrogen peroxide tank: explosion or tank rupture • For sulfuric acid tank: possibility of tank rupture	**A**	**II**	**D**	• Unloading of sodium hydroxide will be done by properly trained personnel, with verification of the type of product transported versus the destination tank • The daily schedule of product delivery schedules should be confronted. No product out of this daily list will be received • The density and composition of the product will be controlled prior to unloading

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Chemicals – Sodium chlorate ($NaClO_3$) Storage							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
45	Leakage of the $NaClO_3$ solution	• Rupture or failure of components (valve, pump) • Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact	• Personal accident • Loss of product • Alteration of soil quality	**D**	**II**	**M**	• The area must be equipped with a leak containment system

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS

Area: Chemicals – Chlorine Dioxide

Item	Risk	Possible Causes	Possible Effects	Grade Freq.	Grade Sever.	Grade Risk	Remarks and/or Recommendations
46	Reactor relief cover opening	• Overpressure in the reactor due to: ✓ Strong or violent decomposition in the reactor due to vacuum loss ✓ Hydrogen peroxide/methanol overdose with reactor vacuum ✓ Presence of contaminants in raw materials or water	• Small chlorine emission • Change in air quality	**D**	**II**	**M**	• The reactor is designed to stand violent decomposition • Safety interlocking: total stop and activation of emergency showers • Opening the relief cover over the reactor assigned to the roof, restricting the area • Vacuum loss warning light
47	Drain relief cap opening	• Overpressure in the drainage tank is due to: ✓ Continuous chemical feed in the absence of drag air ✓ Strong or violent decomposition in the reactor due to vacuum loss ✓ Hydrogen peroxide/methanol overdose with reactor vacuum ✓ Presence of contaminants in raw materials or water	• Chlorine dioxide release • Change in air quality	**D**	**II**	**M**	• The discharge tank is designed to stand a violent decomposition, equipped with a relief cover • The manual contains instructions for draining the reactor • Drag air will be provided to the scrubber
48	Leakage of reactor or drainage tank	• Rupture or hole in piping due to: ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Pump failure • Drainage failure	• Change in soil quality • Change in air quality • Personal accident	**D**	**II**	**M**	• Most chlorine dioxide tubes will be titanium • Mechanical protection is provided for small pipes • Safety interlock is provided with general stop (in the reactor)

APP – PRELIMINARY RISK ANALYSIS

Area: Chemicals – Chlorine Dioxide

Item	Risk	Possible Causes	Possible Effects	Grade: Freq.	Grade: Sever.	Grade: Risk	Remarks and/or Recommendations
49	Leakage of ClO_2 solution from absorption tower to bleaching plant	• Rupture or failure of components (valve, pump) • Rupture or hole in the line due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact	• Gas is released from the solution and broken down into chlorine and oxygen • Change in air quality	**D**	**III**	**S**	• ClO_2 storage tank will have containment walls • A separate vacuum switch will be installed for each tank
50	Opening the relief cover on the ClO_2 storage tank	• ClO_2 decomposition in the storage tank due to a very high concentration of ClO_2, no air current (upper tank ventilation) and a very high temperature or external heating • Very low pressure (empty)	• Gas is released from the solution and broken down into chlorine and oxygen • Change in air quality	**C**	**II**	**Mn**	• A separate vacuum switch will be installed for each tank
51	ClO_2 storage tank overflow	• Overload and failure of level transmitters.	• Release of ClO_2 solution$_2$ • Change in air quality	**B**	**III**	**Mn**	• The ClO_2 storage tank shall be provided with a leak containment vessel

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: Chemicals – Oxygen production (O_2)							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			**Remarks and/or Recommendations**
				Freq.	**Sever.**	**Risk**	
52	Leakage of O_2	• Rupture or hole in piping due to: ✓ Corrosion ✓ Mechanical failure ✓ Operational failure ✓ Mechanical impact • Component rupture or failure (valve, pump, compressor, vaporizer)	• Personal accident	**D**	**I**	**Mn**	• The instrumentation/automation system shall be interlocked in case of changes in operating parameters (pressure, temperature)

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

APP – PRELIMINARY RISK ANALYSIS							
Area: General							
Item	**Risk**	**Possible Causes**	**Possible Effects**	**Grade**			
				Freq.	**Sever.**	**Risk**	
53	Chemical leakage during transport within the Industrial Unit	• Collision of a truck causing a tank rupture	• Material damage • Change in surface water quality • Change in air quality	**D**	**II**	**M**	• Combat, training and retraining brigade training • Direction of street drains with the highest risk potential for ETP • Implementation of signaling (speed limit, etc.)

Frequency: **A** – Very Unlikely, B – Unlikely, C – Remote, D – Likely, **E** – Frequent
Severity: I – Negligible, II – Marginal, III – Critical, IV – Catastrophic
Risk: **D** – Negligible, Mn – Minor, M – Moderate, S – Serious, C – Critical

ANNEX IV

SOUND PRESSURE LEVEL MODELLING

CSI Ingenieros

Paracel

Sound Pressure Level (SPL) Modeling

PARACEL

May 2020

This document has been edited to be printed double face. Blank sheets have been interposed to respect the numbering of the edit style.

Index

1. Introduction 3

1.1.Objective 3

1.2.Scope 3

2. Modeling Methodology 4

2.1.Scenarios to model 4

2.2.Modeling software 4

2.3.Entry data to model 5

3. Results 8

4. Results discussion 17

5. Conclusions 21

6. Intervening technicians 22

ANNEX I Buildings Tanks and Fountains

Figure index

Figure 2-1 Relayed receivers 6
Figure 2-2 Wind Rose for PARACEL pulp mill 7
Figure 4–1 Perception of sound differences in dBA 19

Sheet index

Sheet 3-1 Noise Map - Scenario 1 11
Sheet 3-2 Noise Map - Scenario 2 12
Sheet 3-3 Noise Map - Scenario 3 13
Sheet 3-4 Noise Map - Scenario 4 14
Sheet 3-5 Noise Map - Scenario 5 15
Sheet 3-6 Noise Map - Scenario 6 16

Table index

Table 3–1 SPL modeled for scenarios 1 to 4 – Incremental contribution of pulp mill 9
Table 3–2 SPL modeled for scenarios 5 and 6 - Mill barrier assessment 10
Table 3–3 SPL modeled for scenarios 1 to 4 - Baseline Monitoring Points 10
Table 4–1 Measured baseline values at evaluated receptors 17
Table 4–2 Resulting SPL at baseline monitoring points for the future situation 18
Table 4–3 Contribution of the pulp mill to the records of the base situation 18
Table 4–4 Mill contribution to each sensitive receptor considering LB 20

1. Introduction

1.1. Objective

The objective of the report is to present the modelling of sound pressure levels in the environment of the future pulp mill of PARACEL, to be installed on the Paraguay River north of the city of Concepción, in the department of the same name of the Republic of Paraguay.

The modeling allows to characterize the sound environment by studying the propagation of noise generated by the operation of the mill and the baseline data available for the area, determining the incremental contribution of the project.

1.2.Scope

The characterization of the sound environment in the pulp mill is carried out by mathematical modeling of noise propagation, considering the available information of the equipment to be installed, the estimated operational dynamics, the baseline data generated by PARACEL in April 2020 and the receivers defined by the company.

The information integrated into the model is provided by PARACEL, and is supplemented if necessary with basic information from the consultancy. This supplementary information derives from experiences in similar work with pulp mills in Uruguay.

The characterization of the sound environment of the pulp mill is quantified by determining the sound pressure levels in particular receivers. In addition, noise maps are made from the model for the different scenarios considered.

In all cases, the sound pressure levels modeled with the applicable reference standards, as determined by the regulatory framework of reference constituted by Law No. 1.100/97 and the current standards of the Republic of Paraguay that apply, are compared.

2. Modeling methodology

2.1. Scenarios to be modeled

The basic situation for the different scenarios to be modeled considers the most conservative operational dynamics –*worst case scenario*– where the main sources of noise operates simultaneously and the internal traffic of vehicles is maximum (light, heavy vehicles and pulp bullet transport).

Based on the most conservative operational dynamics, different modeling scenarios were defined:

- Scenario 1: Operation of all equipment in the mill, maximum internal vehicle travel and main access to the mill **option A** (maximum flow of trucks and light vehicles).
- Scenario 2: Operation of all equipment in the mill, maximum internal vehicle travel and main access to the option **B** mill (maximum flow of trucks and light vehicles).
- Scenario 3: Operation of all equipment in the mill, maximum internal vehicle travel, backup access for light vehicles (maximum flow) and main access **option A** for heavy vehicles (maximum flow).
- Scenario 4: Operation of all equipment in the mill, maximum internal vehicle travel, backup access for light vehicles (maximum flow) and main access **option B** for heavy vehicles (maximum flow).

Finally, two additional scenarios were modeled to assess the effectiveness of including a mill barrier as a mitigation measure, according to the following detail:

- Scenario 5: Operation of all equipment in mill and maximum internal vehicle travel.
- Scenario 6: Operation of all equipment in the mill, maximum internal vehicle travel and presence of **mill barrier**.

2.2.Modeling software

DataKustik GmbH's CadnaA software (version 2020) was used for the modeling of Sound Pressure Levels (hereinafter SPL). This software is based on SPL numerical calculation tools across different mathematical noise propagation models.

This particular study integrates the ISO 9613-based calculation for the modelling of industrial complexes and the French calculation model NPMB Routes 96 for linear sources (roads, roads and other vehicle roads). Both calculation methodologies are internationally recognized for SPL modeling.

The calculation software allows to incorporate georeferenced elements for the elaboration of the model, such as the contours of the terrain, the emitting and receiver sources with their respective heights, routes and existing neighborhood roads, forested areas, etc. The model considers attenuations by geometric divergence[1] taking into account terrain, attenuation by atmospheric absorption[2], attenuation by effect of the soil, attenuations due to the presence of barriers (including buildings, structures and topography), weather corrections and wave reflections. The criteria for the determination of attenuation factors were based on the recommendations of ISO 9613 and NPMB Routes 96.

As for the barriers specifically, insulation barriers can be incorporated with their respective characteristics, existing and/or projected mill barriers, giving adequate height and thickness.

In the case of the modeling of the PARACEL pulp mill, where it is necessary to combine fixed sources and sources linked to transit, CadnaA software is very useful since it allows to apply calculation models or complementary reference standards in the same run, applying the most suitable model for each type of source (point, linear and surface). Another important advantage of the program is its high calculation speed, even for large-scale projects.

As a result of modeling, within the calculation configuration adopted, the software returns estimated SPL values on the evaluated receivers, as well as a noise map for the entire evaluation zone (calculation grid). Noise maps can be represented as isophone lines or as noise areas.

It should also be noted that the outputs of the calculation model are exportable to specific software of geographical information, such as *Google Earth,* a feature otherwise valuable to visualize in a simple and practical way the result of the model, exportable in addition to formats shape, dwg, dxf, among others, allowing the editing and management of *outputs* with versatility.

2.3.Data entry to the model

The quality of the input data to the model is key to ensuring accurate results, which interpret the modeled scenarios as realistically as possible.

First the physical model of the mill is built, which was realized incorporating the general *Layout* of the PARACEL pulp mill into the software (according to "General *Mill Site Layout"),* assigning names and heights to all buildings, structures and tanks. Annex I presents the detail of the buildings considered with their characteristics.

Second, the receivers are defined. The receivers that were incorporated correspond to 27 sensitive homes located in the closure of the mill, whose identification and location was provided by PARACEL. Four points were also incorporated, corresponding to monitoring sites where SPL baseline measurements were made in April 2020.

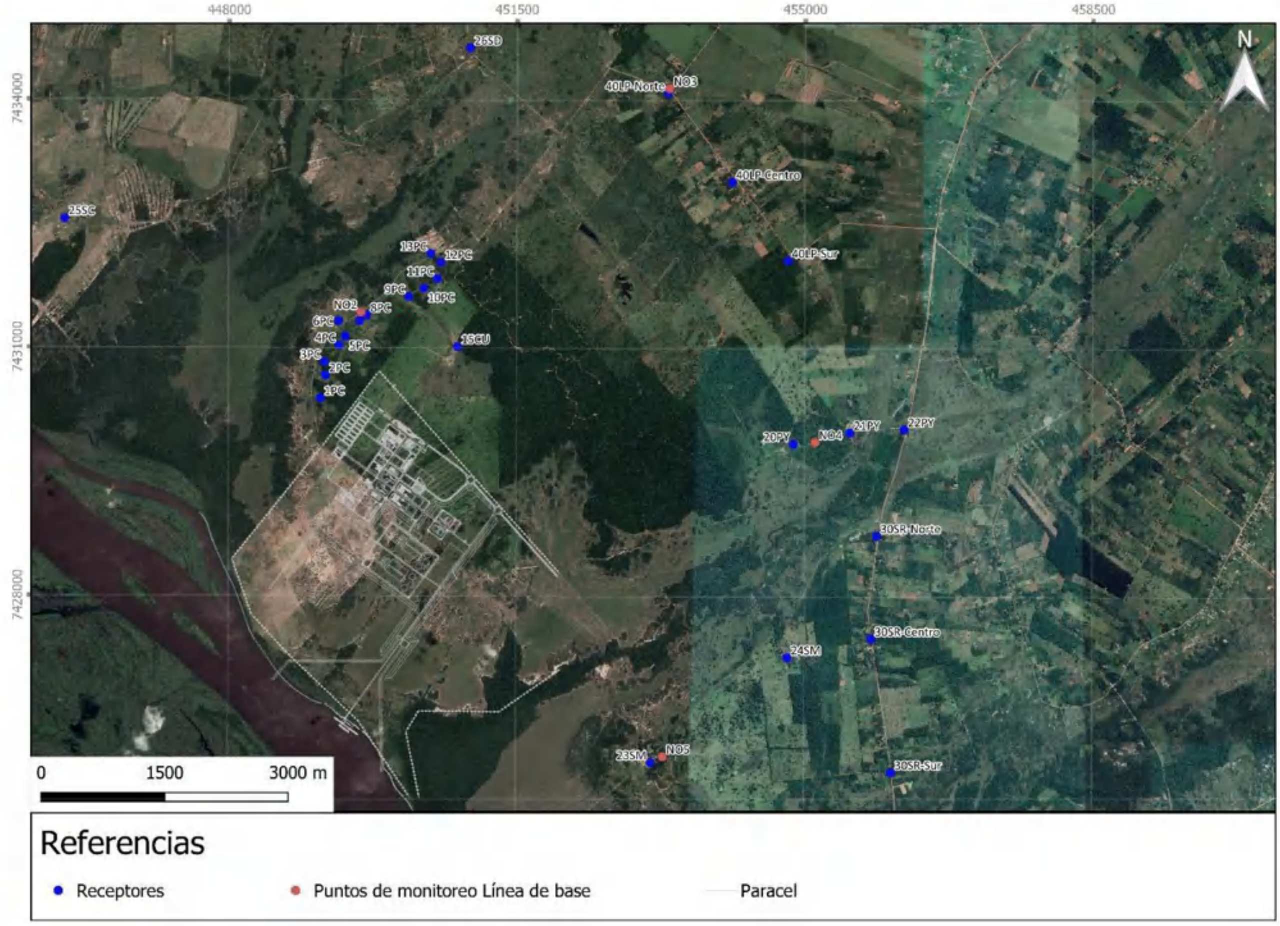
The following figure shows the location of the receivers considered and the points monitored during baseline definition.

---

[1] A_{div}s 20 log(d/d_0) + 11 dB

[2] In CadnaA for the standard frequency of 500 Hz the attenuation by atmospheric absorption A_{atm}x 0.002 dB/m.

Figure 2-1 Relayed receivers



All receivers were assigned a height of 1.60 m, a value commonly defined as a person's average height.

Also, once the physical model of the pulp mill has been developed and the receivers are located, the mill's noise-emitting sources are incorporated, located georeferenced and assigning them the corresponding height. Three types of sources are considered depending on their emission characteristics:

- Linear sources: represent internal streets and access to mill where vehicles circulate.
- Surface sources: represent the emission of sources within buildings.
- Point sources: represent the emission of equipment located outdoors.

The sources under consideration and the operational assumptions considered in some particular cases are detailed in Annex I.

The configuration of the calculation was determined so that in each receiver were considered the sources located within a radius of 10 km, so as to contemplate all the sources of the mill in each case.

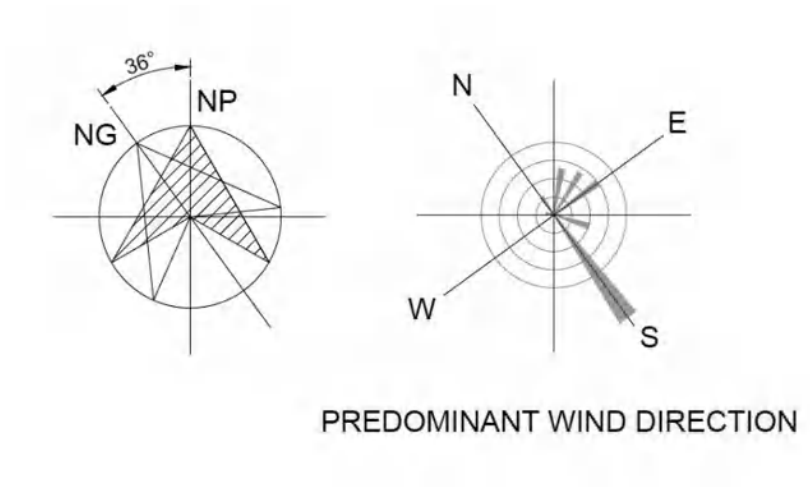
For the absorption of the land was considered a factor G=1 since the majority of the propagation area corresponds to porous land, areas covered with grass, trees and / or vegetation, taking into account that even within the pulp mill there are green areas. The buildings were taken in all cases as reflective surfaces (G=0). The general reflection order of the modeling was set to 1^{st} order.

As mentioned earlier, the base situation considered corresponds to the most conservative operational dynamic or *worst case scenario.* This means considering that all broadcast sources are operational 24 hours simultaneously.

For the mesh calculation, which determines the noise map, a grid size of 10 m x 10 m and a receiver height of 1.60 m was selected.

The weather correction was performed with wind data provided by PARACEL, according to the available wind rose, presented in the following Figure.

Figure 2-2 Wind Rose for PARACEL Pulp mill



3. Results

This chapter presents the results obtained for the various modeled scenarios, noise maps, and estimated emission values on the evaluated receivers. The emission values are represented as A-weighted equivalent continuous SPL, a parameter that is noted as L_{Aeq}.

Table 3-1 presents the estimated L_{Aeq} values for incremental input derived only from the operation of the pulp mill under the conditions described above for scenarios 1 to 4.

Table 3-2 presents the estimated L_{Aeq} values for incremental input derived only from the operation of the pulp mill under the conditions described above for scenarios 5 and 6, where the application of a mill barrier as a mitigation measure is evaluated.

Finally, Table 3-3 presents the estimated L_{Aeq} values that would be recorded at the various monitoring points evaluated on the baseline, in order to be able to make a comparative assessment with the baseline values defined in April 2020.

The generated noise maps are presented as graphical figures, according to the following name:

- Sheet 3–1 Noise Map – Scenario 1.
- Sheet 3–2 Noise Map – Scenario 2.
- Sheet 3–1 Noise Map – Scenario 3.
- Sheet 3–2 Noise Map – Scenario 4.
- Sheet 3–1 Noise Map – Scenario 5.
- Sheet 3–2 Noise Map – Scenario 6.

Table 3–1 SPL modeled for scenarios 1 to 4 - Incremental contribution of pulp mill

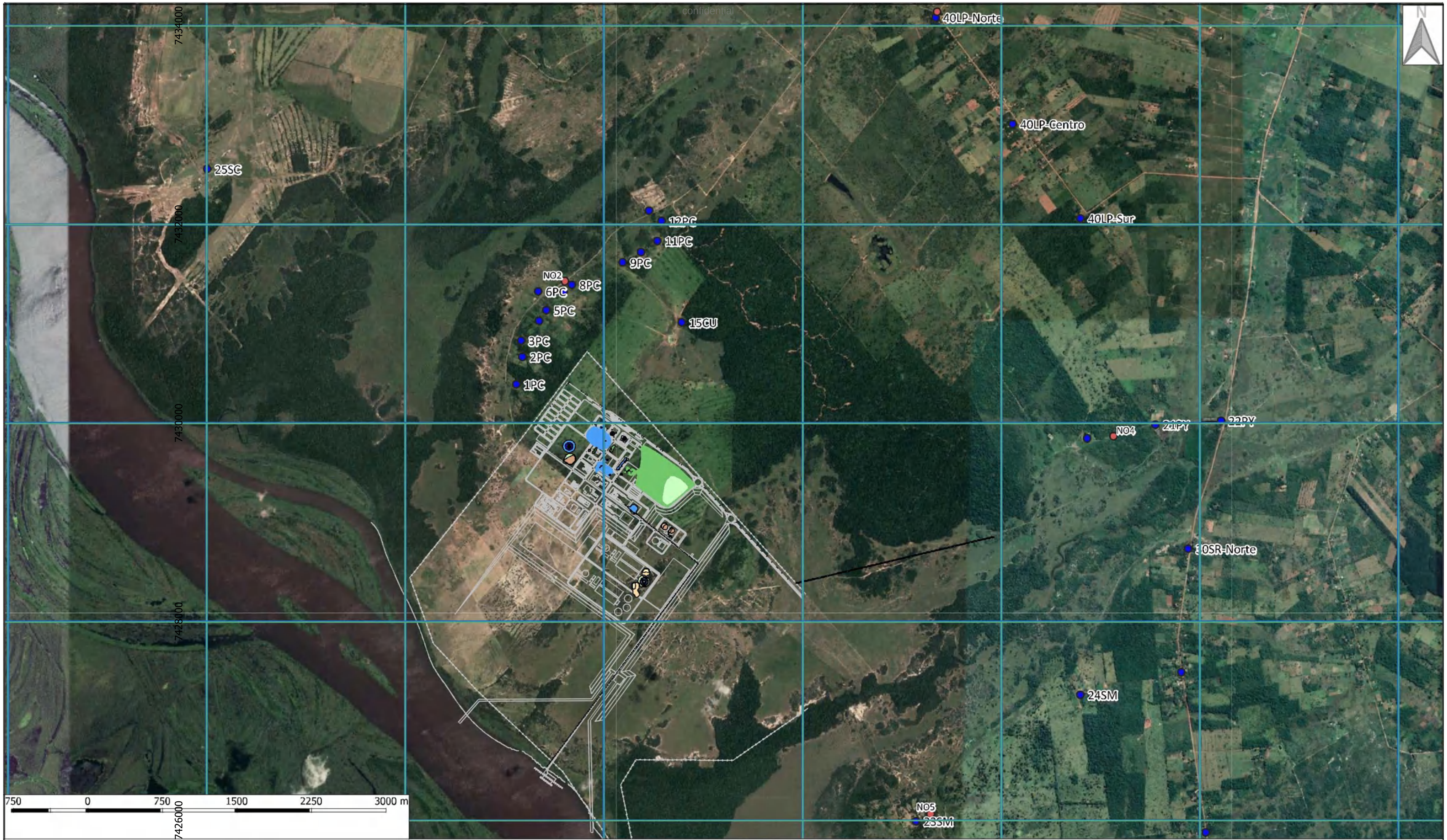
Receiver	Scenario 1 L_{Aeq} (dBA)	Scenario 2 L_{Aeq} (dBA)	Scenario 3 L_{Aeq} (dBA)	Scenario 4 L_{Aeq} (dBA)
1PC	45.3	45.3	45.3	45.3
2PC	42.9	42.9	42.9	42.9
3PC	41.3	41.3	41.4	41.4
4PC	40.3	40.3	40.3	40.3
5PC	39.7	39.7	39.7	39.7
6PC	37.7	37.7	37.8	37.8
7PC	38.5	38.5	38.7	38.7
8PC	37.9	37.9	38.2	38.2
9PC	34.7	34.7	36.2	36.2
10PC	32.3	32.3	35.9	35.9
11PC	28.6	28.6	36.4	36.4
12PC	20.5	20.5	32.7	32.7
13PC	20.0	20.0	29.2	29.2
15CU	38.9	38.9	39.1	39.1
20PY	35.0	< 15	34.6	< 15
21PY	41.5	< 15	41.1	< 15
22PY	61.8	< 15	61.4	< 15
23SM	< 15	31.5	< 15	31.1
24SM	21.3	26.9	20.9	26.5
25SC	< 15	< 15	< 15	< 15
26SD	< 15	< 15	16.0	16.0
30SR-Center	< 15	20.3	< 15	19.9
30SR-North	28.3	< 15	27.9	< 15
30SR-South	< 15	50.9	< 15	50.5
40LP-Center	< 15	< 15	38.1	38.1
40LP-North	< 15	< 15	41.2	41.2
40LP-South	< 15	< 15	35.7	35.7

Table 3–2 SPL modeled for scenarios 5 and 6 - Mill barrier assessment

Receiver	Esc. 5 L_{Aeq} (dBA) No mill barrier	Esc. 6 L_{Aeq} (dBA) With mill barrier	Receiver	Esc. 5 L_{Aeq} (dBA) No mill barrier	Esc. 6 L_{Aeq} (dBA) With mill barrier
1PC	45.3	45.3	20PY	< 15	< 15
2PC	42.9	42.9	21PY	< 15	< 15
3PC	41.3	41.3	22PY	< 15	< 15
4PC	40.3	40.3	23SM	< 15	< 15
5PC	39.7	39.7	24SM	< 15	< 15
6PC	37.7	37.7	25SC	< 15	< 15
7PC	38.5	38.5	26SD	< 15	< 15
8PC	37.9	37.9	30SR-Center	< 15	< 15
9PC	34.7	34.7	30SR-North	< 15	< 15
10PC	32.3	32.3	30SR-South	< 15	< 15
11PC	28.6	28.6	40LP-Center	< 15	< 15
12PC	20.5	20.5	40LP-North	< 15	< 15
13PC	20.0	20.0	40LP-South	< 15	< 15
15CU	38.9	38.9			

Table 3–3 SPL modeled for Scenarios 1 to 4 - Baseline Monitoring Points

Receiver	Scenario 1 L_{Aeq} (dBA)	Scenario 2 L_{Aeq} (dBA)	Scenario 3 L_{Aeq} (dBA)	Scenario 4 L_{Aeq} (dBA)
NO2	29.3	29.3	29.0	29.9
NO3	< 15	< 15	47.2	47.2
NO4	34.6	< 15	34.3	< 15
NO5	< 15	30.9	< 15	30.5



LOCATION MAP

Legend

- Receptors
- Receptors Baseline
- Paracel

Scenario 1

- <= a 30.0 dBA
- 30.0 - 35.0 dBA
- 35.0 - 40.0 dBA
- 40.0 - 45.0 dBA
- 45.0 - 50.0 dBA
- 50.0 - 55.0 dBA
- 55.0 - 60.0 dBA
- 60.0 - 65.0 dBA
- 65.0 - 70.0 dBA
- 70.0 - 75.0 dBA
- 75.0 - 80.0 dBA
- 80.0 - 85.0 dBA

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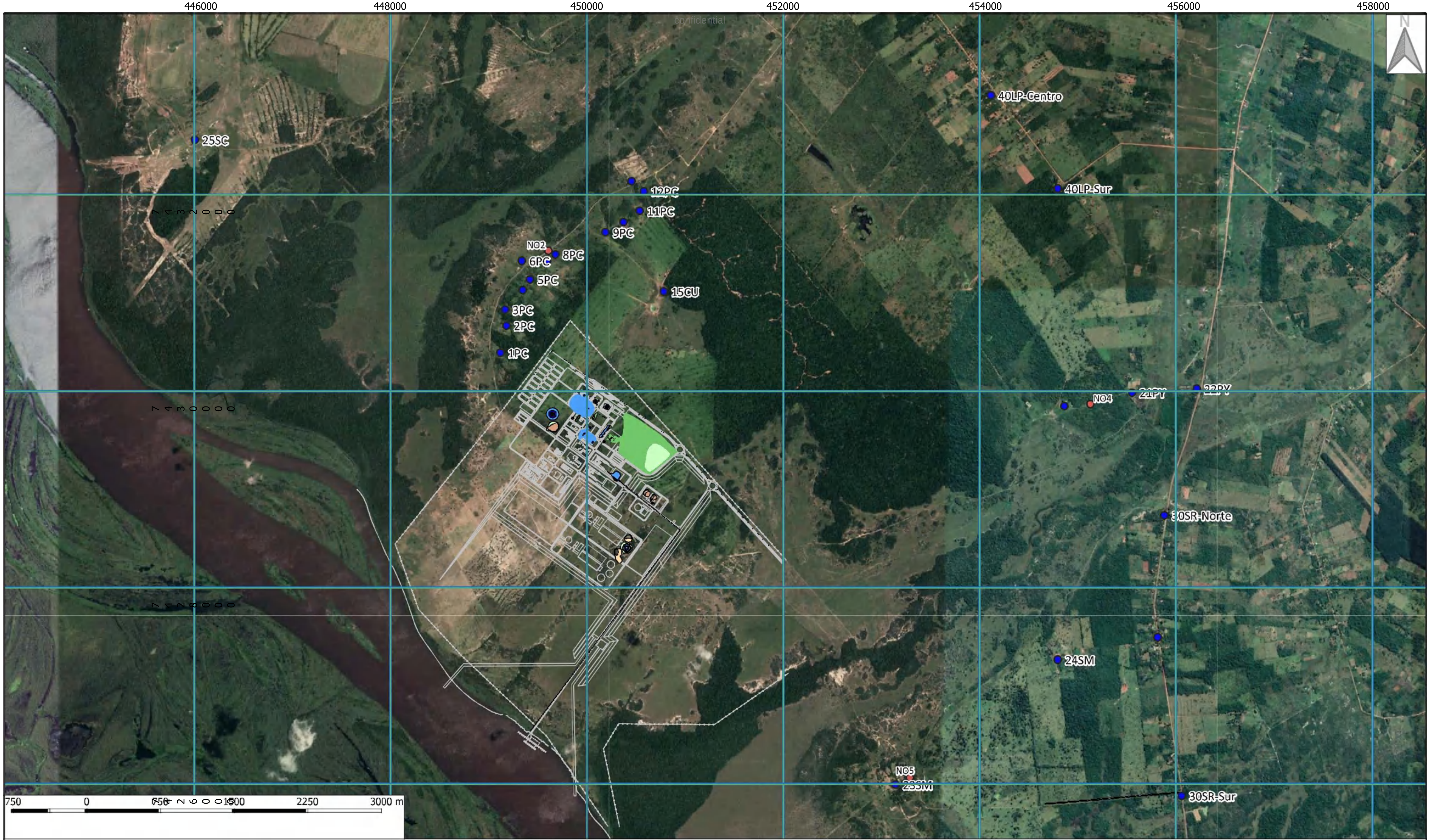
Noise modeling PARACEL

NPL MAP
SCENARIO 1

NUMBER
4-1



LOCATION MAP

Legend

- Receptors
- Receptors Baseline
- Paracel

Scenario 2

<= a 30.0 dBA	55.0 - 60.0 dBA
30.0 - 35.0 dBA	60.0 - 65.0 dBA
35.0 - 40.0 dBA	65.0 - 70.0 dBA
40.0 - 45.0 dBA	70.0 - 75.0 dBA
45.0 - 50.0 dBA	75.0 - 80.0 dBA
50.0 - 55.0 dBA	80.0 - 85.0 dBA

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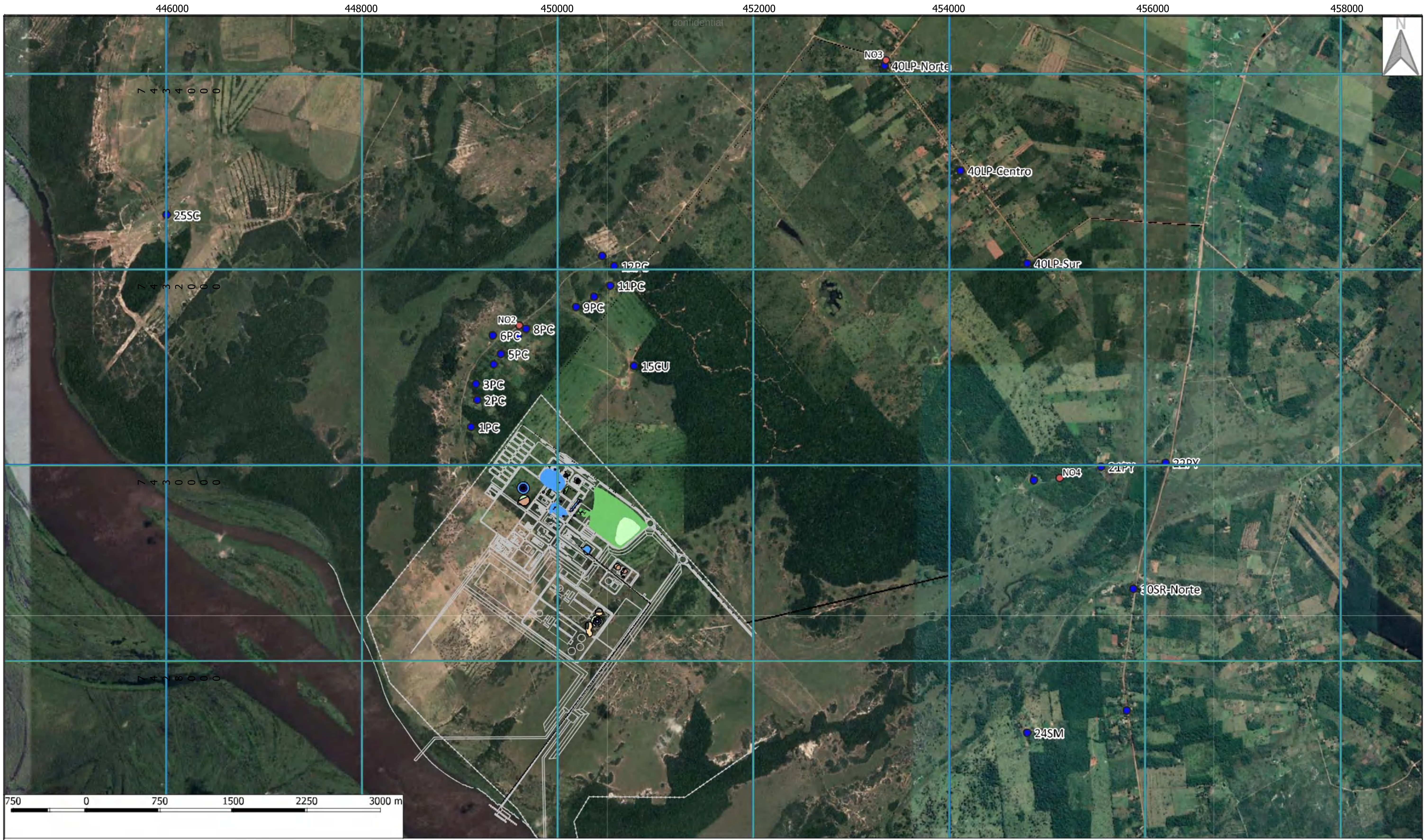
Noise modeling PARACEL

NPL MAP
SCENARIO 2

NUMBER
4-2



LOCATION MAP

Legend

- Receptors
- Receptors Baseline
- Paracel

Scenario 3

- <= a 30.0 dBA
- 30.0 - 35.0 dBA
- 35.0 - 40.0 dBA
- 40.0 - 45.0 dBA
- 45.0 - 50.0 dBA
- 50.0 - 55.0 dBA
- 55.0 - 60.0 dBA
- 60.0 - 65.0 dBA
- 65.0 - 70.0 dBA
- 70.0 - 75.0 dBA
- 75.0 - 80.0 dBA
- 80.0 - 85.0 dBA

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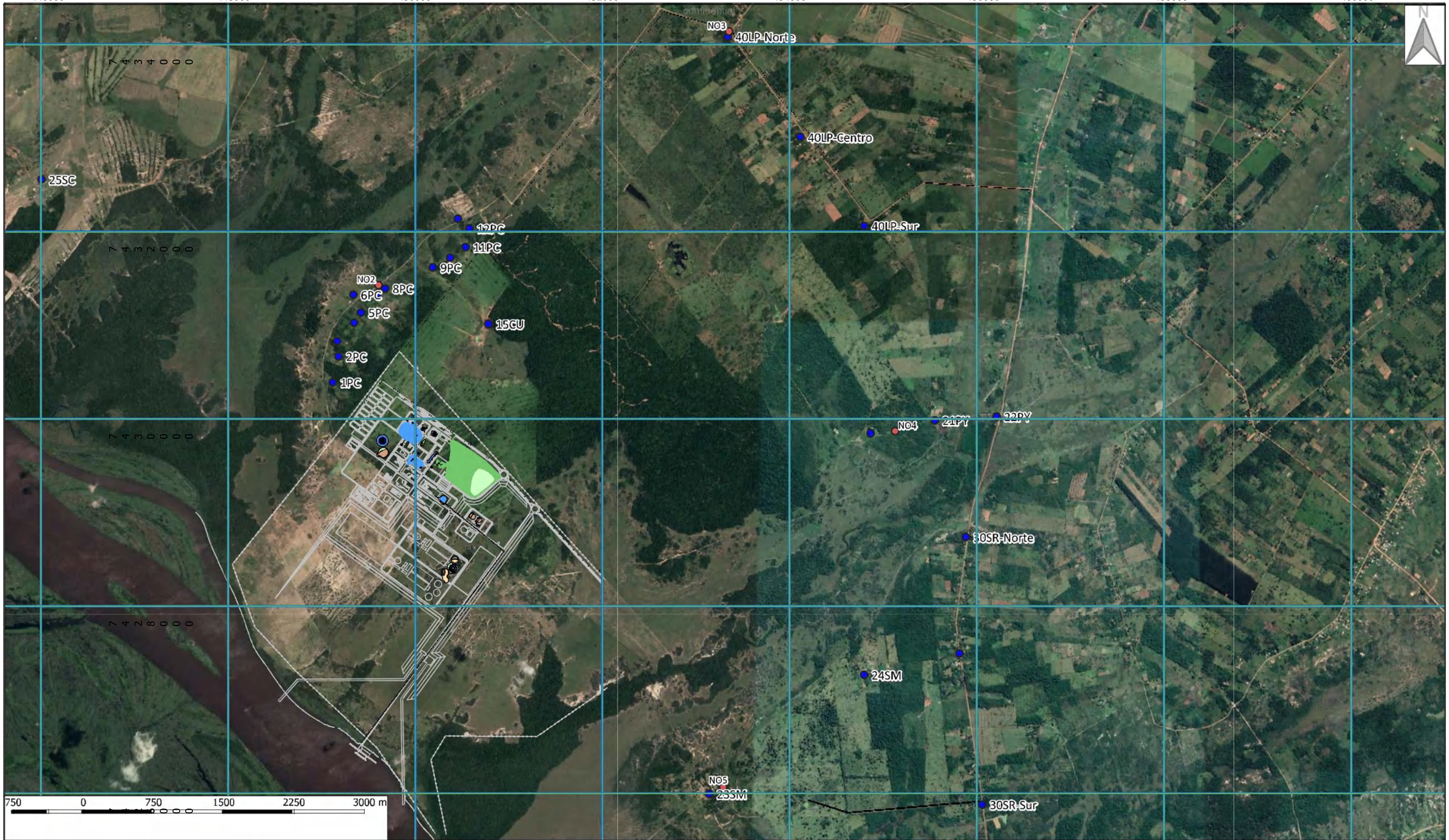
Noise modeling PARACEL

NPL MAP
SCENARIO 3

NUMBER
4-3



LOCATION MAP

Legend

- Receptors
- Receptors Baseline
- Paracel

Scenario 4

- <= a 30.0 dBA
- 30.0 - 35.0 dBA
- 35.0 - 40.0 dBA
- 40.0 - 45.0 dBA
- 45.0 - 50.0 dBA
- 50.0 - 55.0 dBA
- 55.0 - 60.0 dBA
- 60.0 - 65.0 dBA
- 65.0 - 70.0 dBA
- 70.0 - 75.0 dBA
- 75.0 - 80.0 dBA
- 80.0 - 85.0 dBA

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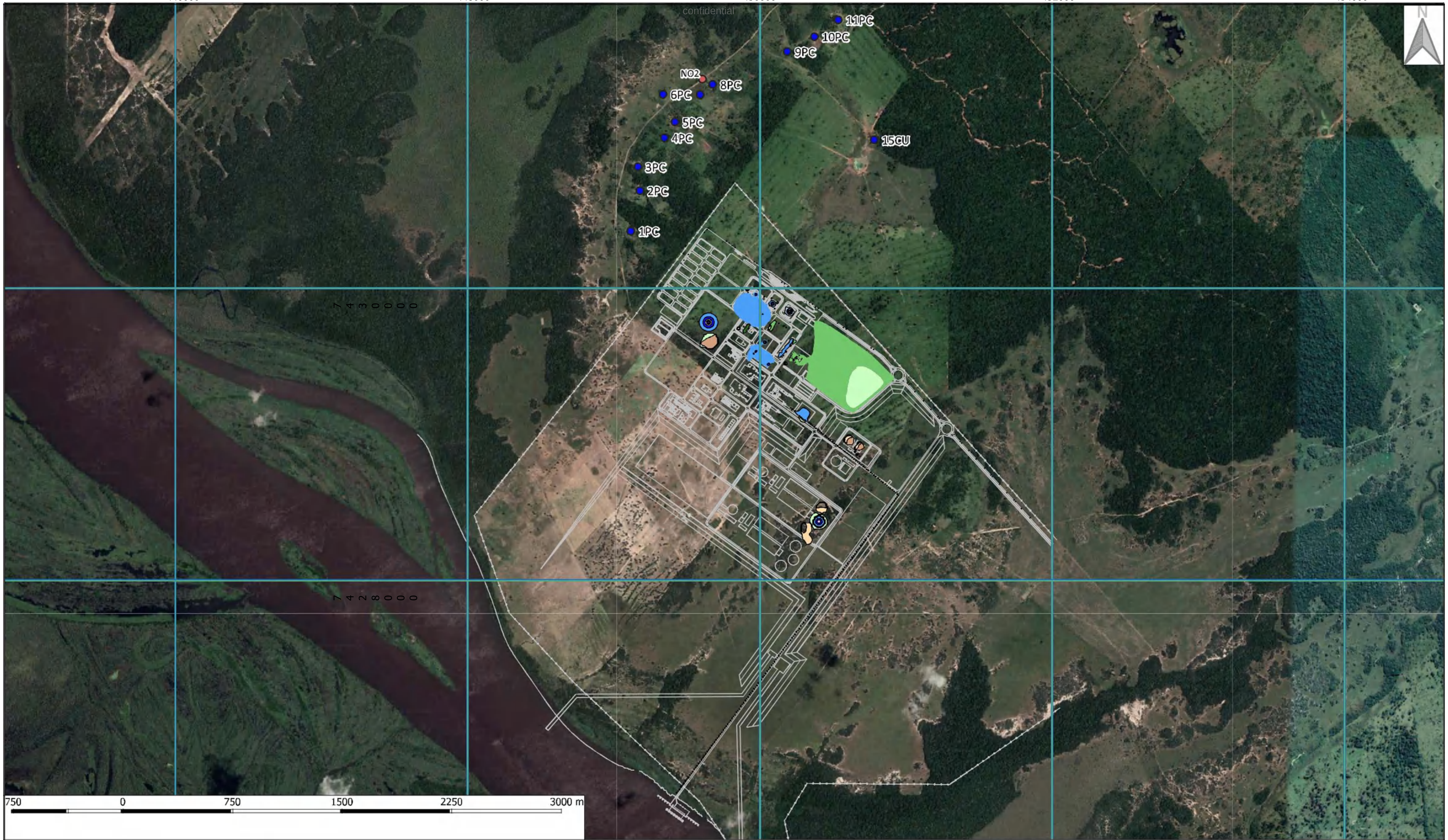
Noise modeling PARACEL

NPL MAP
SCENARIO 4

NUMBER
4-4



LOCATION MAP

Legend

- Receptors
- Receptors Baseline
- Paracel

Scenario 5

- <= a 30.0 dBA
- 30.0 - 35.0 dBA
- 35.0 - 40.0 dBA
- 40.0 - 45.0 dBA
- 45.0 - 50.0 dBA
- 50.0 - 55.0 dBA
- 55.0 - 60.0 dBA
- 60.0 - 65.0 dBA
- 65.0 - 70.0 dBA
- 70.0 - 75.0 dBA
- 75.0 - 80.0 dBA
- 80.0 - 85.0 dBA

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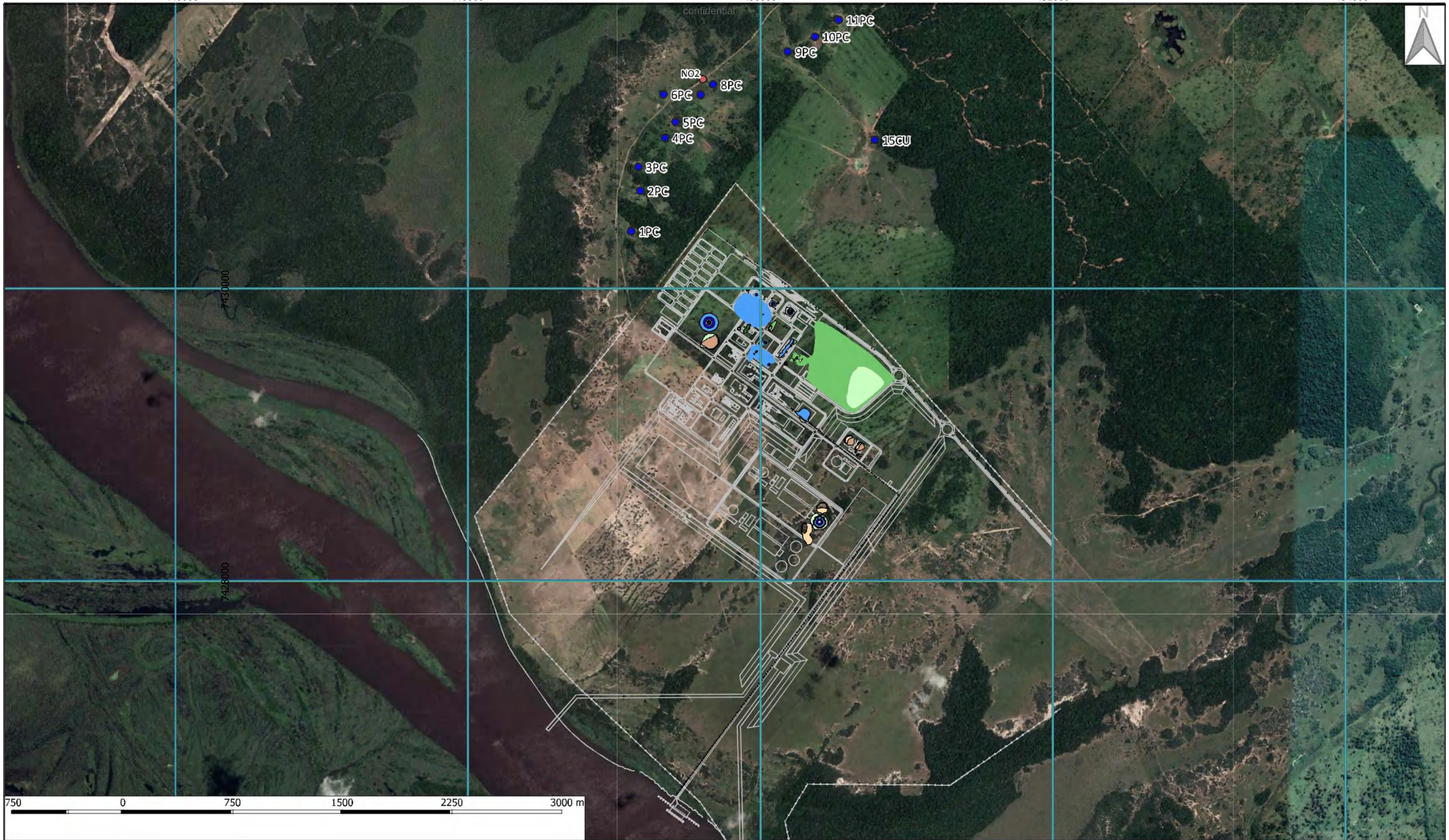
Noise modeling PARACEL

NPL MAP

SCENARIO 5 - SIN BARRERA VEGETAL

NUMBER

4-5



LOCATION MAP

Legend

- Receptors
- Receptors Baseline
- Paracel
- Barrera Vegetal

Scenario 6

<= a 30.0 dBA	60.0 - 65.0 dBA
30.0 - 35.0 dBA	65.0 - 70.0 dBA
35.0 - 40.0 dBA	70.0 - 75.0 dBA
40.0 - 45.0 dBA	75.0 - 80.0 dBA
45.0 - 50.0 dBA	80.0 - 85.0 dBA
50.0 - 55.0 dBA	

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Noise modeling PARACEL

NPL MAP

SCENARIO 6 - CON BARRERA VEGETAL

NUMBER

4-6

4. Discussion of results

This chapter presents the analysis and discussion of SPL submission results presented in the previous chapter. This results analysis is performed with three approaches.

A) Compare baseline SPL values recorded in April 2020 at four points, with inputs from the future mill (intake values presented in Table 3-3, model result).

B) Compare the resulting theoretical SPL values on the evaluated receivers, taking into account the mill input (Table 3-1) and the baseline value measured at the nearest station with the applicable standards of reference standards.

C) Evaluation of mill barrier as a mitigation measure.

Regarding the first point of the discussion of the results, the baseline campaign records provided by PARACEL for measurement points NO2, NO3, NO4 and NO5 are presented below.

Table 4–1 Measured baseline values at evaluated receptors

Point of view Monitoring	Period of Measurement	SPL limit value according to Law 1100/97 (dBA)		L_{Aeq} (dBA) Records*
		Mixed area	Industrial area	
NO2	Day	70	75	50.7
	Night	55	60	38.8
NO3	Day	70	75	43.1
	Night	55	60	50.2
NO4	Day	70	75	34.5
	Night	55	60	35.9
NO5	Day	70	75	43.5
	Night	55	60	46.9

*value without pulp mill activity

To obtain the SPL values that would be recorded at each of the above points when the PARACEL pulp mill is operational, the baseline records (Table 4-1) must be sued logarithmically with the values obtained from the CadnaA model (Table 3-3). It is important to note that the sum of SPL is not algebraic under any circumstances, but is always logarithmic.

Table 4-2 presents the results of the addition of baseline SPL and modeled SPL, as well as their comparison with the adopted standards of reference standards. Values that meet the reference standards and orange values that exceed them are marked in green.

Table 4–2 Resulting SPL at baseline monitoring points for the future situation

Station	Period	Scenario 1 L_{Aeq} (dBA)	Scenario 2 L_{Aeq} (dBA)	Scenario 3 L_{Aeq} (dBA)	Scenario 4 L_{Aeq} (dBA)
NO2	Day	50.7	50.7	50.7	50.7
	Night	39.3	39.3	39.2	39.3
NO3	Day	43.1	43.1	48.6	48.6
	Night	50.2	50.2	52.0	52.0
NO4	Day	37.6	34.5	37.4	34.5
	Night	38.3	35.9	38.2	35.9
NO5	Day	43.5	43.7	43.5	43.7
	Night	46.9	47.0	46.9	47.0

According to the results presented in the Table above, the acoustic objectives set out in Law No. 1100/97 would be met at all monitored points and for all defined operating scenarios of the PARACEL pulp mill.

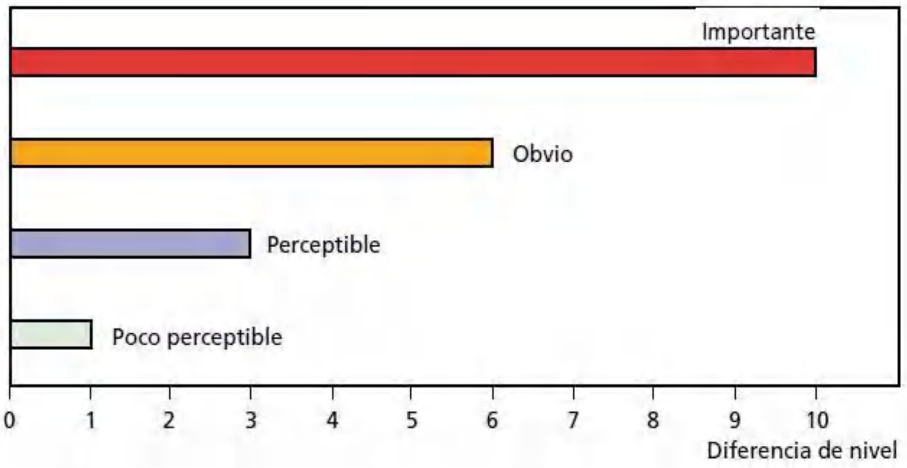
Table 4-3 presents the SPL's difference in in admission between the baseline situation and the future situation with the incremental contribution of the mill at the four baseline points. These contributions are null and void in 50% of cases, and less than 3 dBA in almost all remaining cases (87% of the remaining cases).

An increase of less than 3 dBA is considered to be noticeable according to the commonly used perception scale (Figure 4–1). The only exceptions are given in point NO3, during the day period and considering scenarios 3 and 4. In these cases, the differences between the basic situation and the future situation would be 5.5 dBA and would be obvious on the same level of perception.

Table 4–3 Contribution of the pulp mill to the records of the base situation

Point of view Monitorin g	Period	Scenario 1 L_{Aeq} (dBA)	Scenario 2 L_{Aeq} (dBA)	Scenario 3 L_{Aeq} (dBA)	Scenario 4 L_{Aeq} (dBA)
NO2	Day	0.0	0.0	0.0	0.0
	Night	0.5	0.5	0.4	0.5
NO3	Day	0.0	0.0	5.5	5.5
	Night	0.0	0.0	1.8	1.8
NO4	Day	3.1	0.0	2.9	0.0
	Night	2.4	0.0	2.3	0.0
NO5	Day	0.0	0.2	0.0	0.2
	Night	0.0	0.1	0.0	0.1

Figure 4–1 Perception of sound differences in dBA



Source: Ambient Noise, Br.el & Kjor, 2000.

In relation to the second point, the resulting theoretical SPL values in the evaluated receptors are then evaluated, when the modeled mill input (Table 3-1) and baseline values measured at the nearest monitoring point are considered. These theoretical values are also compared with the reference standards of the applicable regulations.

To do this, the values resulting from the addition of the modeled SPL and the assumed baseline records, obtained by logarithmic sum, are presented in Table 4-4. Values that exceed the reference standards of the applicable regulations are marked in orange.

According to the above, the reference standards are exceeded only twice, which means a non-compliance rate of less than 1%. In particular, the reference standard is exceeded on the 22PY receiver, during the night period in scenarios 1 and 3 (scenarios that consider as main vehicle access to option A).

Taking the applicable standards of reference, the calculated values exceed the acoustic quality targets by less than 7 dBA or less than 2 dBA as the area is considered as mixed or industrial.

It is important to note that the calculated surplus is due only to the flow of heavy vehicles, since in scenario 3 light vehicles are considered to be driven entirely through backup access. In addition, the effect of the mill can be relativized by compliance with the reference standards in scenarios 2 and 4, where it is considered as the main access of vehicles to option B.

As regards the third point in the discussion of the results, where the effectiveness of a mill barrier is assessed as a mitigation measure, the calculated values for scenarios 5 and 6, presented in Table 3-2, should be compared. In this sense, it is clear that the mill barrier has a zero effect on the attenuation of the emission SPL for the receivers concerned, since none of the results of the model is modified when the barrier is introduced into the software.

Table 4–4 Mill contribution to each sensitive receptor considering LB

Receiver	Point of view Monitoring Considered	Scenario 1 L_{Aeq} (dBA)		Scenario 2 L_{Aeq} (dBA)		Scenario 3 L_{Aeq} (dBA)		Scenario 4 L_{Aeq} (dBA)	
		Day	Night	Day	Night	Day	Night	Day	Night
1PC	NO2	51.8	46.2	51.8	46.2	51.8	46.2	51.8	46.2
2PC		51.4	44.3	51.4	44.3	51.4	44.3	51.4	44.3
3PC		51.2	43.2	51.2	43.2	51.2	43.3	51.2	43.3
4PC		51.1	42.6	51.1	42.6	51.1	42.6	51.1	42.6
5PC		51.0	42.3	51.0	42.3	51.0	42.3	51.0	42.3
6PC		50.9	41.3	50.9	41.3	50.9	41.3	50.9	41.3
7PC		51.0	41.7	51.0	41.7	51.0	41.8	51.0	41.8
8PC		50.9	41.4	50.9	41.4	50.9	41.5	50.9	41.5
9PC		50.8	40.2	50.8	40.2	50.9	40.7	50.9	40.7
10PC		50.8	39.7	50.8	39.7	50.8	40.6	50.8	40.6
11PC		50.7	39.2	50.7	39.2	50.9	40.8	50.9	40.8
12PC		50.7	38.9	50.7	38.9	50.8	39.8	50.8	39.8
13PC		50.7	38.9	50.7	38.9	50.7	39.3	50.7	39.3
15CU		51.0	41.9	51.0	41.9	51.0	42.0	51.0	42.0
20PY	NO4	37.8	38.5	34.5	35.9	37.6	38.3	34.5	35.9
21PY		42.3	42.6	34.5	35.9	42.0	42.2	34.5	35.9
22PY		61.8	61.8	34.5	35.9	61.4	61.4	34.5	35.9
23SM	NO5	43.5	46.9	43.8	47.0	43.5	46.9	43.7	47.0
24SM		43.5	46.9	43.6	46.9	43.5	46.9	43.6	46.9
25SC	NO2	50.7	38.8	50.7	38.8	50.7	38.8	50.7	38.8
26SD	NO3	43.1	50.2	43.1	50.2	43.1	50.2	43.1	50.2
30SR-Center	NO5	43.5	46.9	43.5	46.9	43.5	46.9	43.5	46.9
30SR-North	NO4	35.4	36.6	34.5	35.9	35.4	36.5	34.5	35.9
30SR-South	NO5	43.5	46.9	51.6	52.4	43.5	46.9	51.3	52.1
40LP-Center	NO3	43.1	50.2	43.1	50.2	44.3	50.5	44.3	50.5
40LP-North		43.1	50.2	43.1	50.2	45.3	50.7	45.3	50.7
40LP-South		43.1	50.2	43.1	50.2	43.8	50.4	43.8	50.4

5. Conclusions

- The installation and operation of the PARACEL pulp mill would not result in significant changes in the local sound environment if the baseline measurements available for the area are taken into account. Only one of the benchmarks would the difference in the emission of SPLs be perceived as obvious when considering the transit of all light vehicles by backup access. However, the scenario where all light vehicles are driven through backup access would occur in exceptional situations, not being part of the expected normal operational dynamics of the mill.
- In relation to the previous point, it should be noted that the reference standards of the applicable regulations would be met at all points of the baseline.
- The installation and operation of the PARACEL pulp mill would not generate incremental contributions to the local sound environment that result in non-compliance with acoustic quality targets in any of the receivers when considering the transit of vehicles through access B.
- For scenarios that consider vehicle traffic through access A, the benchmarks would be exceeded in one of the 27 receivers evaluated (22 PY) during the night period. This surplus would be 7 dBA if the study area is considered mixed and 2 dBA if the area is considered as industrial.
- The above results do not imply that the operation of the pulp mill is imperceptible from the point of view of the SPL's emission, or that it does not have the potential to generate discomfort in some cases, since perception is a subjective parameter that is not directly linked to the absolute values of emission. However, it can be ensured from an objective point of view, through the quantification of the increase effect of SPL and its comparison with the reference standards, that its impact would not be significant when meeting the objective values of acoustic quality.
- Finally, it is emphasized that the mill barrier would have a zero effect on the attenuation of the emission SPL for the receivers concerned, since none of the model results are modified when the barrier is introduced into the modelling.

6. Intervening technicians

- I'm squid. Emilio Deagosto, MSc. (technical manager)
- You're a. I'm squid. Fernando Diaz

ANNEX I
BUILDINGS, TANKS AND FOUNTAINS

CSI Ingenieros

CSI Ingenieros

CS Ingenieros

Annex Buildings, tanks and fountains

May 2020

Index

1. Introduction... 3

2. Building and Tank Data 4

2.1. Buildings... 4

2.2. Tanks... 4

3. Sources CONSIDERED 5

3.1. Fixed sources 5

3.1.1. Occasional sources.. 5

3.1.2. Surface sources 5

3.2. Mobile sources - vehicles 6

Figure index

Figure 3-1 Vehicle tour 7

Table index

Table 2-1 Height and nomenclature of buildings 4
Table 2-2 Tank height and nomenclature 4
Table 3-1 List of fixed sources considered 5
Table 3-2 Access income data to Floor 6
Table 3-3 Route Data Within Floor 6

1. Introduction

The first step of modeling should be put together the physical model of the mill, for which the main buildings must be loaded into the model, considering both buildings and tanks.

The data on heights and considerations assumed in respect of these structures are summarized in this Annex.

All tanks and buildings were considered as reflective (silent facade/reflective display), i.e. they correspond to an acoustic absorption coefficient of 0.21 according to the model used.

Once the physical model of the pulp mill is lifted, the sound sources to be modeled, located georeferenced and assigning them a certain height are added.

Three types of fonts are considered:

- Linear sources to represent internal streets and floor access;
- Surface sources to represent emission from buildings;
- Point sources to represent the emission of equipment located outdoors.

All information about buildings, sources, location and issuance was provided by PARACEL. In cases where necessary it was supplemented with information from the CSI Ingenieros database, generated in similar studies at pulp mills in Uruguay.

2. Building and Tank Data

2.1. Buildings

Table 2-1 Height and nomenclature of buildings

Name of the building	Relative height considered (m)
Cooking and Fiber Line	78
Drying	26
Chemical preparation	3
Oxygen mill	3
Chlorine Dioxide Plant	3
Oxygen Plant	3
Evaporation	30
Recovery Boiler	82
Causticizing and Lime Kiln	40
Power boiler	39
Turbogenerators/Diesel Generator	26
Cooling Tower	16
Water Treatment Plant	10
Central control building	8
Warehouse maintenance and supplies	15
Office/Laboratory	8
Dressing room	8
First aid and medical facilities	8
Kitchen/Cantina	8

2.2. Tanks

Table 2-2 Tank height and nomenclature

Tank name	Radius (m)	Height (m)
Effluent treatment plant cooling towers	38,8	22
Chimney	3	140
Biomass Silo	57,0	33

3. Sources considered

3.1. Fixed sources

All values were entered as PLW in single band of 500 Hz, i.e. as sound pressure level in dB relative to the reference sound value of 1 pW (when considered at 500 Hz it is interpreted as the A weighted sound level (dBA)).

Table 3-1 List of fixed sources considered

Physical place	Value considered(dBA)	Height (m)
Wood Yard	115	5
Cooking and fiber line	110	Dimensions of the building (h-78)
Drying	105	Dimensions of the building (h-26)
Chemical preparation	100	1
Chlorine dioxide plant	100	1
Oxygen plant	105	1
Evaporation	110	Dimensions of the building (h-30)
Recovery boiler	110	Dimensions of the building (h-82)
Causticizing and Lime Kiln	110	Dimensions of the building (h-40)
Power boiler	105	Dimensions of the building (h-39)
Turbogenerators	85 to 1m, K-2dB	1
Cooling tower	110	Dimensions of the building (h-16)
Water treatment plant	95	Dimensions of the building (h-10)

3.1.1. Point sources

A source is classified as point when its dimensions are very small compared to distances to receivers. In this case the sound energy is propagated spherically. All sources corresponding to equipment, pumps, engines, cooling towers, etc. are considered spot.

3.1.2. Surface sources

Buildings are not only obstacles to the propagation of sound, but can also emit noise in the surroundings, this will be the case for sources that are inside buildings, such as pulp drying buildings, recovery boiler, engine room in the water treatment plant, among others.

In these cases the internal sources are modeled as sources in the facades of the building, these are located 0.05 m from the facade and is considered a transmission loss of 30 dB (value suggested by the model for industrial buildings for 500 Hz).

3.2. Mobile sources - vehicles

The emission generated by transit circulating through the internal accesses and transit routes to the mill is modeled as linear sources, considering for all cases that the transit is evenly distributed throughout the day.

Below are the data provided by PARACEL of routes through possible access to the mill (Table 3-2) and internal route (Table 3-3).

The routes of circulation are those presented in Figure 3-1 for each vehicle typology.

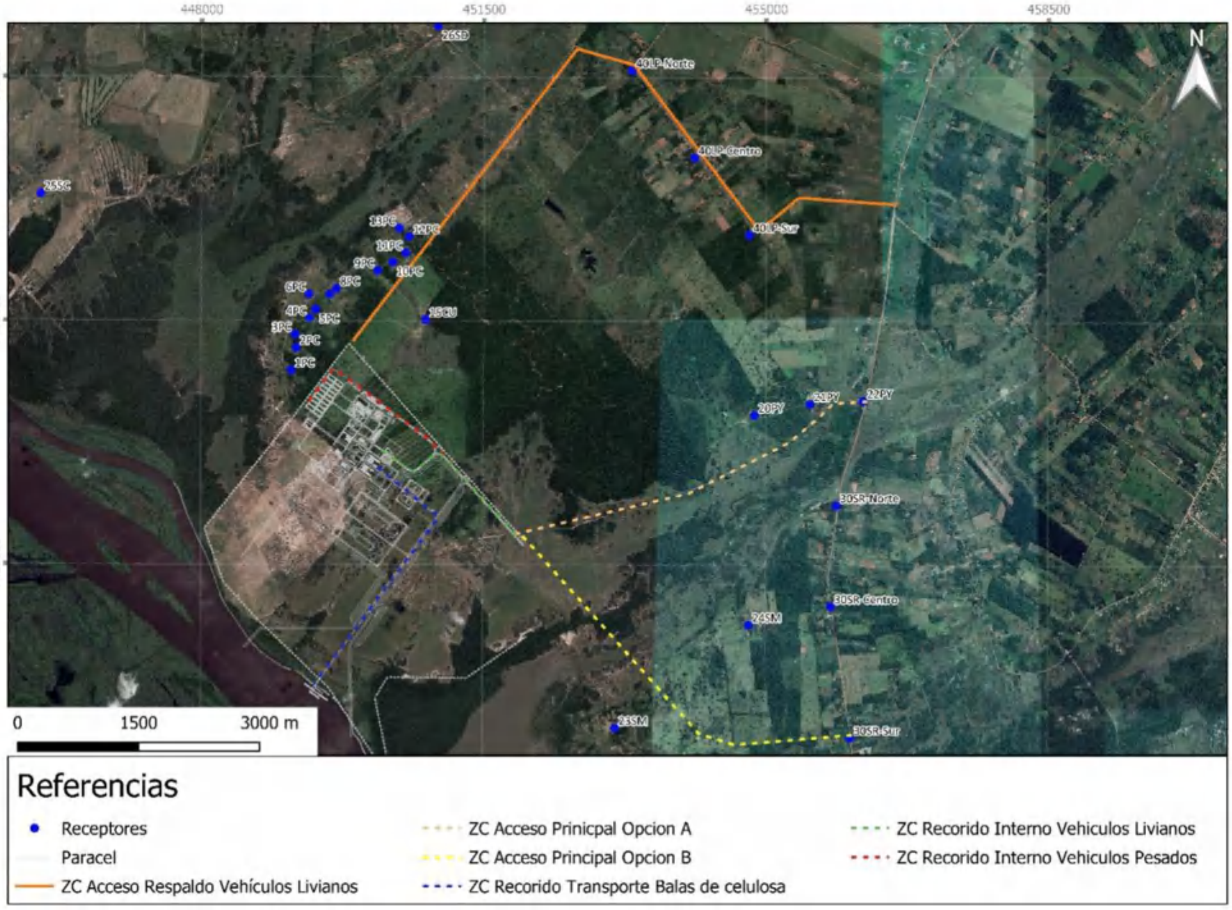
Table 3-2 Mill Access Income Data

Travel	Vehicle Flow Light	Vehicle Flow Heavy	Top speed (km/h)
ZC Main Access Option A	30 vehicles/h	15 trucks/h	60
ZC Main Access Option B	30 vehicles/h	15 trucks/h	60
ZC Main Access Backup Light Vehicles	30 vehicles/h	-	60

Table 3-3 Route Data Within Mill

Travel	Vehicle Flow	Top speed (km/h)
ZC Internal Tour Light Vehicles	30 vehicles/h	30
ZC Internal Tour Heavy Vehicles	15 trucks/h	30
ZC Route Transport Bullets From Pulp	6 trucks/h	30

Figure 3-1 Vehicle tour



ANNEX V

SELF DEPURATION STUDY

Pöyry Tecnologia Ltda.
Av. Alfredo Egídio de Souza Aranha, 100
Bloco B - 5° andar
04726-170 São Paulo - SP
BRASIL
Tel. +55 11 3472 6955
Fax +55 11 3472 6980
E-mail: contato.br@poyry.com

Date 31.05.2021

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Page 1

ENVIRONMENTAL NAD SOCIAL IMPACT ASSESSMENT (ESIA)

Pulp Mill, River Port, Transmission Line and Electrical Substation in Concepción - Paraguay

VOLUME IV – COMPLEMENTARY STUDIES

ANNEX V – SELF-DEPURATION STUDY

Content

1 INTRODUCTION
2 STUDY AREA
3 WASP TOOL
4 HYDRIC SYSTEM TOPOLOGY
5 INPUT DATA
6 MODEL CALIBRATION
7 SELF-DEPURATION SIMULATION
8 CONCLUSION
9 REFERENCES

Attachments

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SUMMARY

1 INTRODUCTION....5
2 STUDY AREA....5
3 WASP TOOL....7
3.1 WASP tool application....7
4 HYDRIC SYSTEM TOPOLOGY....7
5 INPUT DATA....10
5.1 Fluviometric data....10
5.1.1 Calibration process....10
5.1.2 Self-depuration capacity simulation....14
5.2 Consumptive demands....15
5.3 Water quality....15
5.3.1 Calibration process....15
5.3.2 Self-depuration capacity simulation....18
5.4 Climatological data....21
5.5 Hydraulic data....21
6 MODEL CALIBRATION....28
7 SELF-DEPURATION SIMULATION....41
8 CONCLUSION....50
9 REFERENCES....50

Orig.	31/05/21 – bvv	31/05/21 – hbo	31/05/21 – hfw	31/05/21 – hfw	for information
Rev.	Date /Author	Date /Verified	Date /Approved	Date/Authorized	Remarks

LIST OF FIGURES

Figure 1 - Identification of stretchs and points of interest in Paraguay River study area. Author (2021)......6
Figure 2 - Flow division scheme in branched segments. Author (2021)......8
Figure 3 – Water system topology: a) calibration stretchs; b) and c) stretchs of self-depuration capacity model. Author (2021). 9
Figure 4 - Watersheds considered in the calibration and simulation stretchs. Author (2021)......10
Figure 5 - Pluviometric (rain), climatological (weather) and fluviometric stations used. Author (2021)......11
Figure 6 - Adjustment between synthetic and historical flow series in WLS-2. Author (2021). 12
Figure 7 - Land use and vegetation cover in study area. Author (2021) 13
Figure 8 - Temporal variation of the depth in: a) segment 1 (WLS-1) and b) segment 38 (WLS-2). Author (2021)......29
Figure 9 - Fit between simulated profiles and monitored data in WQS-2. Author (2021)......34
Figure 10 - Fit between simulated profiles and monitored data in WQS-3. Author (2021)......38
Figure 11 – Fit between simulated profiles and monitored data in WQS-4. Author (2021). 40
Figure 12 - Longitudinal profiles of pH: (a) Current situation; (b) Future situation after the treated effluent discharge. 42
Figure 13 - Longitudinal profiles of total suspended solids: (a) Current situation; (b) Future situation after the treated effluent discharge. 43
Figure 14 - Longitudinal profiles of dissolved oxygen: (a) Current situation; (b) Future situation after the treated effluent discharge. 44
Figure 15 - Longitudinal profiles of BOD: (a) Current situation; (b) Future situation after the treated effluent discharge. 45
Figure 16 - Longitudinal profiles of ammonia: (a) Current situation; (b) Future situation after the treated effluent discharge. 46
Figure 17 - Longitudinal profiles of nitrate: (a) Current situation; (b) Future situation after the treated effluent discharge. 47
Figure 18 – Longitudinal profiles of total phosphorus: (a) Current situation; (b) Future situation after the treated effluent discharge. 48

LIST OF TABLE

Table 1 - Export coefficients of dry and rainy season loads according to land use SSRH (2016, adapted)....16
Table 2 - Land use and vegetation cover (km² and %) in Paraguay basin between WQS-1 and WQS-4. Author (2021)....17
Table 3 - Water quality data used in the calibration model process. Author (2021)....18
Table 4 - Land use and vegetation cover (km² and %) in Paraguay basin between Concepción and Asunción. Author (2021)....19
Table 5 - Water quality data used in the self-depuration capacity simulation. Author (2021)....20
Table 6 - Water quality data used in the self-depuration capacity simulation. Poyry (2021)....20
Table 7 - Factor values of the Cowan method. Chow (1959, adapted)....23
Table 8 - Hydraulic data adopted in 38 segments during calibration. Author (2021)....24
Table 9 - Hydraulic data adopted in 64 segments during self-depuration simulation. Author (2021). 25

1 INTRODUCTION

One of the most relevant issues to contemporary society is the hydric resources preservation. In Paraguay the concern on this matter is evidenced on the federal law of water resources nº 3239/2007 (PARAGUAY, 2007), which is aimed at to regulate the sustained management of any water and springs, irrespective of their location, physical state or its natural occurrence in Paraguay territory, making it social, economic and environmentally-sustainable for the population. According to Article 37 of this law, the permission to use water resources for effluents discharge into any natural watercourse must be granted (PARAGUAY, 2007).

The increasing water demands for multiple uses result in significant environmental impacts (quantitative and qualitative) and disputes over water use, affecting the maintenance of natural aquatic ecosystems. In this context, the Resolution nº 222/02 (PARAGUAY, 2002) sets water quality standards and intended levels of effluent treatment for all of the national territory, separated into four classes according to the preponderant use.

According to Jhunior et al. (2020), the seek for solutions to water management problems, on a local or basin scale, becomes more efficient with the use of computational tools which act as decision support system. In this regard, water quality models can be useful tools in the assessment for the support capacity of a receiving water (self-depuration capacity). Such models are based on a set of equations whose solution will provide the spatial and temporal distribution of water quality indicator parameters in solution or suspension of a watercourse.

Most current computing tools generate a numerical solution of advective/diffusive equations for a physical and chemical processes, what is called a numerical simulation. Once the model is calibrated, it will be possible to perform innumerable scenarios.

There are many computational tools available for water quality simulation in rivers and reservoirs, whose choice depends on the water system complexity level. The present study used the computational tool called Water Quality Analysis Simulation Program - WASP, developed by United States Environmental Protection Agency – EPA (EPA, 2021).

The purpose of this study was to evaluate the influence of a punctual discharge of a pulp mill treated effluent in the self-depuration capacity of Paraguay River (approximately 300 km). The treated effluent discharge point is located at 20 km upstream of the urban area of Concepción city – Paraguay. The self-depuration model extends from this point until near the Asunción city – Paraguay.

The water quality indicator parameters analyzed were: pH, total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), total phosphorus, ammonium and nitrate. The input data of WASP (climatological data, water discharge, water quality and consumptive demands) were obtained from documents provided by the contractor, National Water Agency (ANA, 2021), National Institute of Meteorology (INMET, 2021), Directorate of Meteorology and Hydrology (DMH, 2021).

2 STUDY AREA

The Paraguay River Basin has a drainage area of almost 365.592 km^2, and a length of 2,695 km from its source to its mouth. Most of their sub-basins are located in Paraguay, which also has areas in Brazil, Bolivia and Argentina. The Paraguay River is the main affluent on the right bank of the Parana River, one of the major tributaries of the Platina Basin.

The source of the Paraguay River is in the Chapada dos Parecis, Brazil, and follows south, continue along the edge between the Amazon and Cerrado biomes entering in the Pantanal biome in the region of Cáceres, where it follows until reach Paraguay (ANA, 2021a).

In Brazil, “the Paraguay river basin district occupies 4.3% of the territory, covering parts of the Mato Grosso and Mato Grosso do Sul states, which included the largest part of Pantanal-matogrossense, the biggest continuous humid area of the planet” (ANA, 2021b). In Paraguayan territory, the Paraguay River flows through the main regions of the country, from north to south, reaching its mouth at Parana River in Paso de Patria. The main tributaries in the Paraguay River in Paraguayan territory include: on the right bank the Yacaré River, Mosquito River, Gonzalez stream, San Carlos River, Verde River, Siete Puntos River, Montelindo River, Negro River and Aguaray Guazú River; on the left bank the APA River, Tagatija River, Aquídaban River, Ypané River, Jejui Guazú River, Manduvirá River e Piribebuy stream.

According to Figure 1, the stretch of Paraguay river analyzed has around 300 km, from the effluent discharge point, 20 km upstream of the urban area of Concepción city (Water Quality Station WQS-2), until near the Asunción city. The stretch between WQS-1 and WQS-4 was used in the calibration process of biochemical and physical coefficients (see Figure 1).

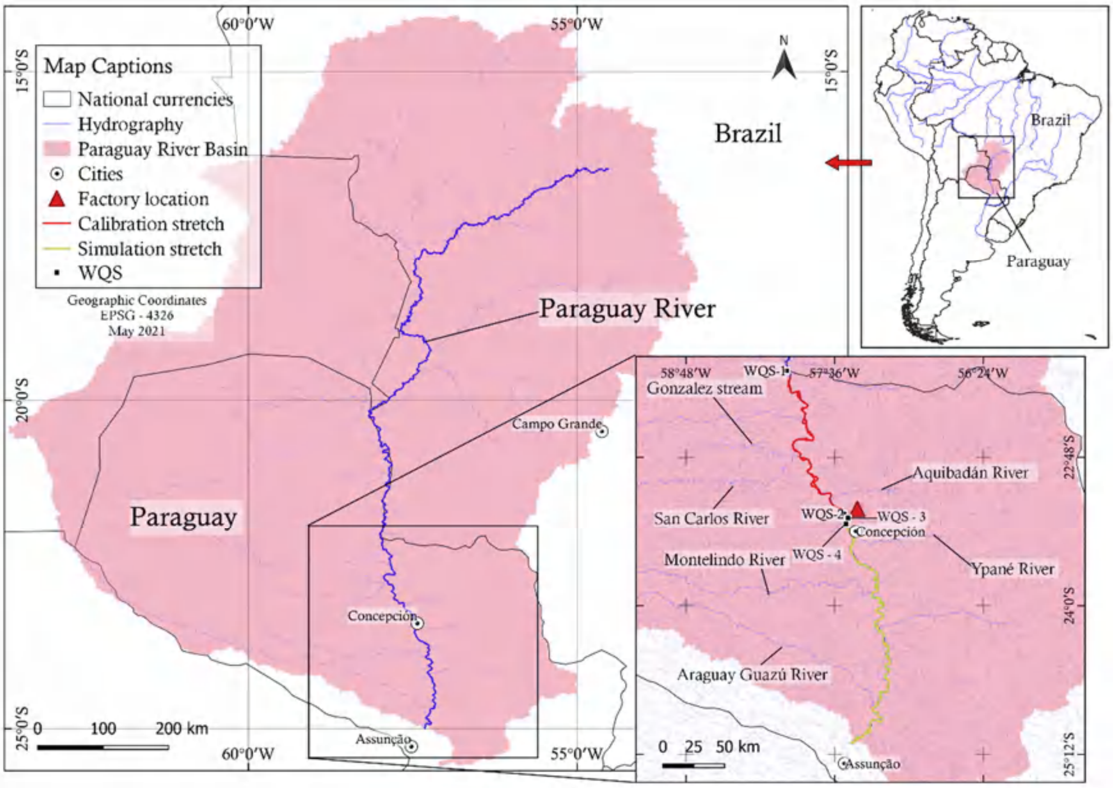


Figure 1 - Identification of stretchs and points of interest in Paraguay River study area. Author (2021)

The region of capital Asunción has a humid hot and temperate environment, with minimum temperature of 13.1ºC in July and maximum of 32.3ºC in January and an average annual rainfall of 1629 mm. Concepción city has a tropical climate, with minimum temperature of 15.1ºC in July and maximum of 32.9ºC in January an average annual rainfall of 1618 mm (CLIMATE, 2021).

The use and occupation of the soil is composed predominantly of natural vegetation (56.5%) and floodplain vegetation (26.4%), with minor uses in pasture (11.2%) and agriculture (7.2%).

Due to the high availability of water resources in Paraguay River and the lack of systematic geo-referenced data, the present study did not consider the possible consumptive demands granted by the environmental agency of Paraguay.

3 WASP TOOL

The computational tool Water Quality Analysis Simulation Program – WASP was developed by the United State Environmental Protection Agency – EPA. It is a dynamic modeling tool in aquatic systems, including the supernatant liquid layer, the benthic layer and the interaction between them. It allows the user to investigate lentic and lotic environments in 1, 2 and 3 dimensions for a variety of water quality parameters. The advective and diffusive process, the punctual and diffuse mass loading and border change processes are represented in the model. The tool can also be linked to hydrodynamic and sediment transport models that can provide flows, temperature, salinity and sediment flows. The WASP8 version predicts the demand for sedimentary oxygen and the nutrient flows of underlying sediments (EPA, 2021). The mathematical equations used by the tool to estimate the behavior of the various water quality parameters in a lentic and lotic environment can be consulted in EPA (2021).

3.1 WASP tool application

According to EPA (2021), WASP is one of the most used water quality models in the United States and worldwide. Due to the modules capacity to integrate various types of pollutants, this tool has application in all the main estuaries in Florida, where it links to a hydrodynamic and watershed model, simulating 12 continuous years in the development of numerical criteria for nutrients in aid to US EPA. Also according to EPA (2019), other uses of WASP include eutrophication from Tampa Bay, FL; phosphorus loading to Lake Okeechobee, FL; eutrophication of the Neuse River estuary, NC; eutrophication of the Coosa River and reservoirs, AL; PCB pollution of the Great Lakes, eutrophication of the Potomac estuary, pollution of the James River estuary, volatile organic pollution of the Delaware estuary, and heavy metal pollution of the Deep River, North Carolina, mercury in the Savannah River, GA. The potential of the WASP computational tool can be confirmed by several scientific publications in qualified journals, such as Knightes et al. (2019), Camacho et al. (2018), Li et al. (2018), Yu et al. (2016), Lai et al. (2013), Lin et al. (2011), Franceschini and Tsai (2010), among others.

4 HYDRIC SYSTEM TOPOLOGY

In this study, before tracing the topology of the water system, it was important to understand the river channel morphology. The course of the Paraguay River in Paraguay takes place in alluvial valleys, characterized by reduced bottom slopes with well accentuated flood plains in some regions due to the dynamics of transport and deposition of sediments.

The sinuosity index in the Paraguay River between Concepción and Asunción is between 1.30 to 1.38, which does not characterize this stretch as meandric but sinuous. It is also observed that in approximately 102 km (37% of the stretch) there is a branched river pattern, with a predominance of 2 to 3 well-defined branches.

In the topology tracing of the water system, in face of the observed morphology, was made the option for the use of a single segment for the single stretches of river and multiple parallel segments for the branched stretches. In these branches, the width coefficient for the flow division was used, according to the explanatory scheme of the flow division shown in Figure 2 and Equations 1 to 3.

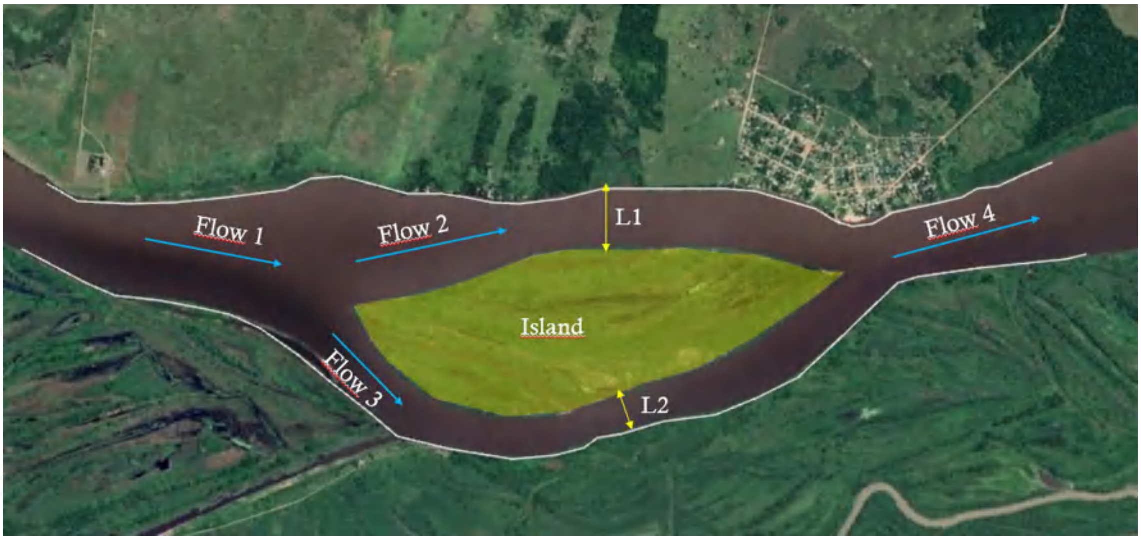


Figure 2 - Flow division scheme in branched segments. Author (2021).

$$\textbf{Flow 1} = \textbf{Flow 2} + \textbf{Flow 3} = \textbf{Flow 4} \quad (1)$$

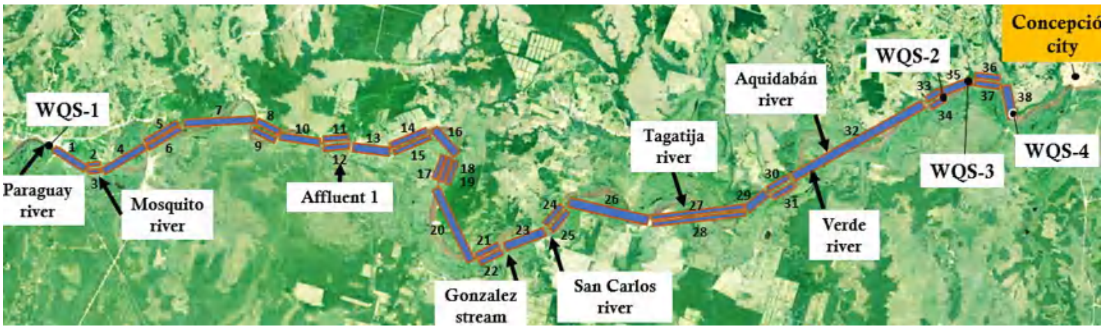
$$\textbf{Flow 2} = \textbf{Flow 1} \times [\, L_1/(L_1 + L_2)] \quad (2)$$

$$\textbf{Flow 3} = \textbf{Flow 1} \times [\, L_2/(L_1 + L_2)] \quad (3)$$

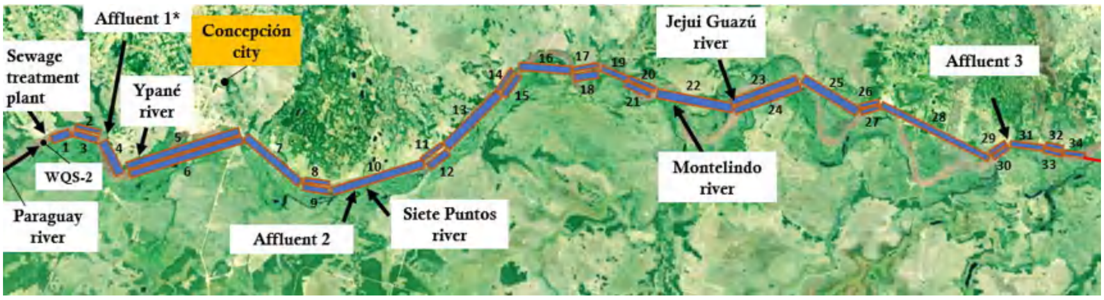
In this study, two independent topologies were defined in different sections, being a topology for the calibration of the physical and biochemical coefficients (stretch between the water quality station WQS-1 and WQS-4 - see Figure 3a) and another topology for the study of self-depuration capacity in face of a treated effluent discharge from a paper and pulp industry (stretch between the water quality station WQS-2 and the nearby upstream of Asunción city - see Figures 3b and 3c).

The calibration topology has 38 segments, distributed in 13 single channels and 12 with branched channels (Figure 3a), whose specific contributions considered were: Paraguay river in WQS-1; tributaries on the right bank (Mosquito River, Affluent 1, Gonzalez stream, San Carlos River and Verde River); tributaries on the left bank (Tagatija River and Aquidabán River); direct diffuse contributions on the right and left margins.

The self-depuration capacity topology has 64 segments, distributed in 22 unique channels and 21 with branched channels, whose specific contributions considered were: Paraguay River nearby the treated effluent discharge (WLS-2); effluent from the paper and pulp industry; tributaries on the right bank (Affluent 1, Affluent 2, Siete Puntos River, Montelindo River, Negro River, Aguaray Guazú River and Affluent 4); tributaries on the left bank (Ypané River, Jejui Guazú River, Manduvirá River and Affluent 3); direct diffuse contributions on the right and left margins (Figures 3b and 3c).



(a)



(b)

(c)

Figure 3 – Water system topology: a) calibration stretchs; b) and c) stretchs of self-depuration capacity model. Author (2021).

The water system topology was kept fixed in all simulations, both in calibration process and self-depuration capacity model.

5 INPUT DATA

This item presents the methodologies for obtaining fluviometric input data, consumptive demands, water quality, climatological and hydraulic coefficients and geometries assumed in calibration simulations of physical and biochemical coefficients and in the self-depuration capacity model of the Paraguay River.

5.1 Fluviometric data

5.1.1 Calibration process

As already mentioned in the topology item, the section of Paraguay River used in the process of calibrating the physical and biochemical coefficients starts at WQS-1 and ends at WQS-4 (close to Concepción city). According to Figure 4, the input flows considered include: Paraguay River in WQS-1; tributaries on the right bank (Mosquito River, Affluent 1, Gonzalez stream, San Carlos River and Verde River); tributaries on the left bank (Tagatija River and Aquidabán River); direct diffuse contributions on the right and left margins.

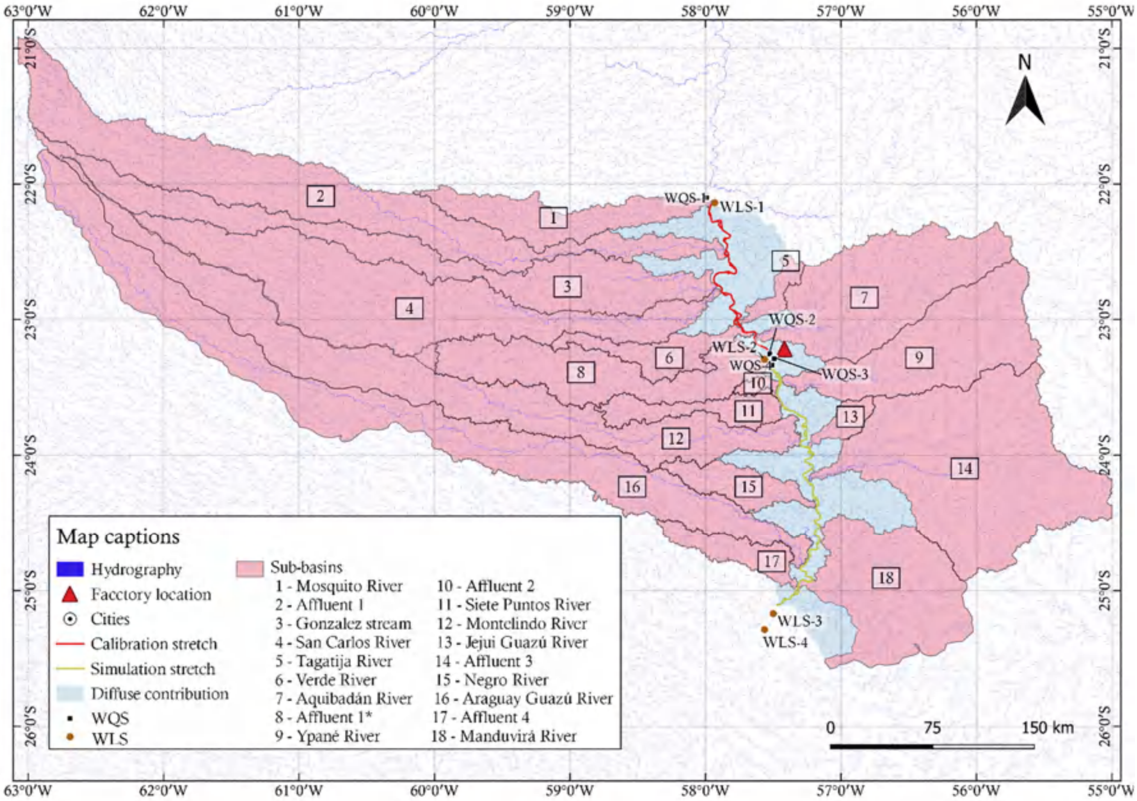


Figure 4 - Watersheds considered in the calibration and simulation stretchs. Author (2021).

Due the absence of fluviometric monitoring stations in this region, a synthetic series were estimated based on hydrological rainfall-flow modeling. The methodology used was:

1º) DMH (2021) has a Water Level Station - WLS next to WQS-2, identified as WLS-2 (see Figure 4). The contracting company provided the turn-key in WLS-2, presented in Equation 4.

$$\mathbf{Q = 547.43 + 583.57 \times H - 26.18 \times H^2} \qquad \mathbf{(4)}$$

Where: Q is the flow in m³/s; H is the water level in meters. With this equation and the water levels available in WQS-2 it was possible to estimate the flows in the section of Paraguay River where these stations are located.

The HBV hydrological model, available in the tool Evaluación de los Recursos Hidricos - EvalHID (COSTA, 2015; MAS, 2013; PAREDES-ARQUIOLA et al. 2014; SALLA et al. 2015), was used to estimate the flow in the input fluviometric datas. The HBV model request as input data the pluviometric and climatological potential evapotranspiration series, provided by ANA (2021) and DMH (2021) stations (see Figure 5). It's also necessary the contribution area of a watercourse (in km^2 – Figure 4) and a series of monitored flows for model calibration (in this case the flows estimated by the Equation 4).

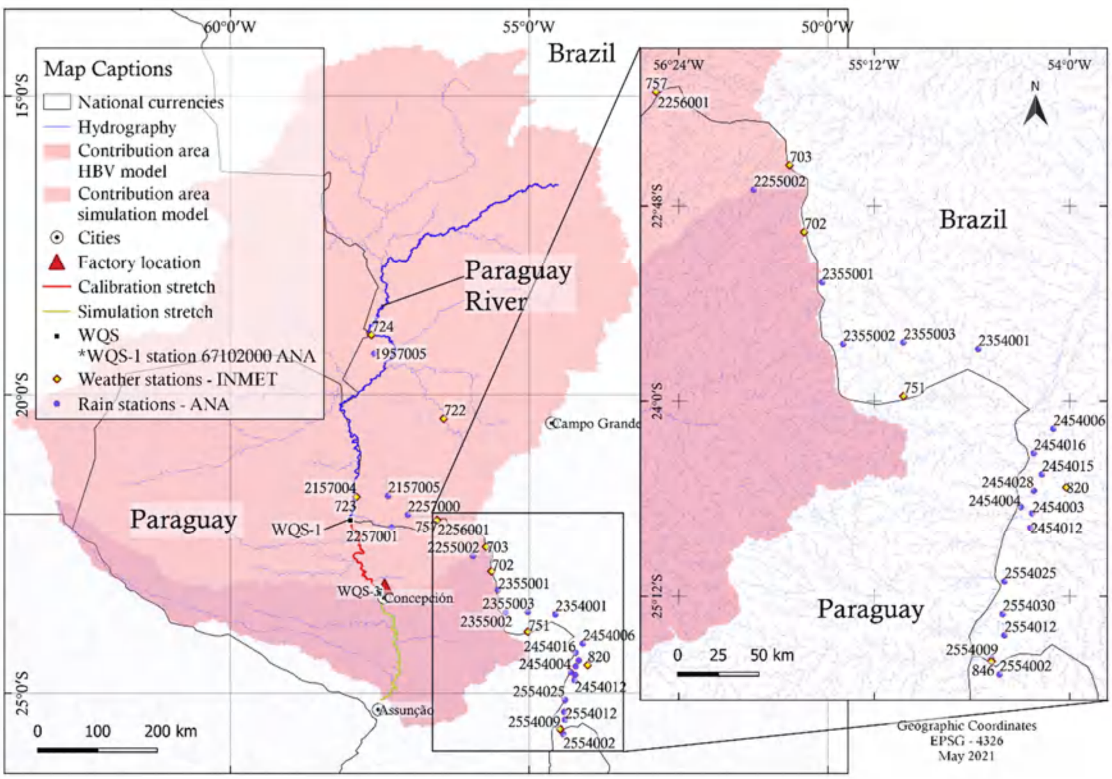


Figure 5 - Pluviometric (rain), climatological (weather) and fluviometric stations used. Author (2021).

The pluviometric and evapotranspiration series in the contribution area centroid of WLS-2 were obtained using the Inverse Squared-Distance Weighting (EUCLYDES et al., 1999; GIRARDI et al. 2013; SILVA, 2011; SOARES, 2000).

The HBV rain-flow hydrological model uses a series of coefficients to estimate surface, subsurface and base flow, being: k_0 - surface flow coefficient (1/T); k_1 - subsurface flow coefficient (1/T); k_2 - base flow coefficient (1/T); $k_{perc.}$ - percolation coefficient (1/T); L_{max}.- maximum subsurface flow limit (L), in addition to adjustment coefficients (PWP, FC and β). The calibration of these coefficients, necessary to adapt the simulations to the characteristics of each sub-basin, was carried out using the SCE-UA evolutionary algorithm (Shuffled Complex Evolution method, University of Arizona), developed by Duan et al. (1992) *apud* Paredes-Arquiola et al. (2014). This algorithm adjusted the synthetic series of simulated flows to the historical series estimated in WLS-2, varying these coefficients. Figure 6 shows the fit between the synthetic and historical flow series in WLS-2. The calibration period (10/2006 to 03/2021) was chosen according to the period of pluviometric and evapotranspiration data available in the stations 724, 722, 723 and 1957005.

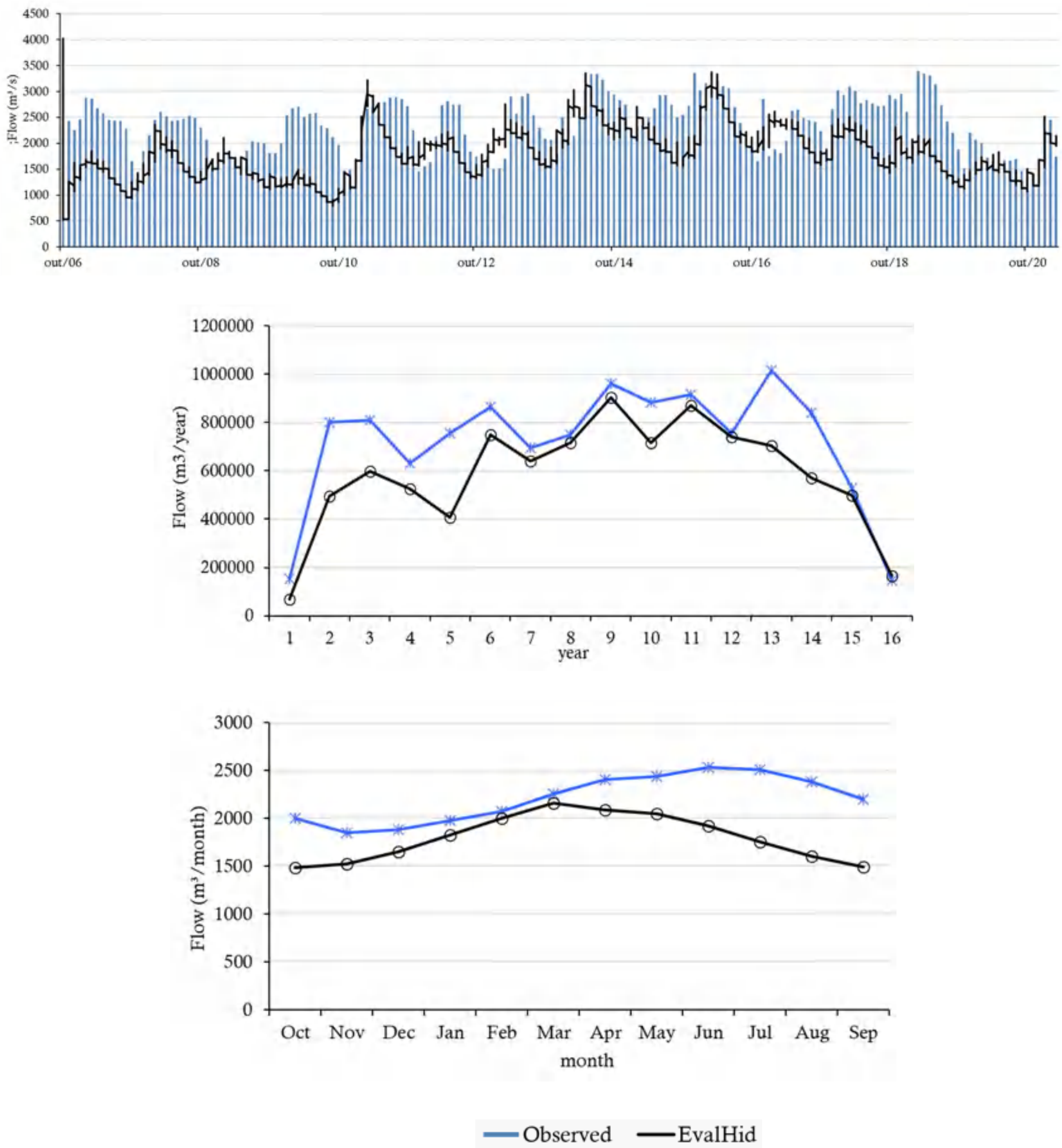


Figure 6 - Adjustment between synthetic and historical flow series in WLS-2. Author (2021).

2º) The concept of hydrologically homogeneous regions was used to estimate the synthetic series of flow in WQS-1 and in the punctual sub-basins and diffuse contributions (BARBOSA et al. 2005; EUCLYDES, 1999; TUCCI, 2005). The hydrological homogeneity is in the similarities of morphological, climatic characteristics and land use and occupation. Figure 7 shows the similarities in land use and occupation in study area, carried out using maps of supervised classification of multispectral images provided by the MapBiomas Chaco project (MAPBIOMAS, 2021). This concept allowed the use of the calibrated coefficients of HBV model obtained in the previous step in other regions and tributaries.

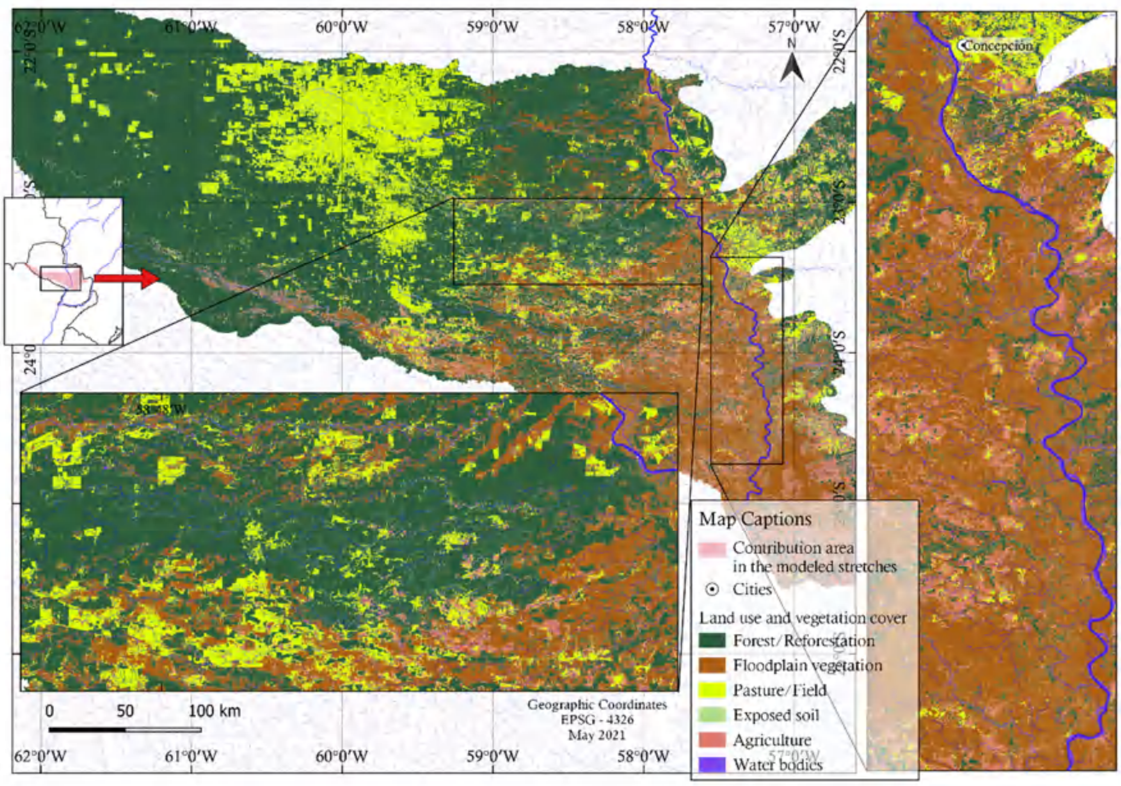


Figure 7 - Land use and vegetation cover in study area. Author (2021)

The hydrological rain-flow modeling HBV, now using as input data the coefficients previously calibrated in WLS-2, the pluviometric and climatological data of the stations presented in Figure 5 (DMH, 2021; ANA, 2021) transported to the centroid of contribution areas of WQS-1 and sub-basins 1 to 7 (Figure 4), it was possible to estimate the synthetic flow series affluent in Paraguay River at WQS-1 and in the punctual and diffuse contributions between WQS-1 and WQS-4. For the period from 09/2001 to 02/2020 (chosen according to the period of water quality data available in WQS-1), the flows considered were:

– Punctual entry in WQS-1 - Paraguay River: minimum flow is 437.9 m^3/s, maximum flow is 3,892.2 m^3/s, average flow is 1,605.8 m^3/s and standard deviation is 355.2 m^3/s;

– Punctual entry in Mosquito River: minimum flow is 3.6 m^3/s, maximum flow is 26.0 m^3/s, average flow is 15.7 m^3/s and standard deviation is 3.2 m^3/s;

– Punctual entry in affluent 1: minimum flow is 13.6 m^3/s, maximum flow is 94.8 m^3/s, average flow is 61.0 m^3/s and standard deviation is 11.4 m^3/s;

– Punctual entry in Gonzalez stream: minimum flow is 9.2 m^3/s, maximum flow is 64.8 m^3/s, average flow is 41.1 m^3/s and standard deviation is 7.9 m^3/s;

- Punctual entry in San Carlos River: minimum flow is 13.4 m^3/s, maximum flow is 94.1 m^3/s, average flow is 60.3 m^3/s and standard deviation is 11.4 m^3/s;
- Punctual entry in Tagatija River: minimum flow is 0.6 m^3/s, maximum flow is 4.5 m^3/s, average flow is 2.9 m^3/s and standard deviation is 0.6 m^3/s;
- Punctual entry in Verde River: minimum flow is 2.0 m^3/s, maximum flow is 13.8 m^3/s, average flow is 8.9 m^3/s and standard deviation is 1.7 m^3/s;
- Punctual entry in Aquibadán River: minimum flow is 8.3 m^3/s, maximum flow is 65.3 m^3/s, average flow is 42.1 m^3/s and standard deviation is 8.1 m^3/s;
- Punctual entry in diffuse sources: minimum flow is 0.1 m^3/s, maximum flow is 0.7 m^3/s, average flow is 0.5 m^3/s and standard deviation is 0.1 m^3/s.

5.1.2 Self-depuration capacity simulation

For the simulations of the self-depuration capacity simulation in Paraguay River, with starting point 20km upstream the urban area of Concepción city (about 300 meters upstream the treated effluent discharge of the cellulose paper industry) and end point nearby upstream of Asunción city, were considered the inflows of: Paraguay River nearby the treated effluent discharge (WLS-2); effluent from the paper and pulp industry; tributaries on the right bank (Affluent 1, Affluent 2, Siete Puntos River, Montelindo River, Negro River, Aguaray Guazú River and Affluent 4); tributaries on the left bank (Ypané River, Jejui Guazú River, Manduvirá River and Affluent 3); direct diffuse contributions on the right and left margins (see Figure 4).

Following the methodology previously described, in the estimation of the synthetic flow series in the punctual sub-basins and diffuse contribution between Concepción and Asunción, the concept of hydrologically homogeneous regions was used (BARBOSA et al. 2005; EUCLYDES, 1999; TUCCI, 2005) to take advantage of the HBV coefficients previously calibrated in the contribution area of WLS-2. For the period from 09/2001 to 02/2020, the flows considered were:

- Punctual entry in WLS-2 - Paraguay River: minimum flow is 499.8 m^3/s, maximum flow is 5,759.3 m^3/s, average flow is 2,162.0 m^3/s and standard deviation is 382.4 m^3/s;
- Punctual entry in affluent 1: minimum flow is 6.1 m^3/s, maximum flow is 51.9 m^3/s, average flow is 31.7 m^3/s and standard deviation is 6.1 m^3/s;
- Punctual entry in Ypané River: minimum flow is 7.3 m^3/s, maximum flow is 66.0 m^3/s, average flow is 41.7 m^3/s and standard deviation is 7.7 m^3/s;
- Punctual entry in affluent 2: minimum flow is 0.3 m^3/s, maximum flow is 2.1 m^3/s, average flow is 1.3 m^3/s and standard deviation is 0.3 m^3/s;
- Punctual entry in Siete Puntos River: minimum flow is 1.9 m^3/s, maximum flow is 15.7 m^3/s, average flow is 9.7 m^3/s and standard deviation is 1.9 m^3/s;
- Punctual entry in Montelindo River: minimum flow is 12.7 m^3/s, maximum flow is 107.4 m^3/s, average flow is 66.9 m^3/s and standard deviation is 12.6 m^3/s;
- Punctual entry in Jejui Guazú River: minimum flow is 0.7 m^3/s, maximum flow is 6.0 m^3/s, average flow is 3.7 m^3/s and standard deviation is 0.7 m^3/s;

– Punctual entry in affluent 3: minimum flow is 14.8 m^3/s, maximum flow is 192.5 m^3/s, average flow is 83.3 m^3/s and standard deviation is 15.9 m^3/s;

Punctual entry in Negro River: minimum flow is 1.8 m^3/s, maximum flow is 15.4 m^3/s, average flow is 9.7 m^3/s and standard deviation is 1.8 m^3/s;

– Punctual entry in Araguay Guazú River: minimum flow is 15.4 m^3/s, maximum flow is 130.0 m^3/s, average flow is 81.6 m^3/s and standard deviation is 15.2 m^3/s;

– Punctual entry in Manduvirá River: minimum flow is 7.5 m^3/s, maximum flow is 65.0 m^3/s, average flow is 42.0 m^3/s and standard deviation is 7.5 m^3/s;

– Punctual entry in affluent 4: minimum flow is 1.6 m^3/s, maximum flow is 13.5 m^3/s, average flow is 8.6 m^3/s and standard deviation is 1.6 m^3/s;

– Punctual entry in diffuse sources: minimum flow is 0.3 m^3/s, maximum flow is 3.0 m^3/s, average flow is 1.8 m^3/s and standard deviation is 0.3 m^3/s;

The constant flow of effluent discharge from the pulp mill equal to 5,700 m^3/h (1.58 m^3/s) was provided by the contracting company.

5.2 Consumptive demands

The contracting company did not provide any document with users registration and location of any punctual withdrawal and amounts granted for water use, as any other effluent discharge in the study area of Paraguay River. This consultancy also did not find any information in websites of the Paraguayan environmental agencies. The representativeness of the self-depuration capacity simulations of Paraguay River was not affected by the absence of grants information (withdrawal and effluent discharge) since Paraguay River has high water availability, with an average flow in the section of effluent discharge from the pulp mill of 2,162.0 m^3/s and $Q_{7,10}$ of 1,093.0 m^3/s (contracting company information).

5.3 Water quality

5.3.1 Calibration process

Input data for water quality considered include: Paraguay River in WQS-1; tributaries on the right bank (Mosquito River, Affluent 1, Gonzalez stream, San Carlos River and Verde River); tributaries on the left bank (Tagatija River and Aquidabán River); direct diffuse contributions on the right and left banks.

The water quality data monitored at stations WQS-2 (end of the stretch 34), WQS-3 (end of the stretch 35), and WQS-4 (end of the stretch 38) were used in the calibration model process (see item 6).

Only the WQS-1 station has a historical series of water quality monitored by ANA (2021). The MQUAL 1.5 method was used to estimate the affluent load of the parameters Total Phosphorus, Total Nitrogen, Biochemical Oxygen Demand and Total Suspended Solids in the tributaries and diffuse inputs. For the other parameters were considered the limit values defined by Resolution nº 222/2002 for class 2 watercourses.

According to Guimarães (2018), the mathematical model of land use/water quality correlation - MQUAL had its first version in 1998, during the Development and Environmental Protection Plan studies in the Guarapiranga Basin, developed by the

Secretariat of Environment of the São Paulo state. According to SMA (2010), the model was designed to explain the relationships between land use, occupation and management in the Guarapiranga basin (SP), and the water quality for public supply purposes, in order to guarantee best possible knowledge for decision makers of the water system. Further on, SSRH (2016) carried out a pollution assessment study from diffuse sources in the area of influence of Alto Tietê Producer System - SPAT -, including the Taiaçupeba, Jundiaí, Biritiba, Ponte Nova and Paraitinga Reservoirs, which are part of the actions foreseen in the Environmental Sanitation Program for the Upper Tietê Watershed - Mananciais Program.

The model had several revisions in order to improve its functioning and quality of results (MORUZZI et al., 2012; OLIVEIRA and SARDINHA, 2014). According to Moruzzi et al. (2012), the MQUAL model consists in three interrelated modules: load generation module; simulation module of main tributaries and reservoir simulation module. Each module represents a phenomena of generation and self-depuration of polluting loads in three environments considered, a terrain surfaces, where are the sources of polluting loads, the main rivers and their tributaries and the reservoir. In the present study, only the first module was used, which indicates, by means of export coefficients, the pollutant load carried superficially.

The export coefficients adopted were extracted from SSRH (2016). Table 1 shows the export coefficients for dry and rainy season loads adopted.

Table 1 - Export coefficients of dry and rainy season loads according to land use SSRH (2016, adapted).

Land use	P_{total}	N_{total}	DBO	SST
	kg/day.km²			
Dry season				
Forest/Reforestation	0.002	0.06	1.172	2.5
Floodplain vegetation	0.002	0.06	1.172	2.5
Pasture/Field	0.001	0.05	1.079	3.75
Agriculture	0.066	0.227	4.917	10.455
Urban	0.272	2.378	40.0	1.1
Exposed fields	0.005	0.09	3.8	8.0
Rainy season				
Forest/Reforestation	0.039	0.6	1.302	20.0
Floodplain vegetation	0.039	0.6	1.302	20.0
Pasture/Field	0.028	0.5	1.079	30.0
Agriculture	0.346	2.95	7.564	230.0
Urban	0.135	2.548	8.0	100.0
Exposed fields	0.05	0.9	2.0	40.0

The mapping of land use and cover in the areas of contribution to the stretch of interest on Paraguay River (between the WQS-1 stations and near Asunción) was carried out using maps of supervised classification of multispectral images provided by MapBiomas Chaco project with 90 meters of spatial resolution for the year 2020

(MAPBIOMAS, 2021). Based on the characteristics of the region, and according to Table 1, the classes of characterization were forest/reforestation, floodplain vegetation, pasture/field, exposed soil, agriculture and water bodies (Figure 7). The areas of land use was obtained through a computational tool (QGIS – Table 2).

The product of the use and occupation area with the pollutant load per area provided by MQUAL model (see Table 1) gives the load produced in the contribution area of a sub-basin or a diffuse area. The average concentration of each parameter, month by month, was obtained from the division between the load produced and the monthly flow (see Table 3). The estimation of nitrogen series (ammonia and nitrate) was based in literature data of the characteristic fractions of total nitrogen concentrations (HEATHWAITE AND JOHNES, 1996; THAYER, 1970; ELSER et al., 2010; RODE AND SUHR, 2007; WIEGNER et al., 2006). For the other parameters, the limit values defined by Resolution nº 222/2002 for class 2 watercourses were considered.

Table 2 - Land use and vegetation cover (km² and %) in Paraguay basin between WQS-1 and WQS-4. Author (2021).

Watershed	Land use and vegetation cover (km² and %)					
	Forest/ Reforestation	Floodplain vegetation	Pasture/ Field	Exposed soil	Agriculture	Water bodies
Mosquito River	6,259.7 km² 64.4%	379.2 km² 3.8%	3,096.5 km² 31.7%	7.9 km² <1%	4.1 km² <1%	7.7 km² <1%
Affluent 1	11,964.8 km² 64.7%	991.9 km² 5.3%	544.9 km² 29.5%	51.8 km² <1%	4.0 km² <1%	25.45 km² <1%
Gonzalez Stream	13,341.5 km² 72.2%	1,504.6 km² 8.1%	3,570 km² 1.9%	22.5 km² <1%	33.1 km² <1%	9.2 km² <1%
San Carlos River	13,637.0 km² 74.9%	635.1 km² 3.5%	3,857.9 km² 21.2%	17.8 km² <1%	41.5 km² <1%	7.0 km² <1%
Tagatija River	408.2 km² 46.7%	256.8 km² 29.4%	141.9km² 16.2%	0.1 km² <1%	62.6 km² 7%	4.2 km² <1%
Verde River	1,561.5 km² 58.8%	816.7 km² 30.7%	204.6 km² 7.7%	0.4 km² <1%	41.5 km² <1%	7.0 km² <1%
Aquibadán River	6,359.9 km² 56.2%	1,216.1 km² 10.7%	1,934.0 km² 17.0%	1.56 km² <1%	4.4 km² <1%	1,799.3 km² 15.8%
Diffuse sources	3,923.7 km² 54.4%	2,228.6 km² 25.7%	703.7 km² 9.7%	8.50 km² 7.50%	139.7 km² 1.9%	207.0 km² 2.8%

Table 3 - Water quality data used in the calibration model process. Author (2021).

Punctual entry	T ºC	pH	DO	BOD	TSS	NO	Ammonia	Nitrate	P_{total}
			mg/L						
Paraguay River	16-33	5.0-8.1	0.4-8.1	0.5	13.0-291.0	0.2-0.4	0.05-0.1	2.5-5.5	0.07-0.2
Mosquito River	16-33	5.0-8.1	5.0	3.9-34.2	9.9-470.3	0.2-9.1	0.04-2.3	1.9-114.1	0.07-0.7
Affluent 1	16-33	6.0	5.0	13.6-119.3	34.3-1557	0.5-30.6	0.13-7.6	6.7-382.3	0.07-2.4
Gonzalez Stream	16-33	6.0	5.0	2.8-24.8	6.7-315.1	0.1-6.5	0.03-1.6	1.4-81.6	0.07-0.5
San Carlos River	16-33	6.0	5.0	2.0-17.6	4.8-224.4	0.1-4.6	0.02-1.1	1.0-57.7	0.07-0.4
Tagatija River	16-33	6.0	5.0	1.9-16.9	4.5-313.3	0.1-4.7	0.02-1.2	0.9-58.5	0.07-0.5
Verde River	16-33	6.0	5.0	1.6-13.9	3.6-198.5	0.06-3.8	0.02-0.9	0.8-46.9	0.07-0.3
Aquibadán River	16-33	6.0	5.0	2.9-25.5	6.6-525.8	0.1-7.1	0.03-1.8	1.4-88.6	0.07-0.8
Diffuse sources	16-33	6.0	5.0	1.7-25.6	4.2-1,157.2	0.07-20.1	0.02-5.0	0.8-251.3	0.07-1.8

5.3.2 Self-depuration capacity simulation

Input data for water quality considered include: Paraguay River in WQS-2; the effluent from the paper and pulp industry; tributaries on the right bank (Affluent 1, Affluent 2, Siete Puntos River, Montelindo River, Negro River, Aguaray Guazú River and Affluent 4); tributaries on the left bank (Ypané River, Jejui Guazú River, Manduvirá River and Affluent 3); direct diffuse contributions on the right and left banks (see Figure 4).

The water quality data monitored in WQS-2 were used as input values in the Paraguay River upstream of the discharge point of effluent (300 m), complemented by the resulting data from calibration process.

For the other tributaries and diffuse areas, the methodology used was the same presented in item 5.3.1, using Figure 7 and Tables 1 and the areas of use and occupation of the region of influence between Concepción (Table 4). The load produced in the contribution area of a sub-basin or a diffuse area between Concepción and Asunción are shown in Table 5.

Table 4 - Land use and vegetation cover (km² and %) in Paraguay basin between Concepción and Asunción. Author (2021).

Watershed	Land use and vegetation cover (km² and %)					
	Forest/ Reforestation	Floodplain vegetation	Pasture/ Field	Exposed soil	Agriculture	Water bodies
Affluent 1*	4,229.1 km² 51.1%	2,127.8 km² 39,10%	1,672.9 km² 20.2%	1.7 km² <1%	245.8 km² 2.9%	1.3 km² <1%
Ypané River	4,100.3 km² 41.3%	2,249.0 km² 22.6%	2,469.2 km² 24.8%	1.6 km² <1%	1,085.2 km² 10.9%	23.8 km² <1%
Affluent 2	86.7 km² 25.6%	217.7 km² 64.2%	20.8 km² 6.1%	0.05 km² <1%	9.2 km² 2.7%	3.9 km² 1.1%
Siete Puntos River	931.8 km² 37.2%	1,011.9 km² 40,4%	212.7 km² 8.5%	0.15 km² <1%	347.3 km² 13.8%	0.3 km² <1%
Montelindo River	12,507.4 km² 73.3%	2,542.2 km² 14.9%	1,130.7 km² 6.6%	14.5 km² <1%	847.7 km² 4.9%	2.4 km² <1%
Jejui Guazú River	348.7 km² 37.8%	195.9 km² 21.3%	221.6 km² 24.0%	0.01 km² <1%	152.3 km² 16.5%	1.9 km² <1%
Affluent 3	8,844.9 km² 44.0%	7,435.5 km² 37.0%	1,130.4 km² 5.6%	7.8 km² <1%	2.490.7 km² 12,4%	159.8 km² <1%
Negro River	299.0 km² 12.3%	1,760.2 km² 72.5%	84.1 km² 3.4%	0.44km² <1%	2.2 km² <1%	280.2 km² 11.5%
Araguay Guazú River	13,027.8 km² 62.5%	5,352.0 km² 25,7%	869.5 km² 4.0%	87.0 km² <1%	1.457.4 km² 7.0%	18.0 km² <1%
Manduvirá River	2,112,3 km² 20.8%	4,179.2 km² 41.2%	283.6 km² 2,8%	4.5 km² <1%	3,528.1 km² 34.8%	15.3 km² <1%
Affluent 4	269.5 km² 12.7%	1,498.8 km² 70.8%	47.9 km² 2.2%	0.2 km² <1%	299.5 km² 14.1%	0.2 km² <1%
Diffuse sources	1,938.4 km² 19.0%	5,176.1 km² 50.9%	854.4 km² 8.4%	3.1 km² <1%	1,949.8 km² 19.2%	227.3 km² 2.2%

Table 5 - Water quality data used in the self-depuration capacity simulation. Author (2021).

Punctual entry	T °C	pH	DO	BOD	TSS	NO	Ammonia	Nitrate	P_{total}
			mg/L						
Affluent 1*	16-33	6.0	5.0	1.7-15.1	4.2-211.1	0.07-3.6	0.02-0.90	0.8-45.23	0.07-0.33
Ypané River	16-33	6.0	5.0	2.3-20.2	5.4-371.0	0.09-5.0	0.02-1.26	1.1-63.08	0.07-0.55
Affluent 2	16-33	6.0	5.0	2.0-17.6	4.5-350.0	0.08-4.6	0.02-1.14	0.9-56.95	0.07-0.54
Siete Puntos River	16-33	6.0	5.0	2.0-17.6	4.5-350.0	0.08-4.6	0.02-1.14	0.9-56.95	0.07-0.54
Montelindo River	16-33	6.0	5.0	2.1-18.3	4.6-254.1	0.08-4.5	0.02-1.12	1.0-56.07	0.07-0.43
Jejui Guazú River	16-33	6.0	5.0	2.7-23.8	6.4-473.9	0.1-6.0	0.03-1.50	1.3-74.94	0.07-0.71
Affluent 3	16-33	6.0	5.0	1.9-18.6	4.1-338.8	0.07-4.6	0.02-1.14	0.9-57.16	0.07-0.54
Negro River	16-33	6.0	5.0	11.7	2.9-271.7	0.05-3.1	0.01-0.78	0.6-39.04	0.07-0.41
Araguay Guazú River	16-33	6.0	5.0	17.8	4.4-273.3	0.08-4.4	0.02-1.10	1.0-55.20	0.07-0.46
Manduvirá River	16-33	6.0	5.0	28.0	6.9-690.9	0.12-7.6	0.03-1.90	1.5-94.94	0.07-1.05
Affluent 4	16-33	6.0	5.0	28.0	6.9-690.9	0.12-7.6	0.03-1.90	1.5-94.94	0.07-1.05
Diffuse sources	16-33	6.0	5.0	19.7	5.0-453.5	0.08-5.2	0.02-1.30	1.1-64.94	0.07-0.68

The water quality data of the pulp mill effluent were provided by the contracting company (Table 6).

Table 6 - Water quality data used in the self-depuration capacity simulation. Poyry (2021).

Standards	Value
Flow (m^3/h)	5,700.0
pH	6.0 to 8.0
Temperature (ºC)	≤ 40
BOD (mg/L)	25
COD (mg/L)	150
Suspended solids (mg/L)	40.0
Colour (mg/L)	250.0

Standards	Value
AOX (mg/L)	3.0
N_{total} (mg/L)	7.0
$N_{ammoniacal}$ (mg/L)	2.0
P_{total} (mg/L)	1.0

5.4 Climatological data

The climatological data used in this study (air temperature, evaporation, relative humidity and solar radiation) for the self-depuration capacity simulation of Paraguay River were obtained from DMH (2021) and ANA (2021), as shown in Figure 5.

5.5 Hydraulic data

The hydrodynamics adopted in WASP to propagate the flow along the segments of this study was the kinematic wave. This model provides a more realistic simulation of the flow dynamics in one-dimensional branched networks. The kinematic wave model allows diverging (branching) and then converging again the river channels, whose hydraulic behavior is similar to the alluvial valleys existing on the Paraguay River. The kinematic wave option is controlled by several hydraulic input data, such as the Manning roughness coefficient, bottom slope, channel width, minimum and average liquid depth and exponents of speed and depth (EPA, 2021). The sequence brings the methodologies and the hydraulic data values adopted in the 38 segments considered in the calibration and 64 segments considered in the self-depuration capacity simulations (see the topology in Figure 3).

Manning roughness coefficient η

There are several methodologies in the literature for estimating the Manning roughness coefficient, including empirical equations based on bottom granulometry and hydraulic characteristics, factors that influence flow resistance, tests and field measurements and analogy to previously existing studied channels. With the absence of granulometric data of bottom material and hydraulic field measurements for the region of interest on Paraguay River, scientific publications and indirect estimates become the only options for estimating the Manning roughness coefficient.

In alluvial channels with high surface widths compared to the liquid depth, the materials of the bottom sediments prevail over the material of the lateral slopes in the calculation of the Manning roughness coefficient. According to Leandro and Souza (2012) and Blettler et al. (2012), the bottom material on the upper course of Paraguay River consists of sand, silt, clay, gravel and benthic plants and organisms.

Paz et al. (2010) carried out a hydrodynamic modeling on the upper course of Paraguay River between the Brazilian cities of Cáceres and Porto Murtinho, getting a Manning roughness coefficient between 0.02 and 0.05. Frigo et al. (2015) estimated values between 0.035 and 0.055 for the Manning roughness coeficiente in the same region. Bahramifar et al. (2013), using a method based on an adaptive neuro-diffuse inference system, proposed an empirical equation to estimate the Manning roughness coefficient in alluvial channels. The empirical equation is a function of the bottom particle size, liquid depth and longitudinal bottom slope, with a high adjustment between the measured and estimated values in the range between 0.03 and 0.07. Kim et al. (2010)

estimated the Manning roughness coefficient in a South Korea river with a length/width ratio between 20 and 30, bottom material formed by coarse gravel and stone (diameter between 10 and 1000 mm) and flow between 6 and 1200 m^3/s. For these hydraulic configurations, using several equations in the literature and field measurements, the authors reached Manning roughness coefficients between 0.04 and 0.08.

In addition to the literature values previously reported, the Cowan method (CHOW, 1959) allows, from Equation (5), a joint analysis of the several factors that influence the flow resistance.

$$\boldsymbol{\eta = (\eta_o + \eta_1 + \eta_2 + \eta_3 + \eta_4).m} \tag{5}$$

Where: η_o is the basic value of the roughness coefficient for a straight, uniform channel with flat surfaces, according to the material associated with the contact surface; η_1 is the additional value corresponding to irregularities present in the watercourse, such as erosions, silting, protrusions and depressions on the surface; η_2 is the value corresponding to the frequency of shape variations in the watercourse, analyzed according to the possibilities of causing disturbances in the flow; η_3 is the value based on the presence of obstructions present in the watercourse, such as depositions of boulders, roots, trunks, among others, evaluated according to their extension in the sense of reducing the section and their possibility of causing turbulence in the flow; η_4 is the value based on the influence of vegetation type in the runoff, and must be evaluated according to the density and height of vegetation on the banks, as well as the obstruction caused in the flow section; m represents the meandering degree of the watercourse, evaluated by the ratio between the effective length of the section and the straight distance covered.

The possible variations and values of the factors inserted in Equation (1) are shown in Table 7.

Table 7 - Factor values of the Cowan method. Chow (1959, adapted).

Factors	Variations	Values	Factors	Variations	Values
η_o	Soil	0.020	η_3	Negligible	0.000
	Rock	0.025		Little	0.010-0.015
	Fine gravel	0.024		Appreciable	0.020-0.030
	Big gravel	0.028		Severe	0.040-0.060
η_1	Smooth	0.000	η_4	Low	0.005-0.010
	Little	0.005		Average	0.010-0.025
	Moderate	0.010		Hight	0.025-0.050
	Severe	0.020		Very Hight	0.050-0.100
η_2	Gradual	0.000	m	Small	1.000
	Occasional alternations	0.005		Appreciable	1.150
	Frequent alternations	0.010-0.015		Severe	1.300

In view of the alluvial characteristics in Paraguay River, the factors inserted in the Cowan method were: η_o equal to 0.020 $m^{-1/3}.s$ (soil) in all stretches, considering the accumulation of granulometry sediments between sand and mud in the benthic layer; η_1 equal to 0.010 $m^{-1/3}.s$ in all stretches, considering the possibility of moderate irregularities due to the erosive process at the margins (degree of sinuosity close to 1.3); η_2 equal to 0.005, considering the existence of occasional variations in the shape of the watercourse due to changes in the cross sections in the winding stretches and the various branches of the main channel; η_3 equal to zero in all stretches, considering the occurrence of turbulence in the flow as a result of depositions of boulders, roots and trunks as negligible, since the length/width ratio is close to 100; η_4 equal to 0.005 in all stretches, considering the influence of the margins vegetation in runoff as low (length/width ratio is close to 100); m equal to 1.30, considering the effective length of the meandering section close to 276 km and the "rectified" length close to 202 km. As result, the Manning roughness coefficient estimated by the Cowan method (CHOW, 1959) provides a value of 0.052 $m^{-1/3}.s$.

Width and length by segment

WASP tool uses width and length of the river segment discretized to calculate the water volume in each segment, with consequent obtaining of the pollutant mass in the segment. These values were obtained from Google Earth images. In order to obtain the width in each segment, a previous analysis of historical images was made to assess the level of flooding of the floodplains in rainy months.

Longitudinal slope by segment

The longitudinal slope in each stretch was obtained from the planialtimetric plan in the Terrain profile tool of QGIS, using the Digital Elevation Model of the Consortium for Spatial Information (CGIAR-CSI), with a precision of 90 m from the orbits srtm_24_16, srtm_24_17, srtm_25_15, srtm_25_16 and srtm_25_17 (CSI-CGIAR, 2021). The slope along the Paraguay River varied between 0,04 to 0,62 m/km in the calibration stretch and 0,04 to 3,05 m/km in the stretch between Concepción and Asunción. Paz et al. (2010) carried out a hydrodynamic modeling on the high course of Paraguay River, between Cáceres and Porto Murtinho cities, reaching a minimum, an average and a maximum longitudinal slopes equal to 0,02; 0,04 and 0,09 m/km.

Depth by segment

WASP tool uses depth by river segment discretized to calculate the water volume, with consequent obtaining of the pollutant mass by segment. The minimum depths by segment are assumed as zero flow, while the average depth is used to estimate the volume water by segment in the beginning of the simulation.

The minimum depths were fixed and equal to 0,001 m in all segments. In obtaining the average depths, WLS-1 (Vallemi), WLS-2 (Concepción), WLS-3 (Rosário) and WLS-4 (Asunción) were considered, all provided by DMH (2021) (see Figure 4). The average depth of each station was considered fixed in the adjacent upstream and downstream segments.

Depth exponent and velocity exponent

These exponents come from the potential relationships of depth and average speed with flow. The absence of historical flow monitoring in the stretch of interest prevented the adjustment of potential relationships from field data. As a result, the mean values recommended by the WASP manual for a cross-section shape “U” in a lotic environment were assumed as exponents of depth and velocity. Tables 8 and 9 show the hydraulic data adopted in the 38 segments considered in the calibration (lotic environment) and 64 segments considered in the self-depuration simulation (also lotic environment).

Table 8 - Hydraulic data adopted in 38 segments during calibration. Author (2021).

Segment	Longitudinal distance (m)	Bottom slope (m/m)	Width (m)	Manning roughness coefficient ($m^{-1/3}.s$)	Minimum depth (m)	Average depth (m)	Velocity exponent	Depth exponent
1	6000	0.000193	800	0.052	0.001	4.64	0.4	0.6
2	3100	0.000374	143	0.052	0.001	4.64	0.4	0.6
3	3510	0.000330	597	0.052	0.001	4.64	0.4	0.6
4	9430	0.000125	559	0.052	0.001	4.64	0.4	0.6
5	8988	0.000129	286	0.052	0.001	4.64	0.4	0.6
6	7362	0.000158	258	0.052	0.001	4.64	0.4	0.6
7	13310	0.000089	435	0.052	0.001	4.64	0.4	0.6
8	3029	0.000383	324	0.052	0.001	4.64	0.4	0.6
9	4625	0.000251	425	0.052	0.001	4.64	0.4	0.6
10	7876	0.000147	614	0.052	0.001	4.64	0.4	0.6
11	4789	0.000242	488	0.052	0.001	4.64	0.4	0.6
12	6842	0.000170	297	0.052	0.001	4.64	0.4	0.6

Segment	Longitudinal distance (m)	Bottom slope (m/m)	Width (m)	Manning roughness coefficient ($m^{-1/3}.s$)	Minimum depth (m)	Average depth (m)	Velocity exponent	Depth exponent
13	6239	0.000189	782	0.052	0.001	4.64	0.4	0.6
14	6915	0.000168	450	0.052	0.001	4.64	0.4	0.6
15	7051	0.000165	358	0.052	0.001	4.64	0.4	0.6
16	8245	0.000141	365	0.052	0.001	4.64	0.4	0.6
17	3553	0.000326	216	0.052	0.001	4.64	0.4	0.6
18	2936	0.000395	154	0.052	0.001	4.64	0.4	0.6
19	3234	0.000359	355	0.052	0.001	4.64	0.4	0.6
20	16000	0.000074	595	0.052	0.001	4.64	0.4	0.6
21	3249	0.000357	353	0.052	0.001	4.64	0.4	0.6
22	3489	0.000332	304	0.052	0.001	4.64	0.4	0.6
23	8231	0.000141	654	0.052	0.001	4.64	0.4	0.6
24	4239	0.000274	363	0.052	0.001	4.72	0.4	0.6
25	5067	0.000229	496	0.052	0.001	4.72	0.4	0.6
26	18376	0.000063	471	0.052	0.001	4.72	0.4	0.6
27	18328	0.000263	179	0.052	0.001	4.72	0.4	0.6
28	17511	0.000202	415	0.052	0.001	4.72	0.4	0.6
29	1871	0.000620	661	0.052	0.001	4.72	0.4	0.6
30	4180	0.000278	229	0.052	0.001	4.72	0.4	0.6
31	4484	0.000259	403	0.052	0.001	4.72	0.4	0.6
32	30475	0.000038	783	0.052	0.001	4.72	0.4	0.6
33	4338	0.000267	143	0.052	0.001	4.72	0.4	0.6
34	3908	0.000297	839	0.052	0.001	4.72	0.4	0.6
35	3293	0.000352	796	0.052	0.001	4.72	0.4	0.6
36	4753	0.000244	362	0.052	0.001	4.72	0.4	0.6
37	3848	0.000301	468	0.052	0.001	4.72	0.4	0.6
38	5060	0.000229	883	0.052	0.001	4.72	0.4	0.6

Table 9 - Hydraulic data adopted in 64 segments during self-depuration simulation. Author (2021).

Segment	Longitudinal distance (m)	Bottom slope (m/m)	Width (m)	Manning roughness coefficient ($m^{-1/3}.s$)	Minimum depth (m)	Average depth (m)	Velocity exponent	Depth exponent
1	3293	0.000352	796	0.052	0.001	4.72	0.4	0.6
2	4753	0.000244	362	0.052	0.001	4.72	0.4	0.6
3	3848	0.000301	468	0.052	0.001	4.72	0.4	0.6

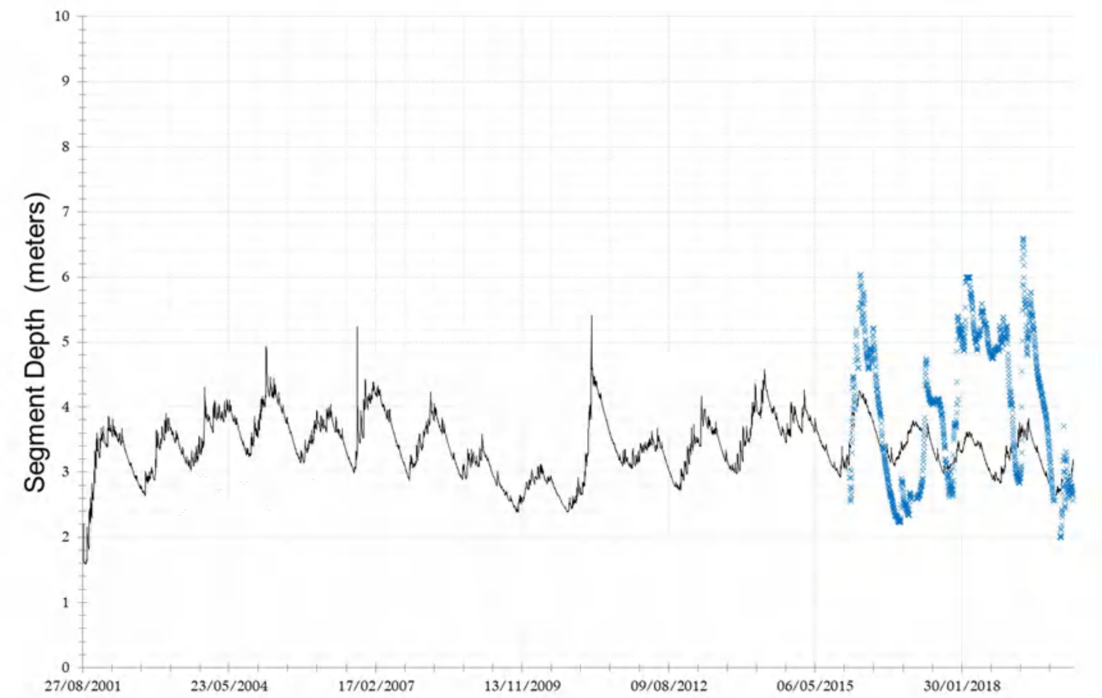
Segment	Longitudinal distance (m)	Bottom slope (m/m)	Width (m)	Manning roughness coefficient ($m^{-1/3}.s$)	Minimum depth (m)	Average depth (m)	Velocity exponent	Depth exponent
4	5060	0.000229	883	0.052	0.001	4.72	0.4	0.6
5	17720	0.000069	478	0.052	0.001	4.72	0.4	0.6
6	17164	0.000071	190	0.052	0.001	4.72	0.4	0.6
7	6585	0.000176	664	0.052	0.001	4.72	0.4	0.6
8	3096	0.000375	157	0.052	0.001	4.72	0.4	0.6
9	1873	0.000619	636	0.052	0.001	4.72	0.4	0.6
10	12260	0.000095	529	0.052	0.001	4.72	0.4	0.6
11	2874	0.000404	326	0.052	0.001	4.72	0.4	0.6
12	3527	0.000329	214	0.052	0.001	4.72	0.4	0.6
13	9430	0.000123	386	0.052	0.001	4.72	0.4	0.6
14	2559	0.000453	180	0.052	0.001	4.72	0.4	0.6
15	2975	0.000390	204	0.052	0.001	4.72	0.4	0.6
16	10284	0.000113	559	0.052	0.001	4.72	0.4	0.6
17	3778	0.000307	530	0.052	0.001	4.72	0.4	0.6
18	5922	0.000196	184	0.052	0.001	4.72	0.4	0.6
19	3892	0.000303	269	0.052	0.001	4.72	0.4	0.6
20	4153	0.000279	310	0.052	0.001	4.72	0.4	0.6
21	4685	0.000248	841	0.052	0.001	4.72	0.4	0.6
22	12889	0.000275	599	0.052	0.001	4.72	0.4	0.6
23	11956	0.000097	308	0.052	0.001	4.72	0.4	0.6
24	12529	0.000093	222	0.052	0.001	4.57	0.4	0.6
25	11380	0.000102	501	0.052	0.001	4.57	0.4	0.6
26	3100	0.000374	441	0.052	0.001	4.57	0.4	0.6
27	2972	0.000390	187	0.052	0.001	4.57	0.4	0.6
28	14058	0.000083	501	0.052	0.001	4.57	0.4	0.6
29	3074	0.000377	622	0.052	0.001	4.57	0.4	0.6
30	3207	0.000362	128	0.052	0.001	4.57	0.4	0.6
31	3188	0.000364	613	0.052	0.001	4.57	0.4	0.6
32	2871	0.000404	583	0.052	0.001	4.57	0.4	0.6
33	2600	0.000446	369	0.052	0.001	4.57	0.4	0.6
34	8919	0.000130	613	0.052	0.001	4.57	0.4	0.6
35	4826	0.000240	348	0.052	0.001	4.57	0.4	0.6
36	5057	0.000229	111	0.052	0.001	4.57	0.4	0.6
37	2756	0.000421	766	0.052	0.001	4.57	0.4	0.6
38	2807	0.000413	264	0.052	0.001	4.57	0.4	0.6
39	2669	0.000435	154	0.052	0.001	4.57	0.4	0.6

Segment	Longitudinal distance (m)	Bottom slope (m/m)	Width (m)	Manning roughness coefficient ($m^{-1/3}.s$)	Minimum depth (m)	Average depth (m)	Velocity exponent	Depth exponent
40	3498	0.000332	906	0.052	0.001	4.57	0.4	0.6
41	2777	0.000418	515	0.052	0.001	4.57	0.4	0.6
42	2989	0.000388	184	0.052	0.001	4.57	0.4	0.6
43	12665	0.000092	455	0.052	0.001	4.57	0.4	0.6
44	3053	0.001160	289	0.052	0.001	4.57	0.4	0.6
45	2373	0.000489	440	0.052	0.001	4.57	0.4	0.6
46	16221	0.000073	494	0.052	0.001	4.57	0.4	0.6
47	2330	0.003047	493	0.052	0.001	4.57	0.4	0.6
48	2727	0.000425	197	0.052	0.001	4.57	0.4	0.6
49	8663	0.000134	457	0.052	0.001	4.57	0.4	0.6
50	970	0.001196	290	0.052	0.001	4.57	0.4	0.6
51	1120	0.001036	583	0.052	0.001	4.57	0.4	0.6
52	3304	0.000351	504	0.052	0.001	4.57	0.4	0.6
53	1943	0.000597	477	0.052	0.001	4.57	0.4	0.6
54	1899	0.000611	194	0.052	0.001	4.57	0.4	0.6
55	30425	0.000038	671	0.052	0.001	4.57	0.4	0.6
56	2633	0.000441	333	0.052	0.001	4.57	0.4	0.6
57	2500	0.000464	99	0.052	0.001	4.57	0.4	0.6
58	12734	0.000091	675	0.052	0.001	4.57	0.4	0.6
59	7467	0.000268	224	0.052	0.001	4.59	0.4	0.6
60	5595	0.000357	557	0.052	0.001	4.59	0.4	0.6
61	7441	0.000134	574	0.052	0.001	4.59	0.4	0.6
62	4839	0.000207	629	0.052	0.001	4.59	0.4	0.6
63	5734	0.000174	290	0.052	0.001	4.59	0.4	0.6
64	3625	0.000276	569	0.052	0.001	4.59	0.4	0.6

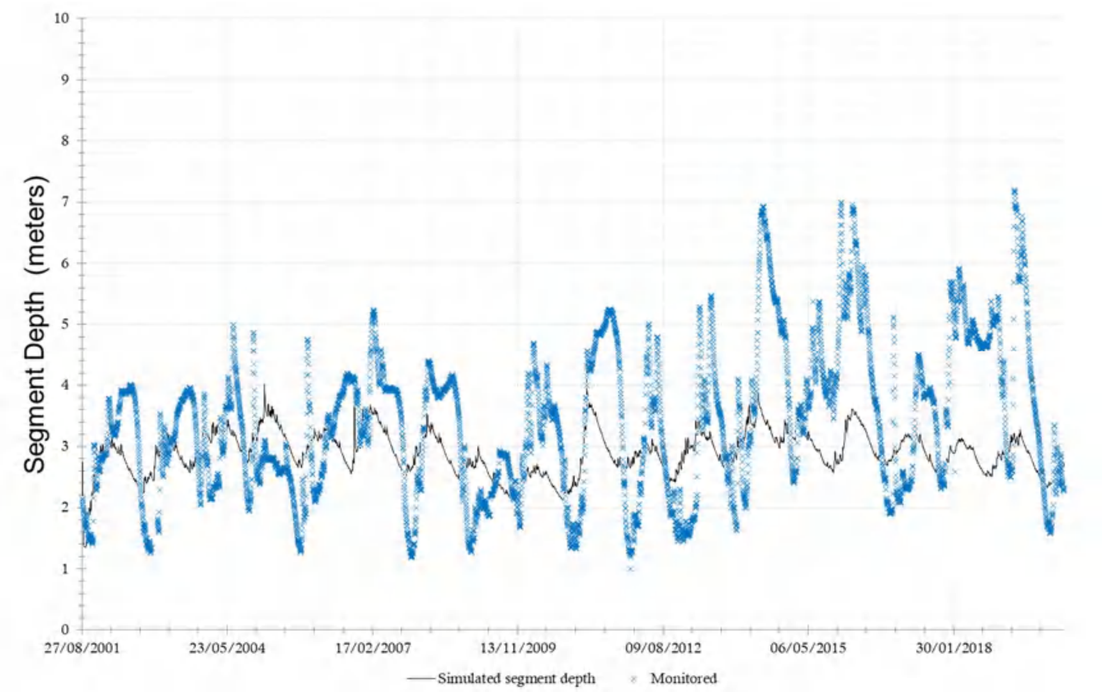
6 MODEL CALIBRATION

The correct representation of hydraulics and hydrogeometry (depth, surface width and average velocity) in each segment is essential for the estimation of the volume and consequent obtaining of the mass and transport of pollutant per segment.

The discharge coefficients that provide the depth, surface width and average velocity as a function of the flow are obtained from fieldwork (Leopold and Maddox, 1953 *apud* WASP, 2021). The absence of empirical data makes it necessary to use values from the literature. The WASP tool define different transverse geometries for the watercourse from exponents of depth, surface width and average velocity in rectangular channels, “U” shape, “V” shape and shallow. As previously mentioned, the mean values recommended by the WASP manual for cross-section type “U” shape were assumed as exponents of depth and velocity. Figure 8 shows the temporal variation of the depth in segment 1 (WLS-1) and segment 38 (WLS-2) from 09/2001 to 12/2020.



(a)



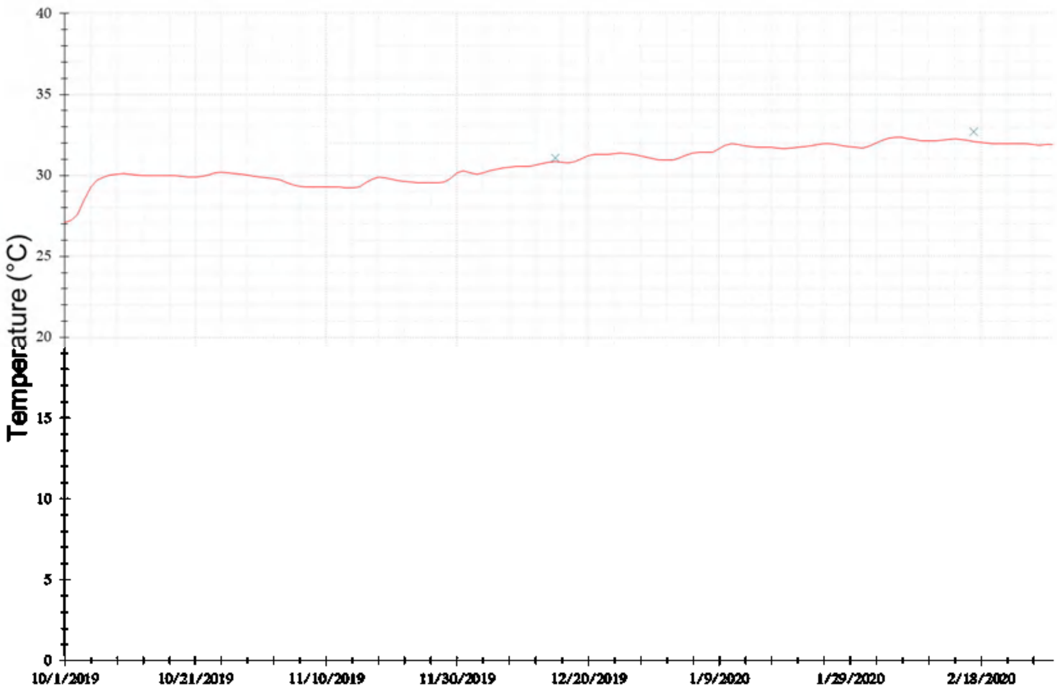
(b)

Figure 8 - Temporal variation of the depth in: a) segment 1 (WLS-1) and b) segment 38 (WLS-2). Author (2021).

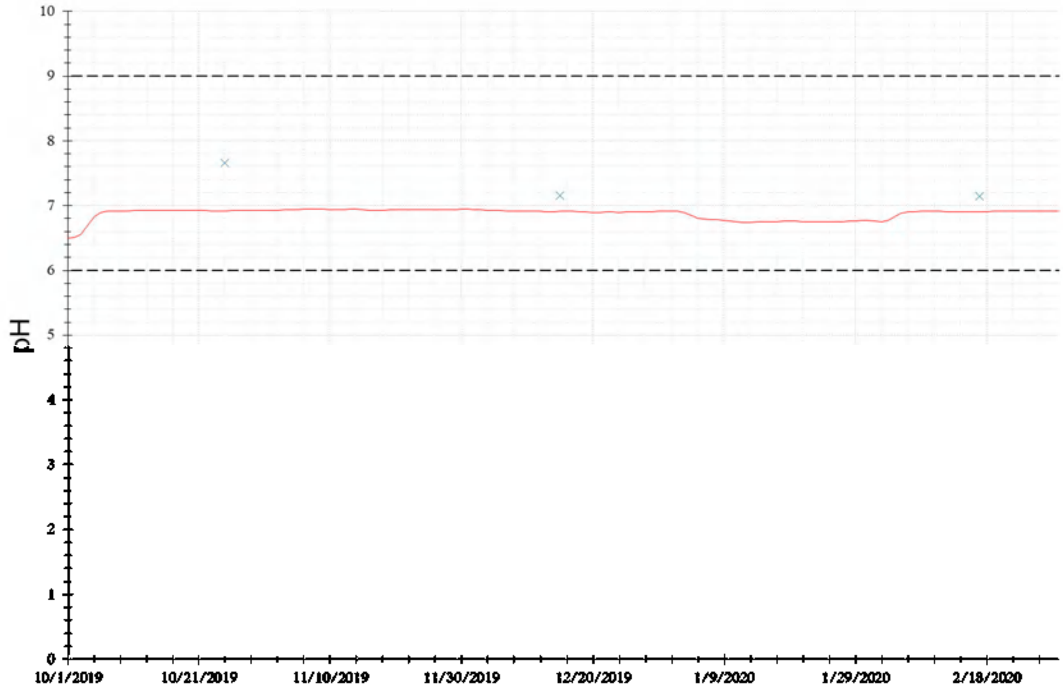
The transverse geometry along the Paraguay River is variable, mainly due to the alluvial character and high sinuosity index, which causes oscillate position of the main channel between the left and right banks. The composite geometry of the river near of the liquid level monitoring stations causes a greater variation in the depth, between 2,0 and 6,6 m for WLS-1 and between 1,0 and 7,2 m for WLS-2 (see Figure 8). WASP tool works with simple sections to represent the geometry of the river in each segment. The actual depths are transformed into hydraulic depths. However, the variation of depth in segments 1 and 38 was smaller, between 1,6 and 5,4 m for WLS-1 and between 1,4 and 4,3 m for WLS-2 (see Figure 8).

The contracting company provided water quality data (physical and chemical parameters) monitored in three Water Quality Stations along Paraguay River (WQS-2, WQS-3 and WQS-4 - see location in Figures 1, 3 and 4), with collections on 10/25/2019, 12/15/2019 and 2/17/2020 for WQS-2 and WQS-3 and 02/2017, 04/2017, 08/2017, 09/2017, 12/2017, 02/2018, 03/2018, 04/2018, 07/208 and 12/2018 for WQS-4. The parameters monitored at stations WQS-2 and WQS-3 were water temperature, pH, total solids, dissolved oxygen, biochemical oxygen demand, total phosphorus, ammonia and nitrate. Only the parameters pH, total solids, ammonia and nitrate were monitored in WQS-4.

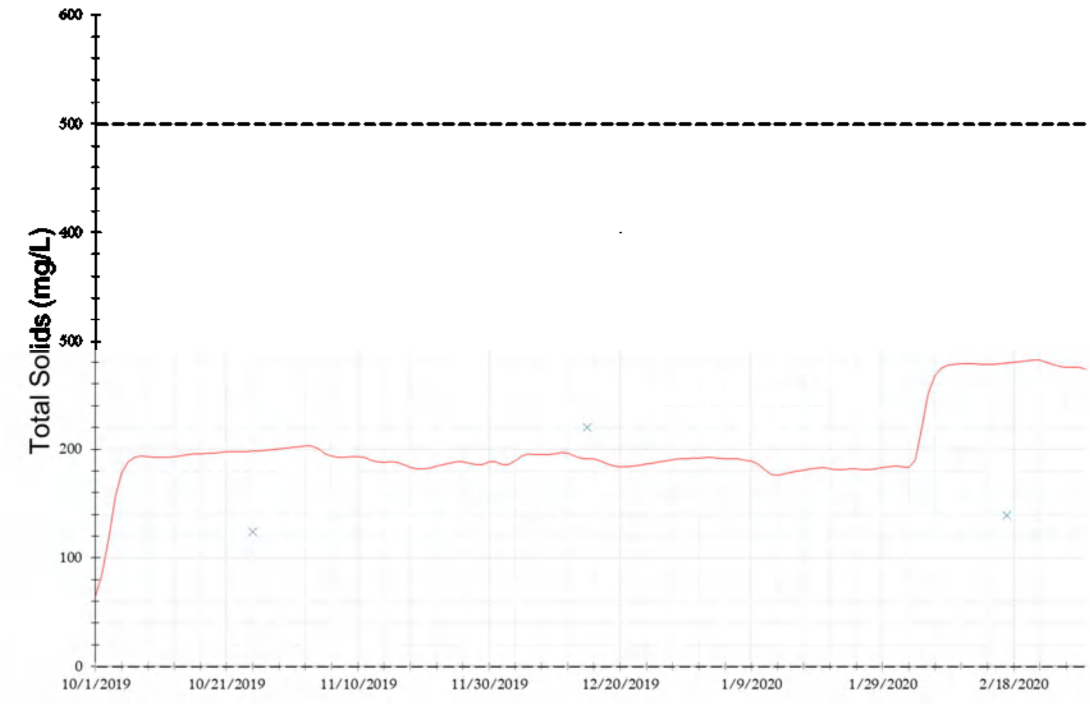
The calibration process of coefficients related to the physical and biochemical processes provided a good fit between the simulated profiles and monitored data in WQS-2, WQS-3 and WQS-4, according Figures 9, 10 and 11. These calibrated coefficients were kept fixed in the analysis of the self-depuration capacity of the Paraguay River with release of effluent from the industry.



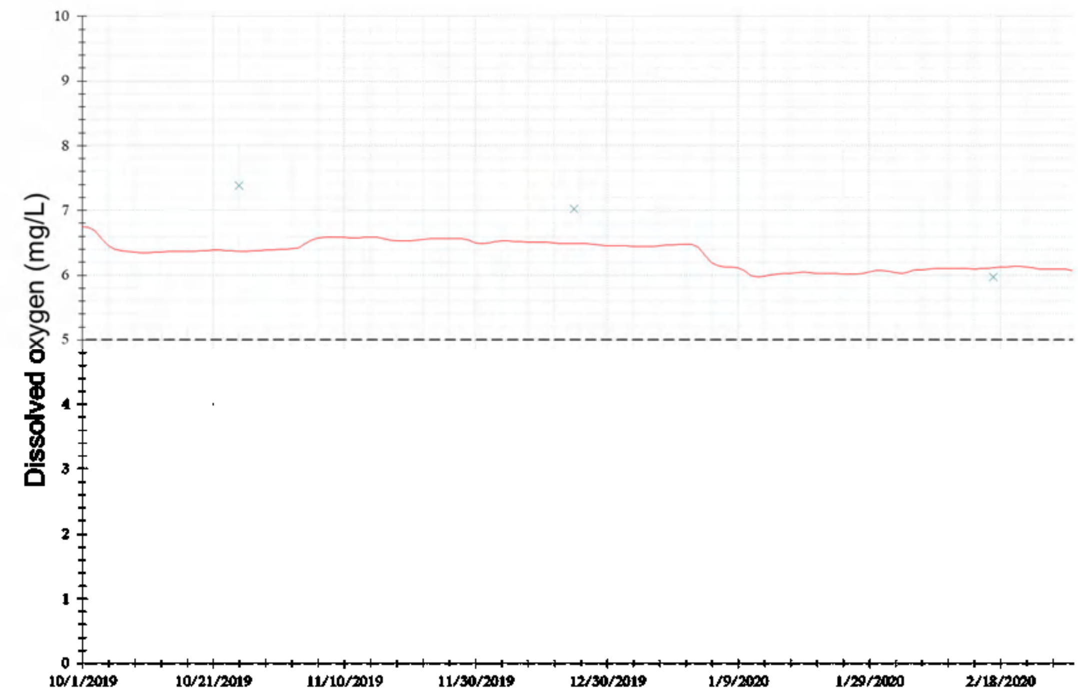
(a) temperature



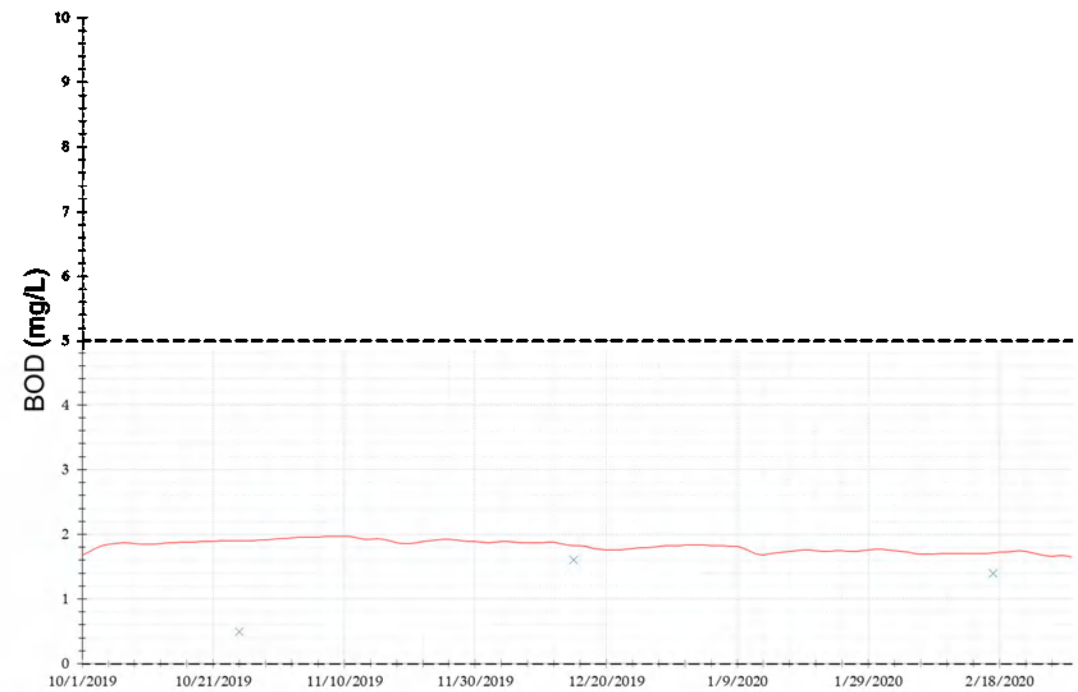
(b) pH



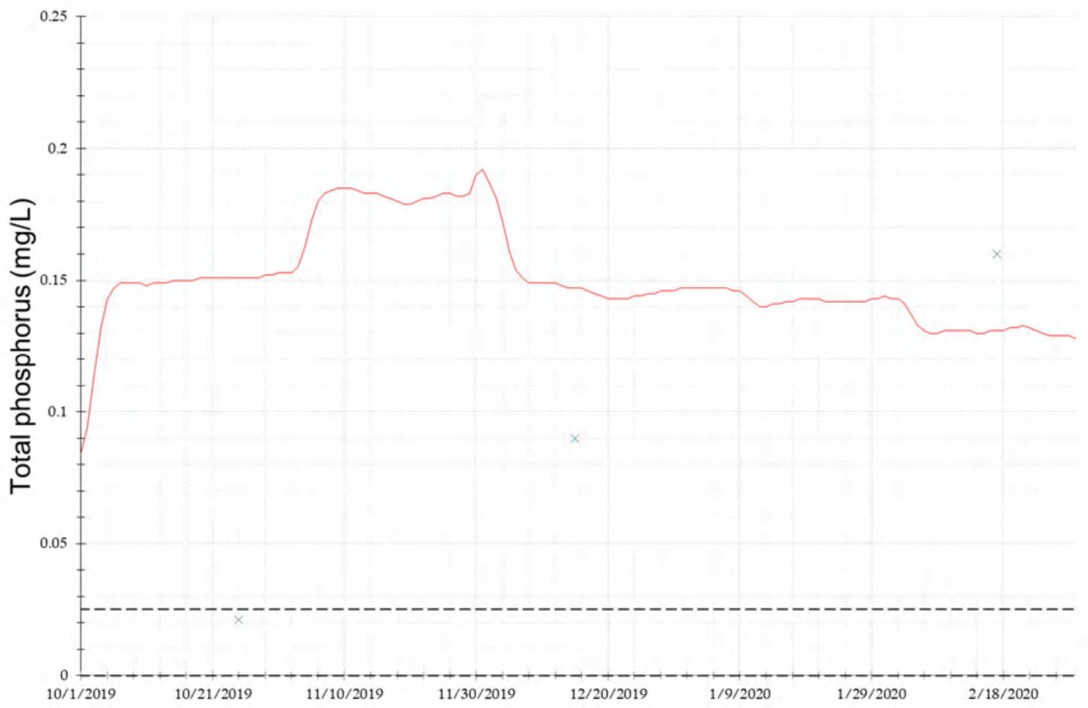
(c) total solids



(d) dissolved oxygen



(e) BOD



(f) total phosphorus

(g) ammonia

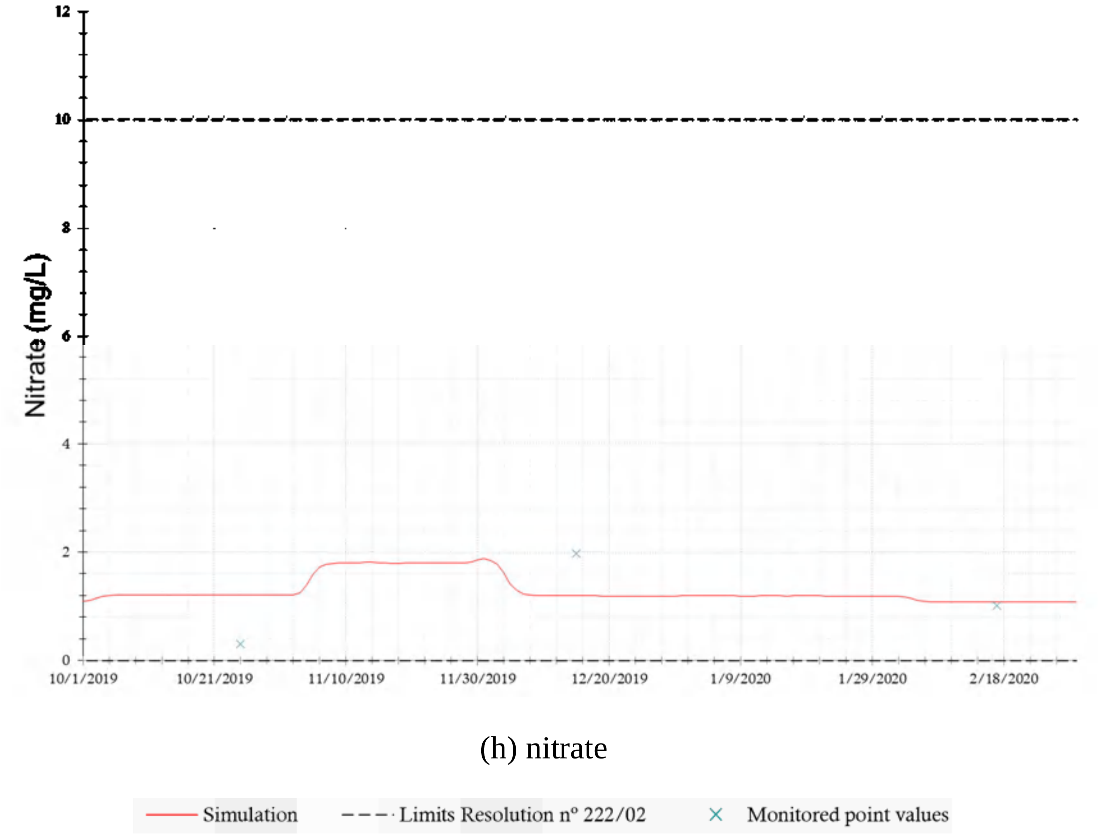
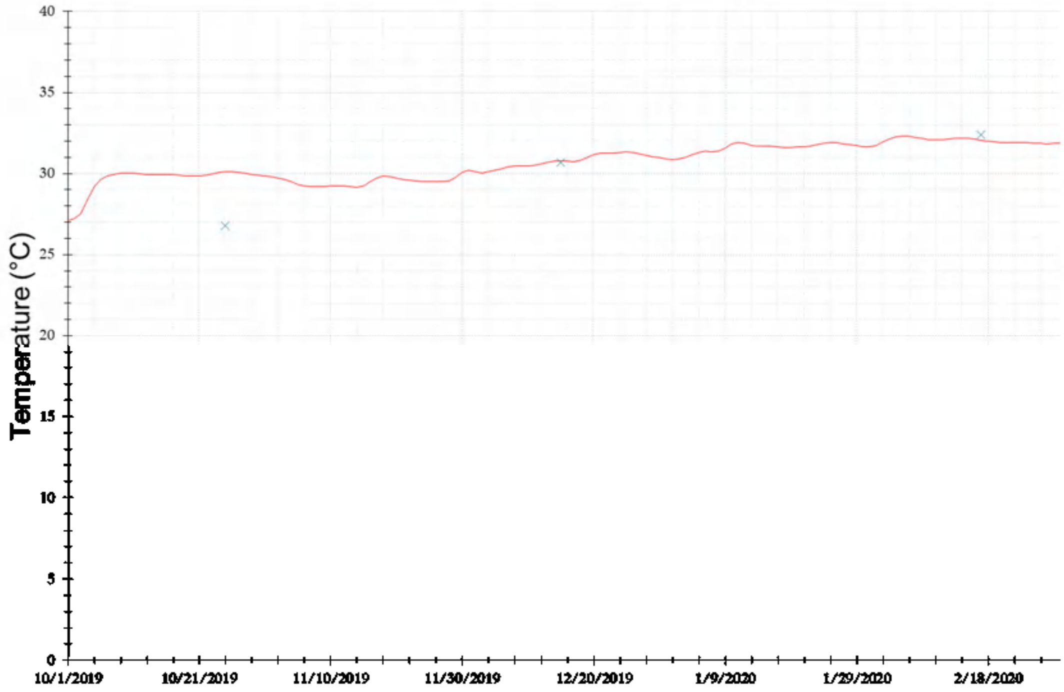
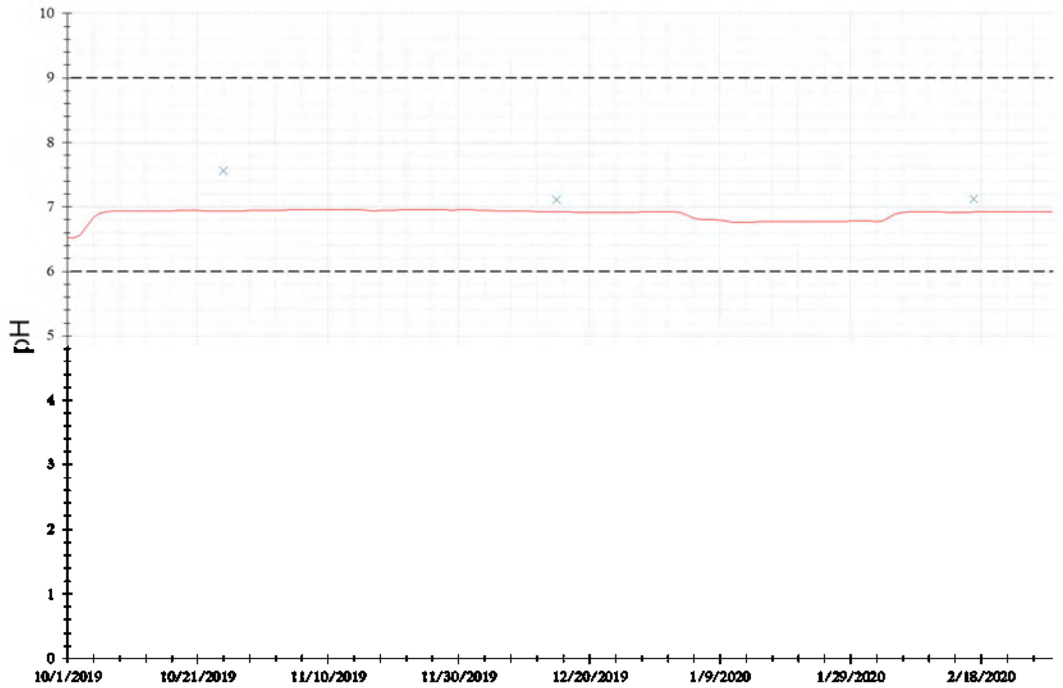


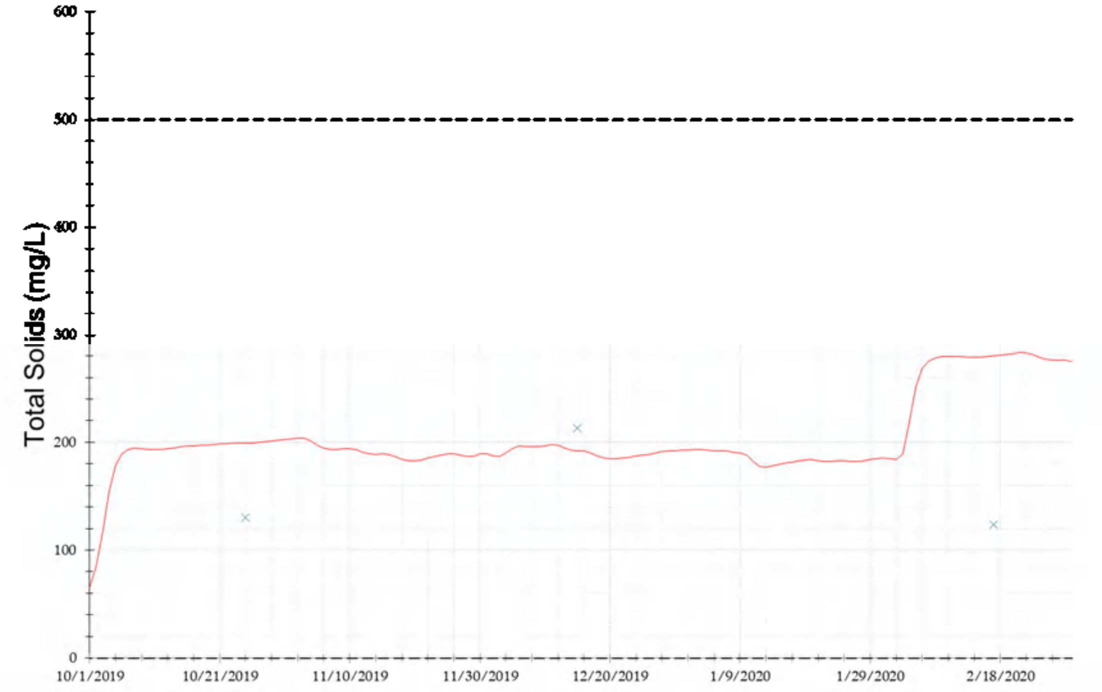
Figure 9 - Fit between simulated profiles and monitored data in WQS-2. Author (2021).



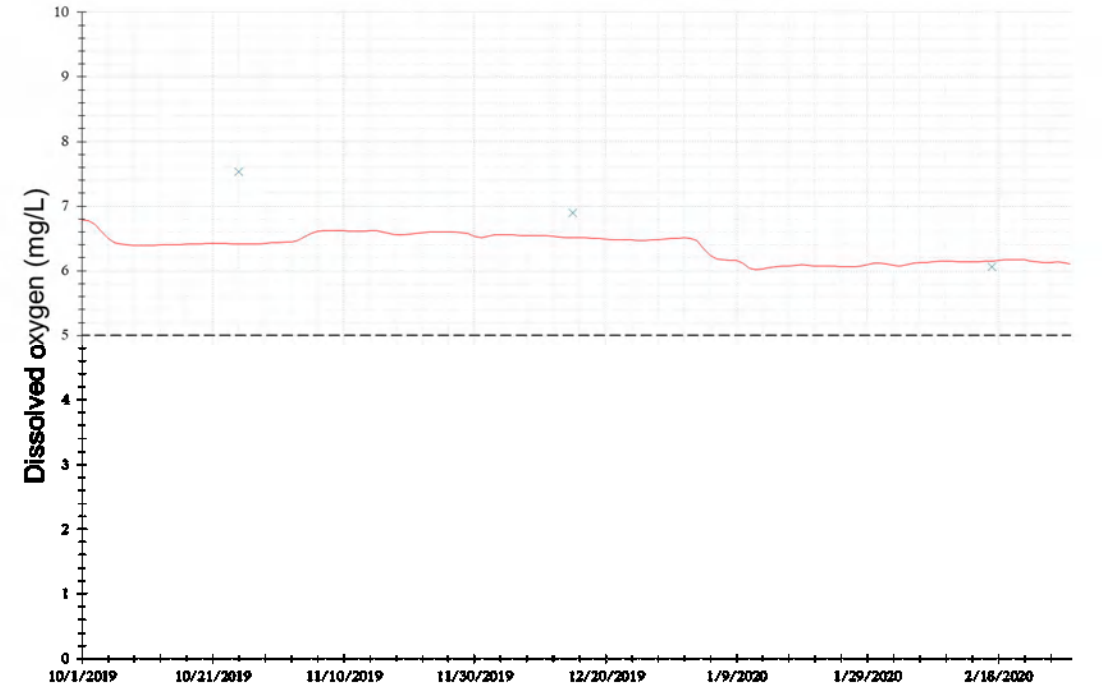
(a) temperature



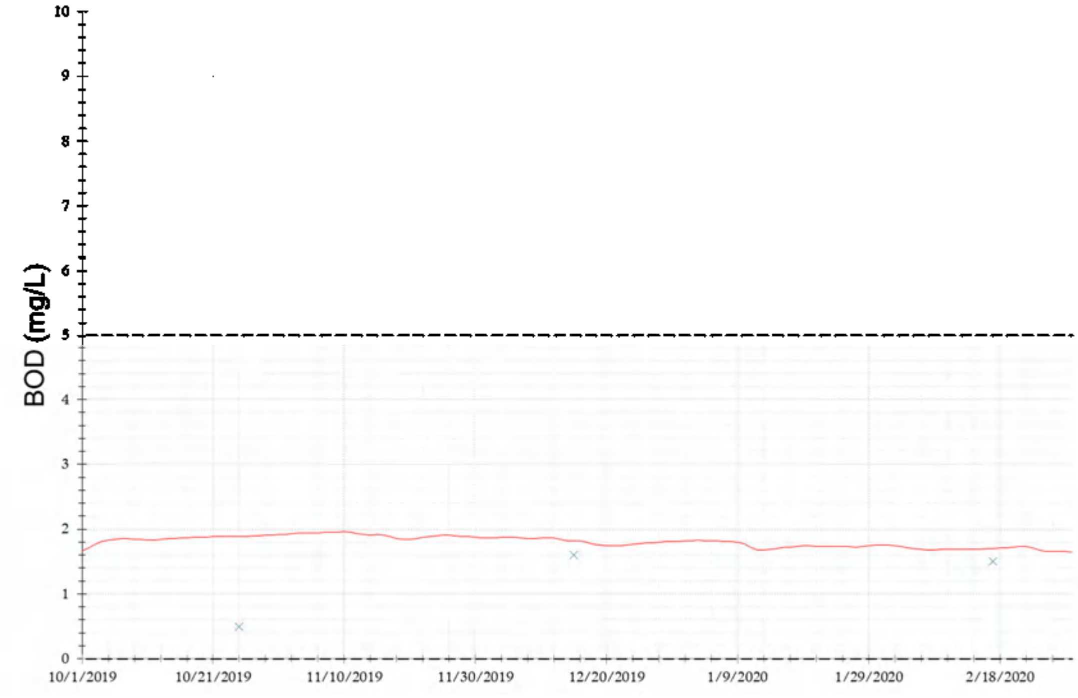
(b) pH



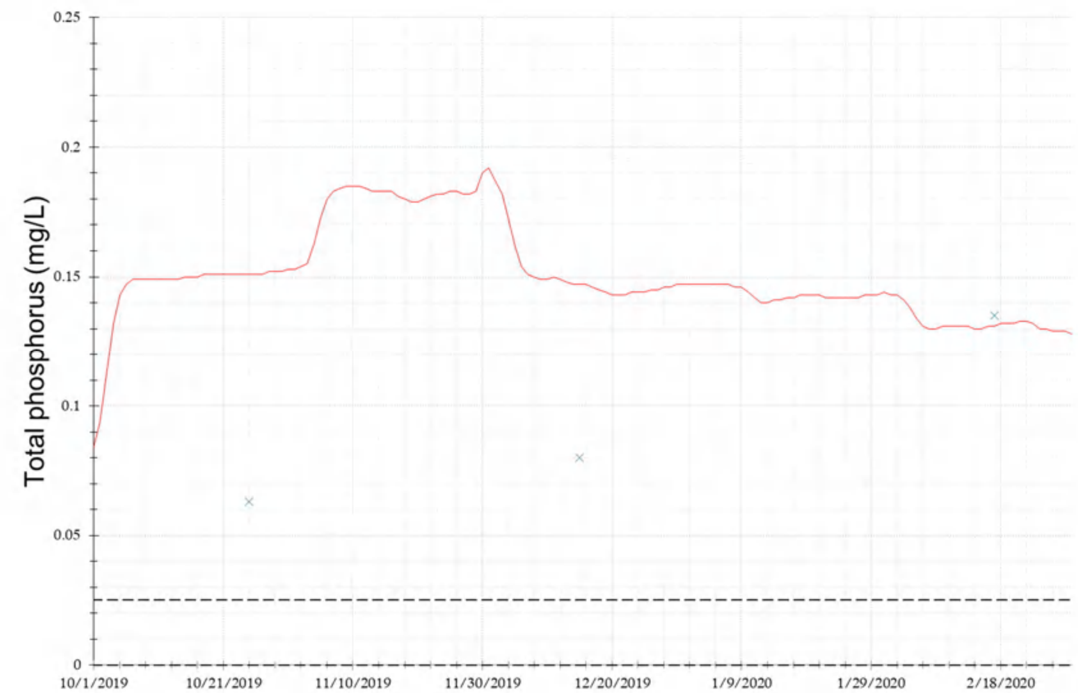
(c) total solids



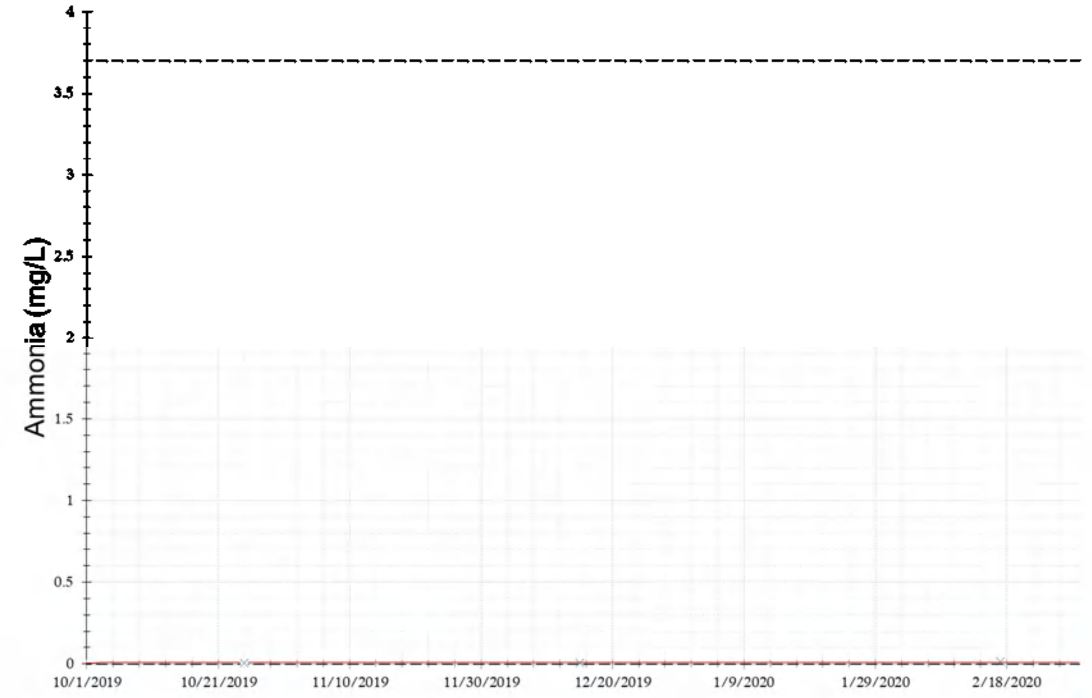
(d) dissolved oxygen



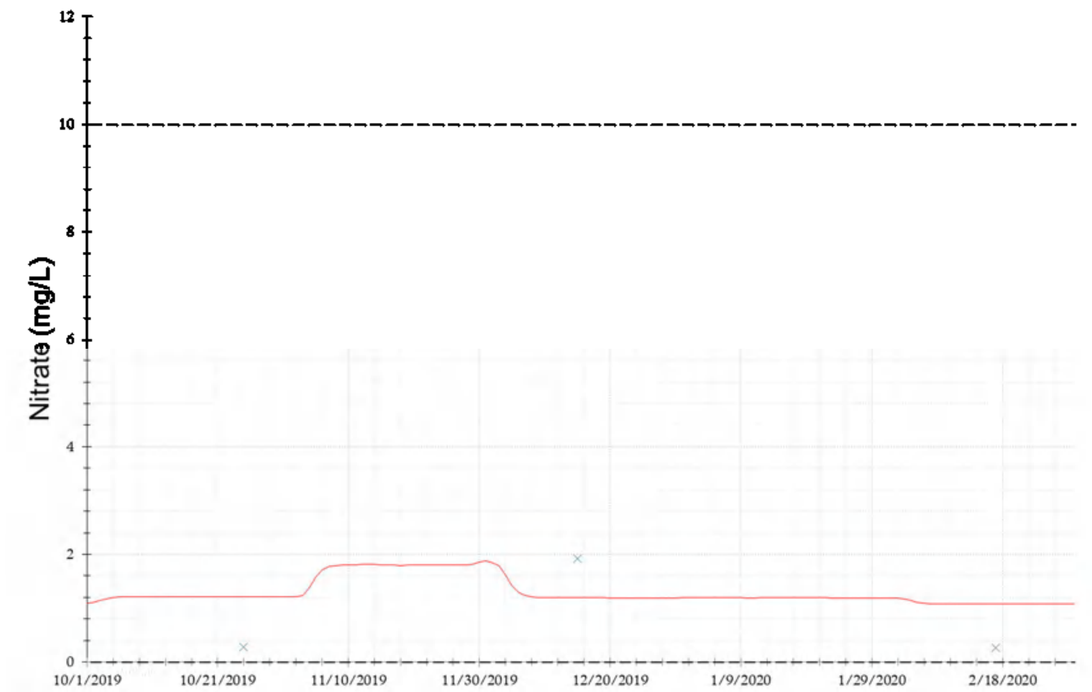
(e) BOD



(f) total phosphorus



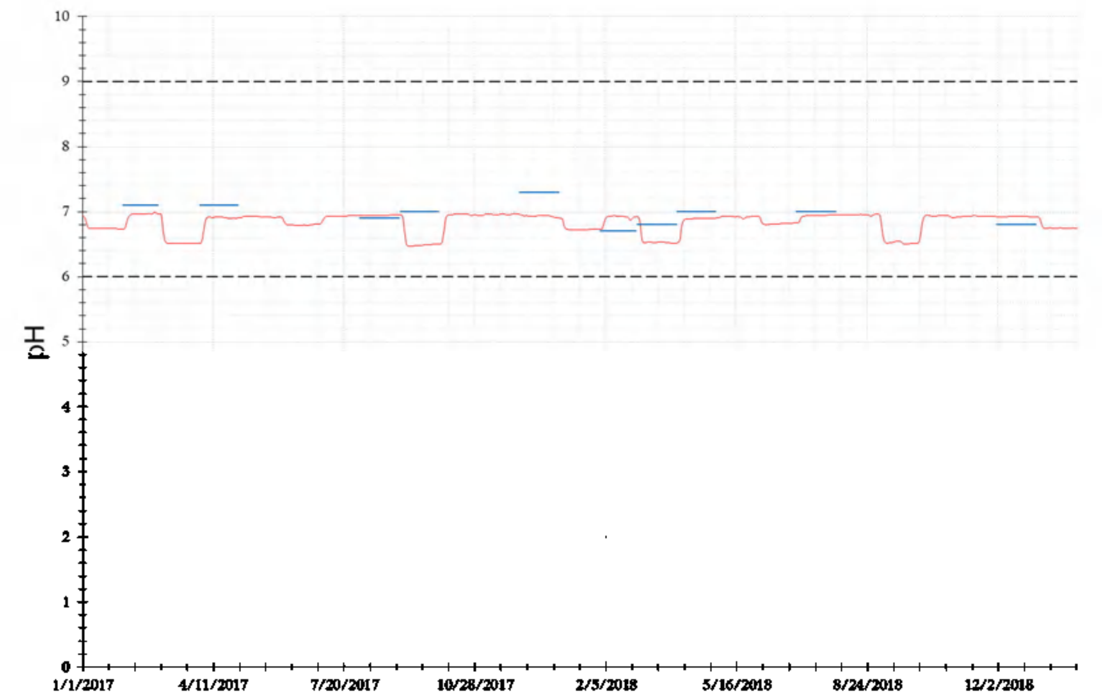
(g) ammonia



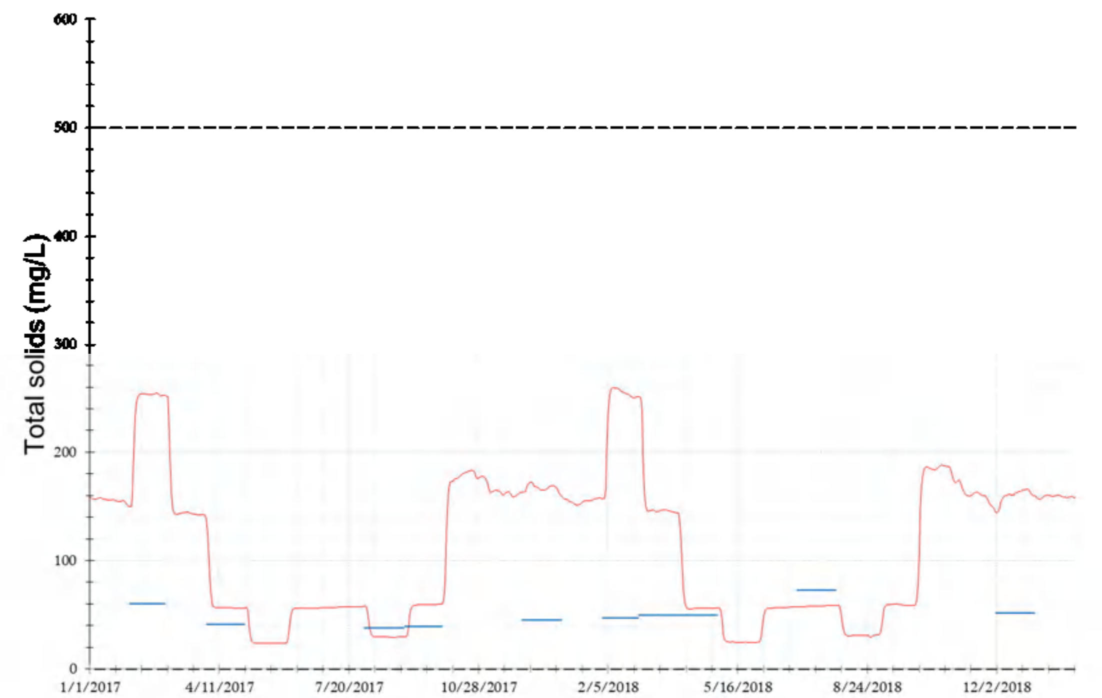
(h) nitrate

Simulation   Limits Resolution nº 222/02   Monitored point values

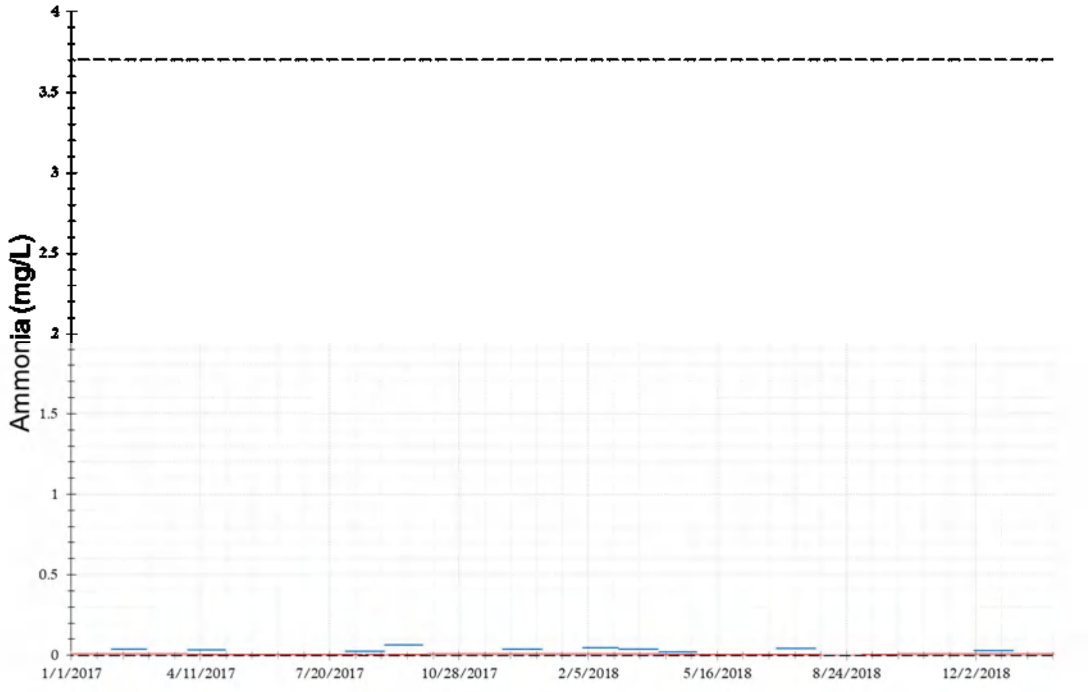
Figure 10 - Fit between simulated profiles and monitored data in WQS-3. Author (2021).



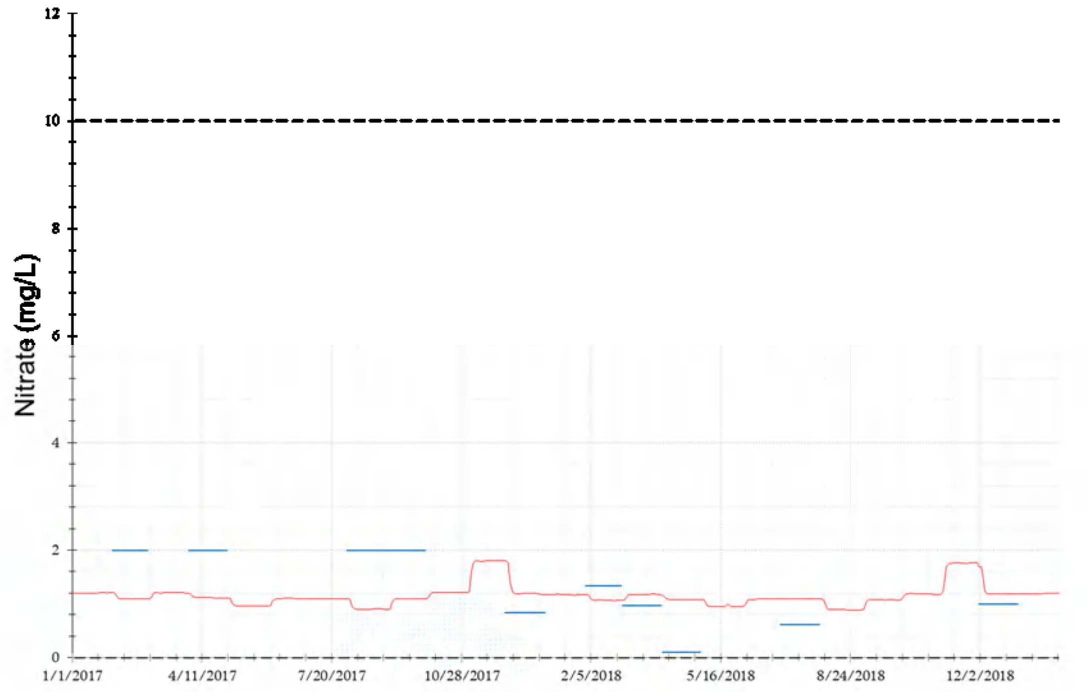
(a) pH



(b) total solids



(c) ammonia



(d) nitrate

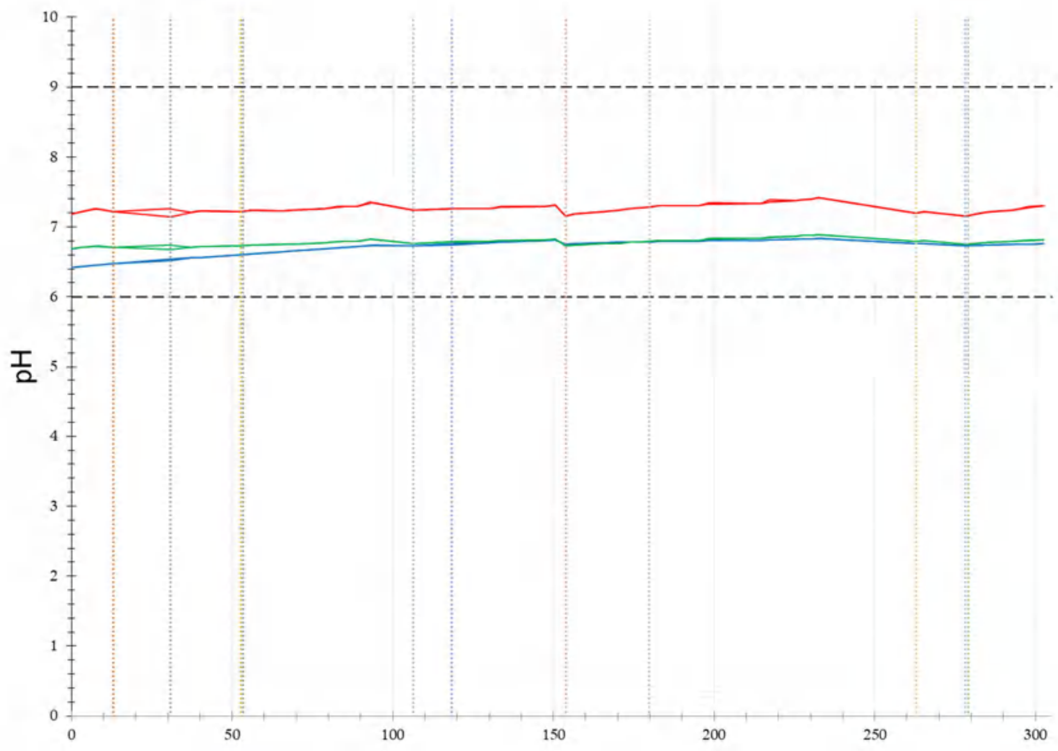
Simulation ---- Limits Resolution nº 222/02 Monitored average values

Figure 11 – Fit between simulated profiles and monitored data in WQS-4. Author (2021).

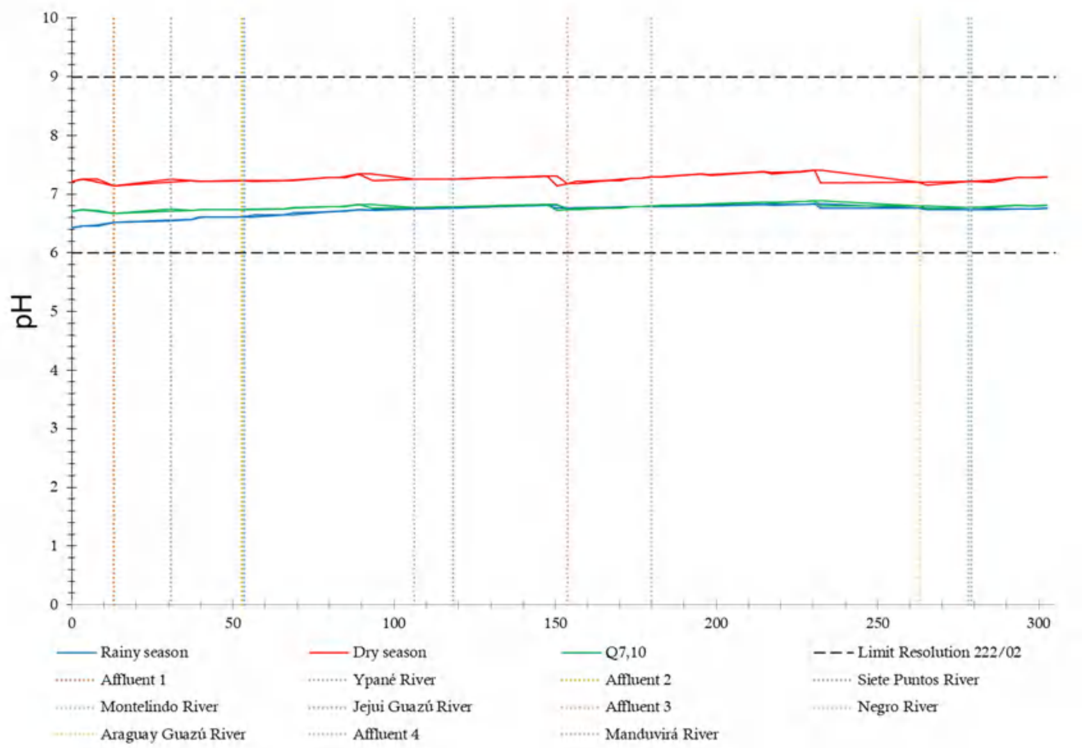
7 SELF-DEPURATION SIMULATION

In general, the water quality modeling in lotic environment evaluates if the natural watercourse has a self-depuration capacity against a pollutant. The objective is to adapt the water quality to the minimum limits established in a specific environmental resolution, with a consequent guarantee of balance in the abiotic and biotic processes.

The simulation focus is assessing the influence of the pollutants launched by the pulp mill on the self-depuration capacity of Paraguay River between Concepción and Asunción. For this, considering the maximum flow (5,759.3 m^3/s), minimum (499.8 m^3/s) and critical flows $Q_{7,10}$ (1,093 m^3/s) for period of September 2001 to February 2020, longitudinal profiles of pH, total suspended solids, dissolved oxygen, biochemical oxygen demand, ammonia, nitrate and total phosphorus parameters were compared, in the current situation and in the future situation after the launch of the industry effluent. Comparing the current situation and the future situation after launching of the industrial pollutant, Figures 12 to 18 show, for the maximum, minimum and critical flows ($Q_{7.10}$), the longitudinal profiles of pH, total suspended solids, dissolved oxygen, biochemical oxygen demand, ammonia, nitrate and total phosphorus parameters.

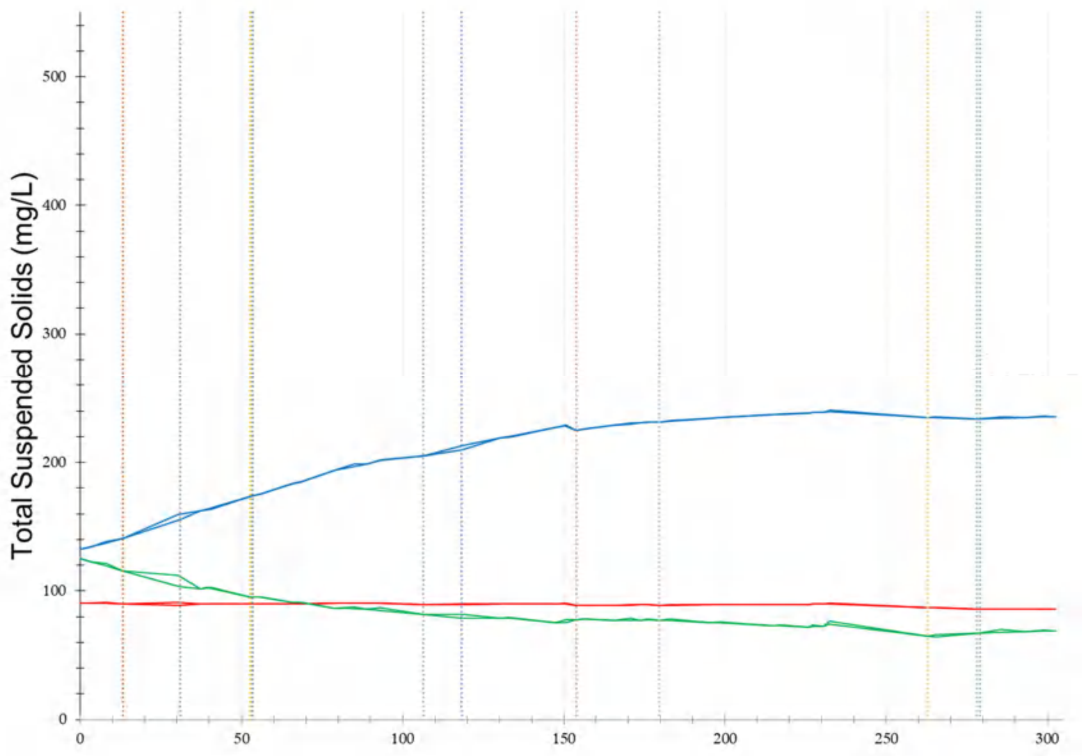


(a)

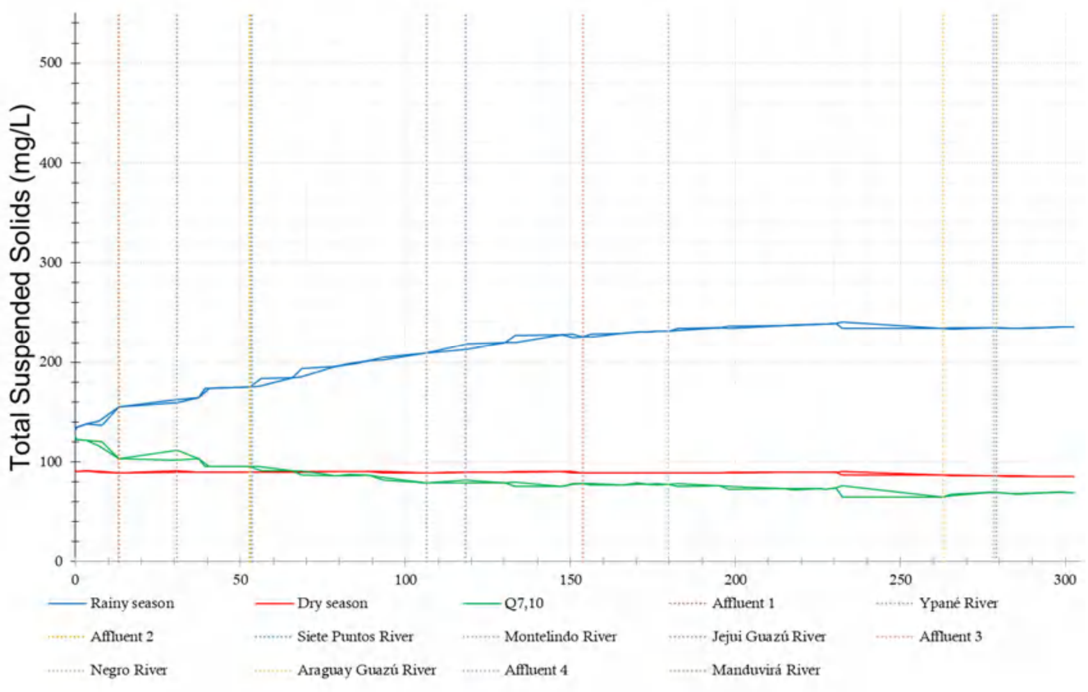


(b)

Figure 12 - Longitudinal profiles of pH: (a) Current situation; (b) Future situation after the treated effluent discharge.

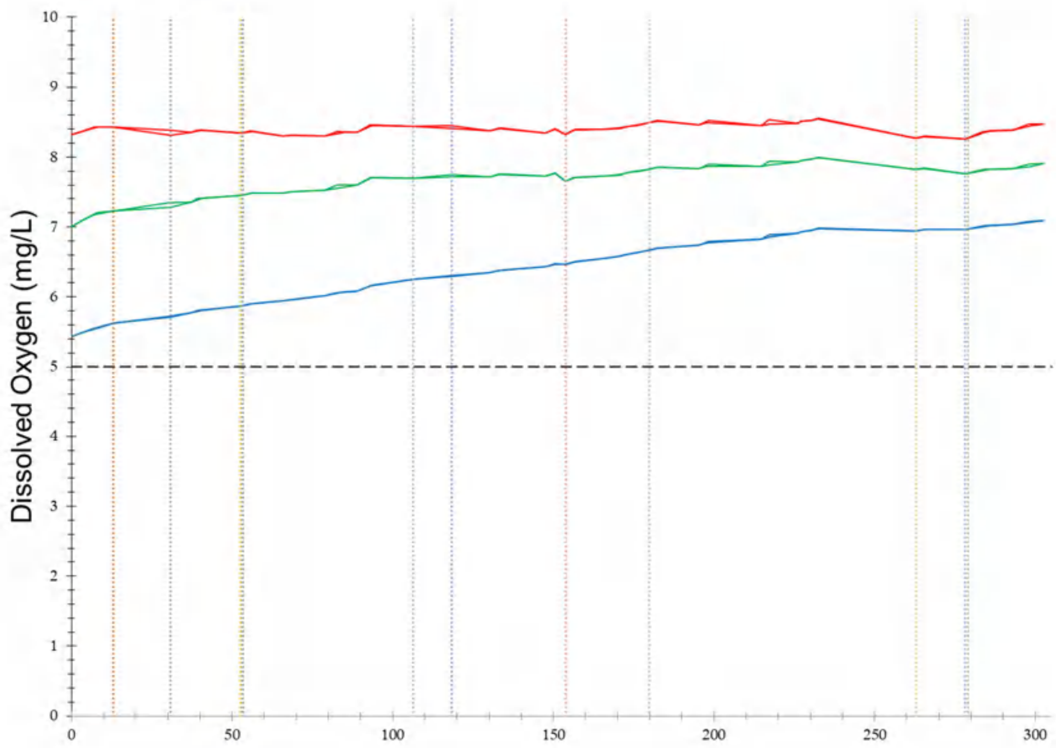


(a)

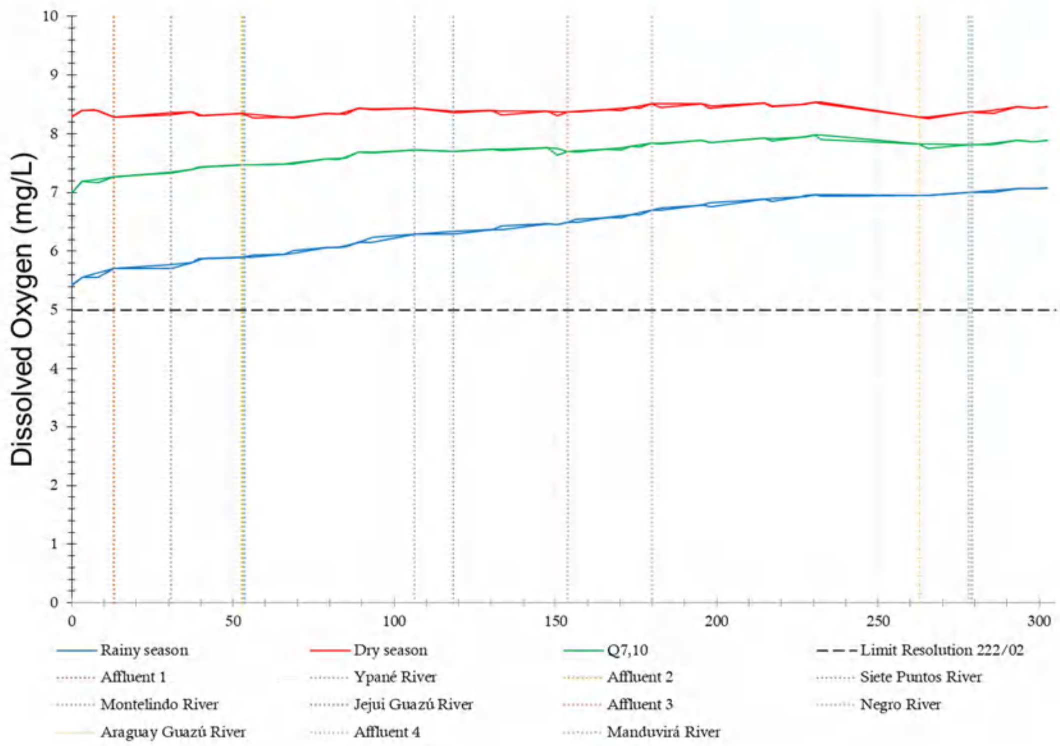


(b)

Figure 13 - Longitudinal profiles of total suspended solids: (a) Current situation; (b) Future situation after the treated effluent discharge.

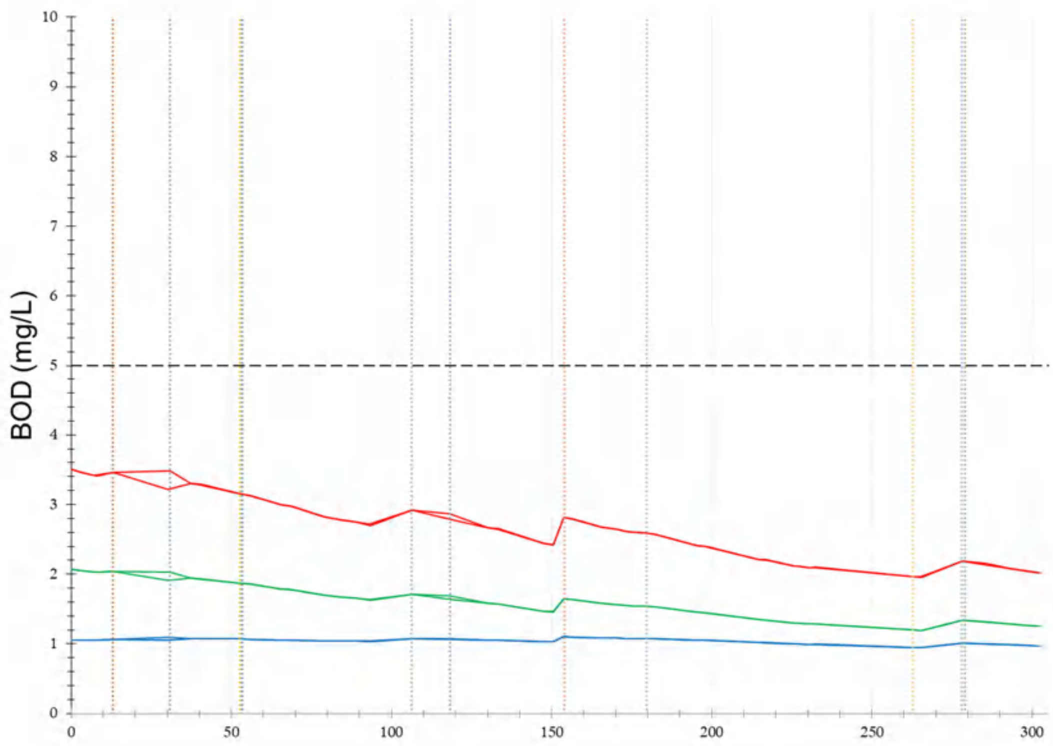


(a)

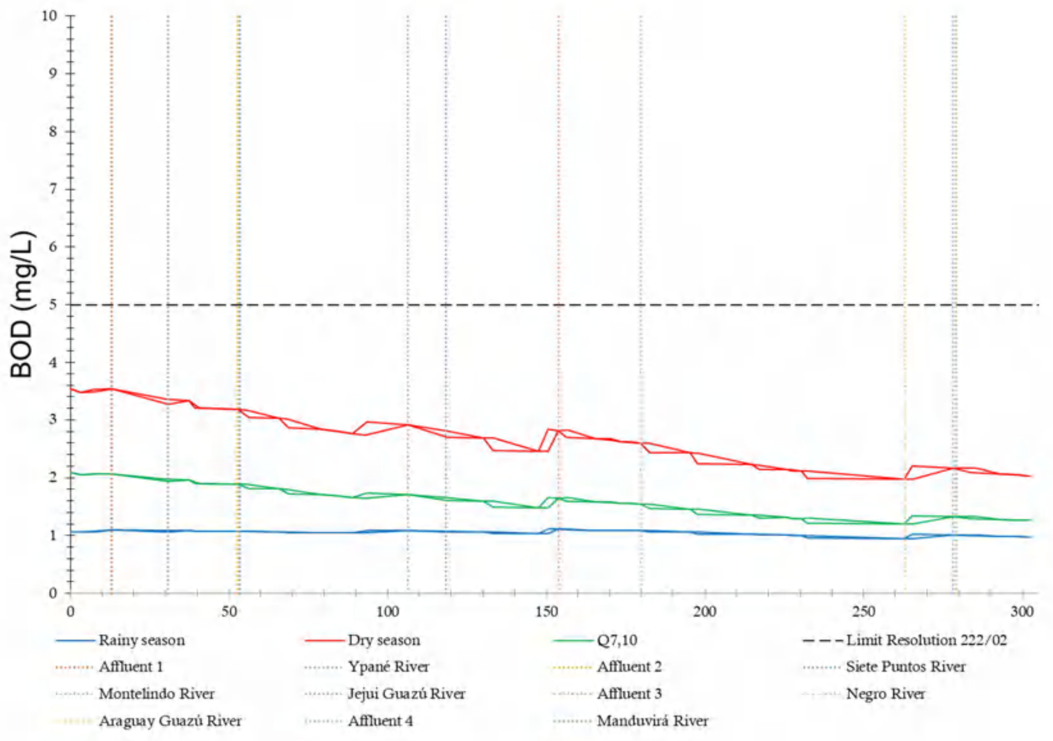


(b)

Figure 14 - Longitudinal profiles of dissolved oxygen: (a) Current situation; (b) Future situation after the treated effluent discharge.

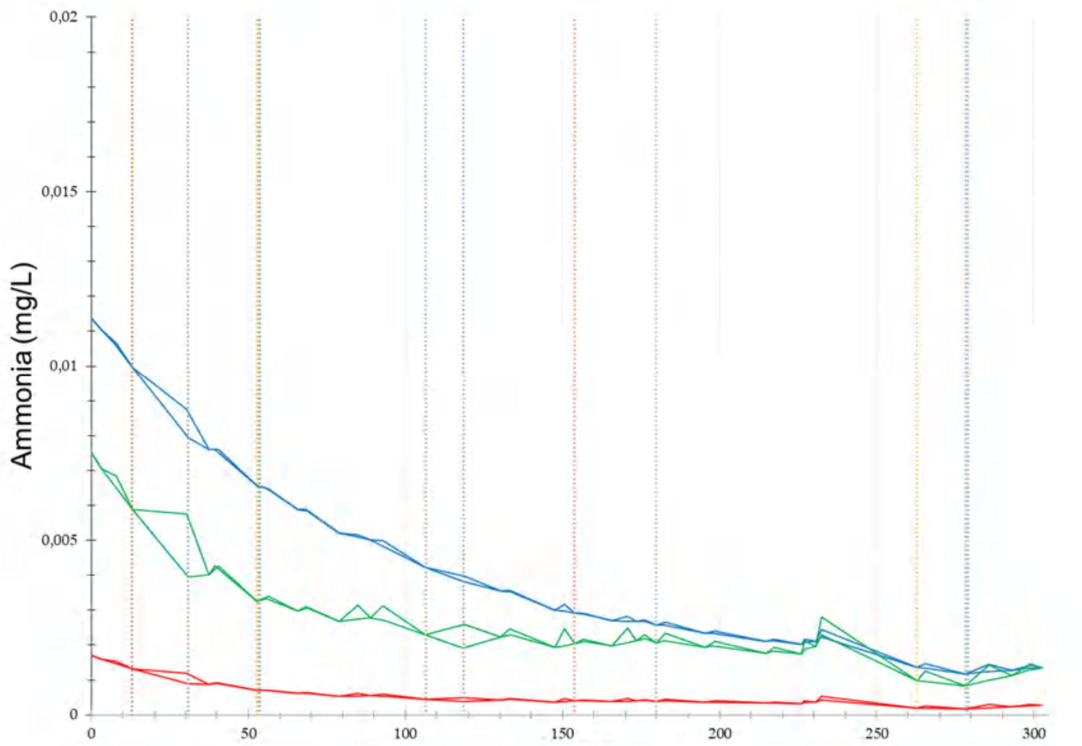


(a)

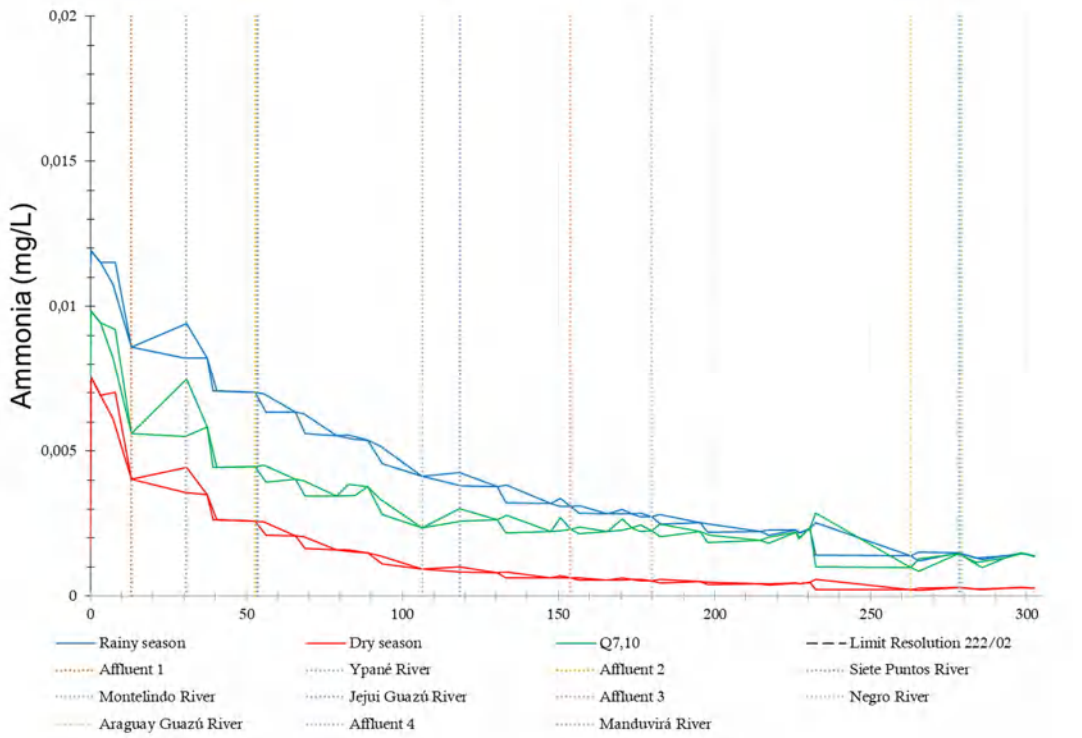


(b)

Figure 15 - Longitudinal profiles of BOD: (a) Current situation; (b) Future situation after the treated effluent discharge.



(a)



(b)

Figure 16 - Longitudinal profiles of ammonia: (a) Current situation; (b) Future situation after the treated effluent discharge.

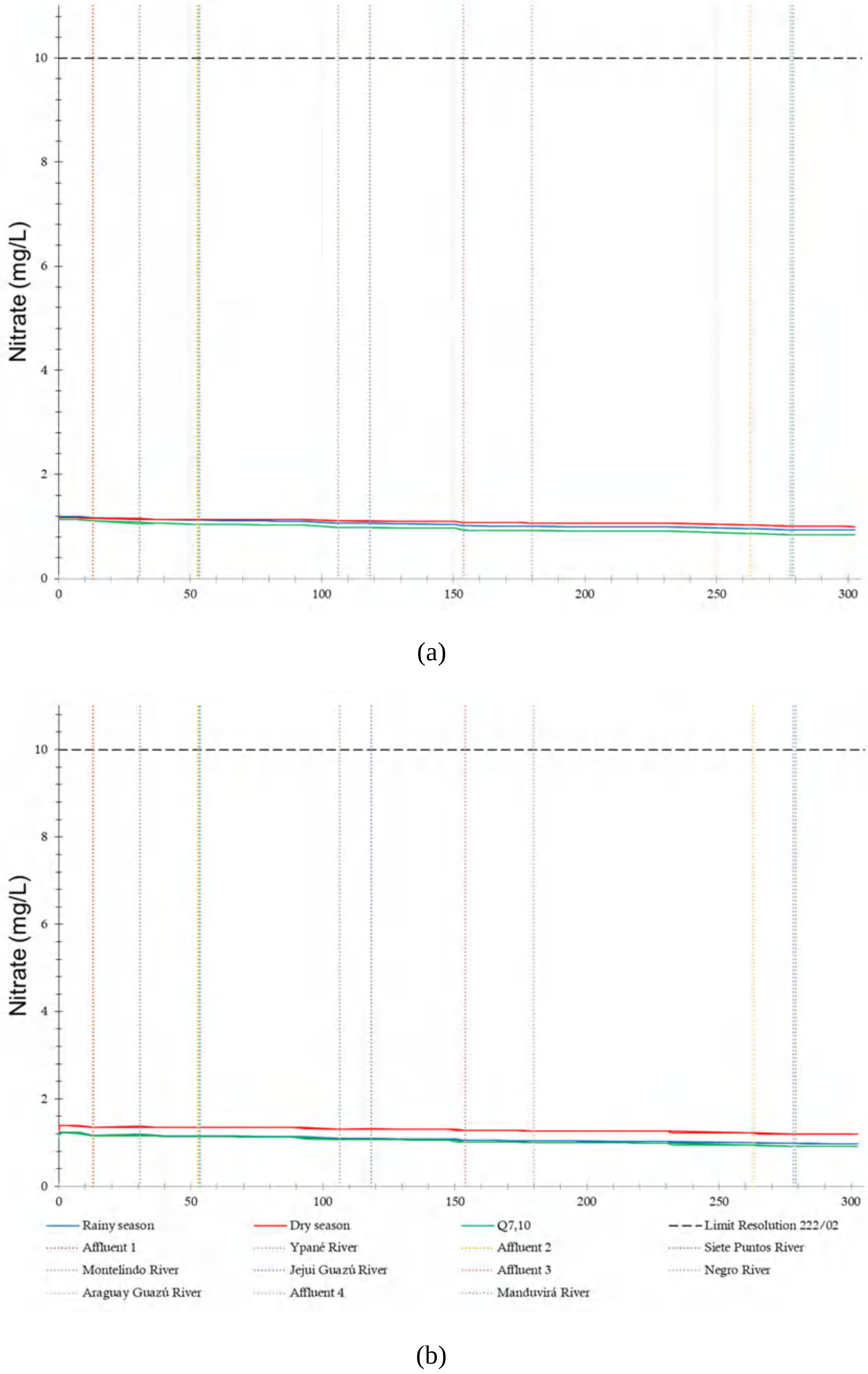
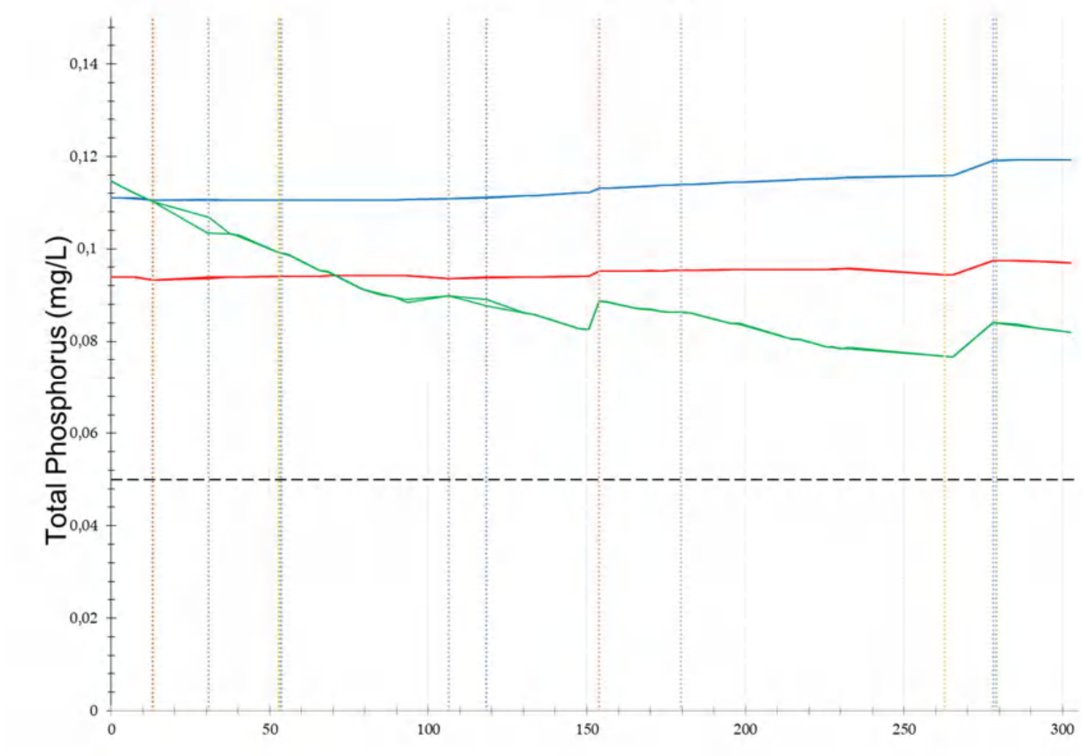
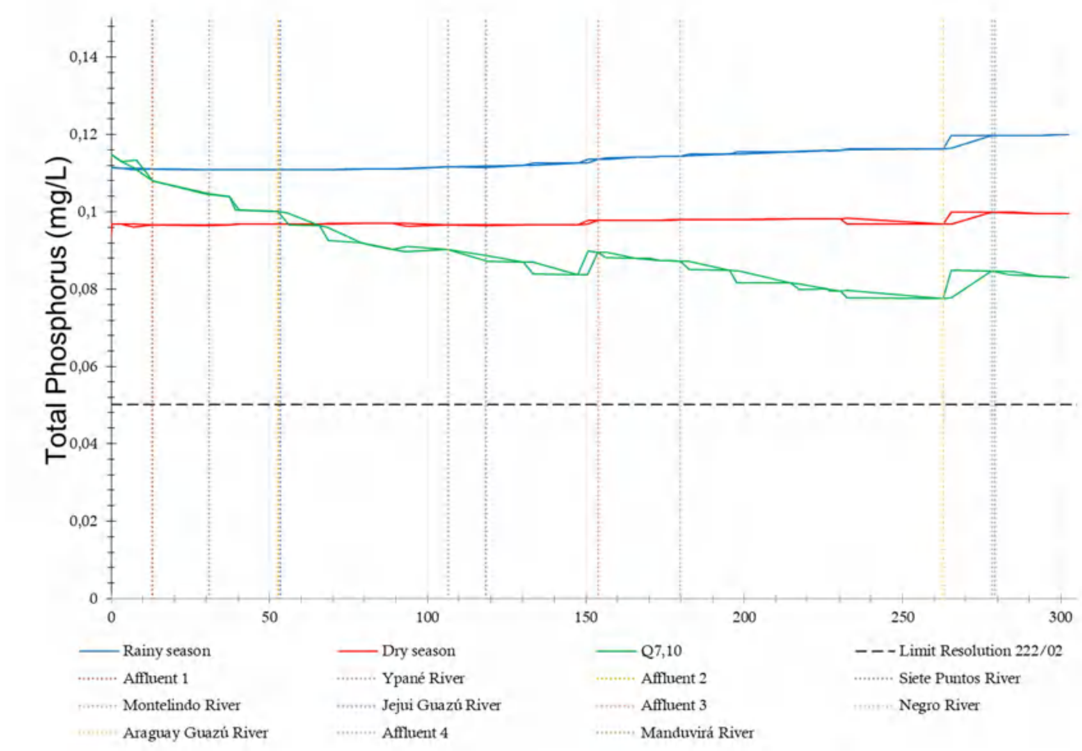


Figure 17 - Longitudinal profiles of nitrate: (a) Current situation; (b) Future situation after the treated effluent discharge.



(a)



(b)

Figure 18 – Longitudinal profiles of total phosphorus: (a) Current situation; (b) Future situation after the treated effluent discharge.

A comparative analysis between the current situation and the future situation after the treated effluent discharge of the industry shows that, for all water quality parameters, there was no significant impact of the industry pollutant launched. The high flows in Paraguay River, between 499,8 and 5,759.3 m^3/s in the section of confluence with the effluent released by the paper and cellulose industry, guarantee a satisfactory dilution capacity of the pollutants. It is also informed that the effluent flow from the paper and cellulose industry represents less than 1% of the critical $Q_{7,10}$ flow in Paraguay River from September 2001 to February 2020.

The Resolution nº 222/2002 (PARAGUAY, 2002) defines the watercourses classification in the Paraguayan territory. According to the contracting company, the Paraguay River is ranked into Class 2, in which the following limits must be respected: pH between 6.0 and 9.0; total dissolved solids ≤ 500.0 mg/L; DO ≥ 5.0 mg/L; BOD ≤ 5.0 mg/L; nitrate ≤ 10.0 mg/L; total phosphorus ≤ 0.05 mg/L. The environmental resolution Paraguayan does not bring the maximum limits for the total suspended solid and ammonia parameters. The limit defined by CONAMA Resolution 357/2005 (BRASIL, 2005) was used to evaluate ammonia parameter.

The parameters pH, total suspended solids, OD, BOD, ammonia and nitrate parameters are within limits of the Resolution nº 222/2002 (PARAGUAY, 2002) and Resolution CONAMA nº 357 (BRAZIL, 2005), where the impact of the diffuse surface load carrying pollutant in the rainy season was noticeable only in the total suspended solid, ammonia and total phosphorus parameters. According to Figures 12 to18, the limit values were:

- pH: 6.4 to 8.3 in the rainy month, 7.1 to 8.3 in the driest month and 6.7 to 8.5 in the critical flow $Q_{7,10}$;
- Total dissolved solids: 132.4 to 240.7 mg/L in the rainy month, 85.7 to 91.2 mg/L in the driest month and 64.5 to 124.9 mg/L in the critical flow Q7,10;
- DO: 5.4 to 7.1 mg/L in the rainy month, 8.3 to 8.5 mg/L in the driest month and 7.0 to 8.0 mg/L in the critical flow $Q_{7,10}$;
- BOD: 1.0 to 1.1 mg/L in the rainy month, 2.0 to 3.5 mg/L in the driest month and 1.2 to 2.1 mg/L at the critical flow $Q_{7,10}$;
- Ammonia: 1.2^10^{-3} to 11.9^10^{-3} mg/L in rainy month, 0.2^10^{-3} to 7.5^10^{-3} mg/L in the driest month and 0.8^10^{-3} to 9.8^10^{-3} mg/L in the critical flow $Q_{7,10}$;
- Nitrate: 1.0 to 1.2 mg/L in the rainy month, 1.2 to 1.4 mg/L in the driest month and 0.9 to 1.2 mg/L in the critical flow $Q_{7,10}$.

Only total phosphorus parameter did not respect the maximum limit of 0,05 mg/L recommended by Resolution nº 222/2002 (PARAGUAY, 2002), both in the current situation and in the future situation. The monitoring of water quality in the WQS-2, WQS-3 and WQS-4 confirms the disagreement of this parameter with the limits recommended in environmental legislation. According to Figure 18, it varied between 0.11 to 0.12 mg/L in the rainy month, 0.09 to 0.10 mg/L in the driest month and 0.08 to 0.11 mg/L in the critical flow $Q_{7,10}$.

The high total phosphorus concentrations in the Paraguay river are observed from the headwater region of the watershed (upper Paraguay river) until of its mouth on the Paraná river (low Paraguay river). Fava (2012) found high total phosphorus concentration in the Bugres River, upper Paraguay River, above that allowed for class 2 of this watercourse, justified by the carrying of soil particles and phosphorus-based fertilizers used in pastures and sugar cane cultivation. According to SEMA (2018), the total phosphorus concentration in the tributaries of the headwaters on the upper Paraguay river are also above the limits recommended by Resolution CONAMA nº 357/2005 (BRASIL, 2005).

8 CONCLUSION

The robustness of the WASP tool enabled the mathematical modeling of the self-depuration process along the Paraguay River between Concepción and Asunción.

The simulations for the current and future situation after the treated effluent discharge of a pulp mill will not impact on the surface water quality of Paraguay River. The behavior of the various parameters is maintained.

The high dissolved oxygen concentrations along the Paraguay River will maintain aquatic life and the ammonia, nitrate and total phosphorus concentrations do not have potential to change trophic state in the watercourse.

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