KATINGAN PEATLAND RESTORATION AND CONSERVATION PROJECT

PDD COVER PAGE

1. **Project name:**

   The Katingan Peatland Restoration and Conservation Project (The Katingan Project)

2. **Project location (country, sub-national jurisdictions):**

   Mendawai, Kamipang, Seranau and Pulau Hanaut sub-districts of Katingan and Kotawaringin Timur districts, Central Kalimantan, Republic of Indonesia

3. **Project proponent (organization and contact name with email address and phone number):**

   Organization: PT. Rimba Makmur Utama (PT. RMU)
   Contact name: Dharsono Hartono, Director
   Email: dharsono@ptrmu.com
   Phone: +62 (0)21-2358-4777
   Mobile: +62 (0)816-976-294

4. **Auditor (organization and contact name with email address and phone number):**

   Organization: SCS Global Services
   Contact name: Christie Pollet-Young, Program Director
   Email: CPollet-Young@scsglobalservices.com
   Phone: (510) 452-9093

5. **Project start date, GHG accounting period and lifetime:**

   Project start date: November 1, 2010
   GHG accounting period: November 1, 2010 to October 31, 2070 (60 years)
   Project lifetime: November 1, 2010 to October 31, 2070 (60 years)

6. **Whether the document relates to a full validation or a gap validation:**

   This PDD relates to a full validation.

7. History of CCB status, where appropriate, including issuance date(s) of earlier validation/verification statements etc.:

No CCB history, including any prior issuance of validation/verification statements.

8. The edition of the CCB standards being used for this validation:

CCB Standards Third Edition

9. A brief summary of the project's expected climate, community and biodiversity benefits:

The Katingan Project seeks to protect and restore 149,800 hectares of peatland ecosystems, to offer local people sustainable sources of income, and to tackle global climate change – all based on a solid business model. The project area stores vast amounts of CO_2, and plays a vital role in stabilizing water flows, preventing devastating peat fires, enriching soil nutrients and providing clean water. It is rich in biodiversity, being home to large populations of many high conservation value species, including some of the world's most endangered; such as the Bornean Orangutan (*Pongo pygmaeus*) and Proboscis Monkey (*Nasalis larvatus*). It is surrounded by villages for which it supports traditional livelihoods including farming, fishing, and non-timber forest products harvesting. The project's expected CCB benefits include:

A) Climate benefits

- Average 7,451,846 tons of GHG emission reductions annually through avoided deforestation and forest degradation, prevention of peat drainage and fires
- Ecological enhancement at the landscape scale through ecosystem restoration

B) Community benefits

- Improved quality of life and reduced poverty of the project-zone communities through a creation of sustainable livelihoods options and economic opportunities
- Stronger community resilience through increased capacity to cope with socio-ecological risks
- Enhanced ecosystem services for the overall well-being of the project-zone communities through ecosystem restoration

C) Biodiversity benefits

- Stabilized and healthy populations of faunal and floral species in the project zone by eliminating drivers of deforestation and forest degradation
- Enhanced natural habitats and ecological integrity through ecosystem restoration

10. Which optional Gold Level criteria are being used and a brief description of the attributes that enable the project to qualify for each relevant Gold Level:

The Katingan Project seeks to achieve all climate, community and biodiversity Gold Level criteria.

A) Climate Gold Standard

The Katingan Project provides significant support and benefits to the project-zone communities in coping with and adapting to the expected impacts of climate change in coming years. The project aims to strengthen community and biodiversity resilience through various project activities, including restoration of peat swamp ecosystems and reforestation, climate resilient infrastructural development, adjustment and diversification of agroforestry and agricultural practices, capacity building for forest management and non-timber forest product development, and the implementation of integrated natural disaster prevention and management systems.

B) Community Gold Standard

The project zone is qualified as a rural area of a high concentration of population living under the national poverty line, and the Katingan Project delivers significant well-being benefits to smallholders/community members. The project seeks to benefit communities through a variety of socio-economic activities which also target the most vulnerable and marginalized community members. This includes the poor, women, elderly and the disabled. These programs are designed to lift the poorest out of poverty by engaging them in community-based business development such as microfinance, women's empowerment, sustainable agroforestry, renewable energy development, and NTFPs. All community programs are designed and implemented through community participation, transparent decision-making processes based on mutual trust, and proper management of project activities.

C) Biodiverstiy Gold Standard

The Katingan Project is qualified as a Key Biodiversity Area (KBA), and conserves and protects the biodiversity of global significance. The project is expected to generate exceptional biodiversity benefits based on multiple achievement of the criteria defined in the CCB Standards Third Edition. This includes four species considered critically Endangered, 10 considered Endangered, and 31 species considered Vulnerable. For two of these at least, Orangutan and Proboscis Monkey, the project zone is estimated to hold over 5% of the entire global population.

11. Date of completion of this version of the PDD, and version number, as appropriate:

Date: August 6, 2015
Version: Katingan_PDD_v1.1

12. Expected schedule for verification, if known:

To be scheduled

KATINGAN PEATLAND RESTORATION AND CONSERVATION PROJECT

Project Title	**Katingan Peatland Restoration and Conservation Project**
Version	Katingan_ PDD_v1.1
Date of Issue	August, 6, 2015
Prepared By	**PT. Rimba Makmur Utama**
Contact	Address: Menara BCA, Fl. 45, Jl. MH Thamrin No. 1, Jakarta, Indonesia Phone: +62 (0)816-976-294 Email: dharsono@ptrmu.com URL: www.katinganproject.com

TABLE OF CONTENTS

Table of Contents 2
List of figures 5
List of tables 5
List of maps 7

1 General 11

1.1 Summary Description of the Project 11
1.1.1 Project summary 11
1.1.2 Project objectives (G1.2) 11
1.2 Project Location 13
1.2.1 Project geographic boundaries (G1.3) 13
1.2.2 Basic physical parameters (G1.3) 15
1.3 Conditions Prior to Project Initiation 17
1.3.1 Historical land use change and conditions in the project zone (G1.3) 17
1.3.2 Current land use in the project zone (G1.3) 19
1.3.3 Current condition and types of vegetation in the project area (G1.3) 19
1.3.4 Current carbon stocks (G1.3) 21
1.3.5 Communities in the project zone (G1.3) 22
1.3.6 Land rights and conflict (G1.3, G5.5) 22
1.3.7 Current biodiversity (G1.3) 23
1.3.8 Identification of high conservation values (HCV) (G1.3, G1.7) 23
1.4 Project Proponent 25
1.4.1 Contact information and roles of the project proponent (G1.1) 25
1.4.2 Organizational structure (G4.1) 26
1.5 Other Entities Involved in the Project 27
1.5.1 Implementing and technical partners (G4.2) 27
1.5.2 Key technical skills required for project implementation (G4.2) 28
1.6 Project Start Date (G1.9) 29
1.7 Project Crediting Period (G1.9) 30

2 Design 30

2.1 Sectoral Scope and Project Type 30
2.2 Project Activities 30
2.2.1 Project activities (G1.8) 30
2.2.2 Lifetime of the project activities 38
2.3 Management of Risks to Project Benefits 38
2.3.1 Non-permanence risk assessment (G1.10) 38
2.3.2 Measures taken to maintain and enhance benefits beyond project lifetime (G1.11) 39
2.4 Measures to Maintain High Conservation Values (G1.11) 39
2.5 Project Financing (G1.12, G4.3) 39
2.6 Employment Opportunities and Worker Safety (G3.9, G3.10, G3.11, G3.12) 39
2.6.1 Equal employment opportunities (G3.10) 40
2.6.2 Training and capacity building (G3.9) 40
2.6.3 Worker safety (G3.12) 41
2.7 Stakeholders 41
2.7.1 Stakeholder identification (G1.5, G1.6) 41
2.7.2 Free, prior and informed consent (FPIC) (G3.2) 43
2.7.3 Stakeholder consultations and community involvement (G3.4, G3.5, G3.6, G3.7) 43
2.7.4 Procedure to publicize project documentation and monitoring plans (G3.1, G3.3, CM4.3, B4.3) 44
2.7.5 Feedback and grievance redress procedure (G3.8) 45
2.8 Commercially Sensitive Information 46

3 Legal Status 46

3.1 Compliance with Laws, Statues, Property Rights and Other Regulatory Frameworks (G5) 46

3.1.1 Compliance with laws and regulations (G5.6) ... 46
3.1.2 Documentation of legal approval (G5.1, G5.2, G5.7, G5.8) ... 48
3.2 Evidence of Right of Use (G5.8) ... 50
3.3 Emissions Trading Programs and Other Binding Limits (G5.9) ... 50
3.4 Participation under Other GHG Programs (G5.9) ... 50
3.5 Other Forms of Environmental Credit (G5.9) ... 51
3.6 Projects Rejected by Other GHG Programs (G5.9) ... 51
3.7 Respect for Rights and No Involuntary Relocation (G5.3) ... 51
3.8 Illegal Activities and Project Benefits (G5.4) ... 51

4 Application of Methodology ... 51

4.1 Title and Reference of Methodology ... 51
4.2 Applicability of Methodology ... 51
4.3 Methodology Deviations ... 59
4.4 Project Boundary ... 59
4.4.1 Spatial boundary of the project area (G1.4) ... 59
4.4.2 Temporal boundary (G1.9, CL1) ... 85
4.4.3 Carbon pools ... 85
4.4.4 Sources of GHG emissions ... 86
4.5 Baseline Scenario and Additionality (G2.1, G2.2) ... 88
4.5.1 Justification of baseline scenario and additionality ... 88
4.5.2 Description of acacia plantations as the baseline scenario ... 95
4.5.3 Estimated impacts of the baseline scenario on communities and biodiversity ... 98

5 Quantificaton of GHG Emission Reductions and Removals ... 98

5.1 Project Scale and Estimated GHG Emission Reductions or Removals (CL2.2) ... 98
5.2 Leakage Management (CL3.2) ... 99
5.3 Baseline Emissions (CL1) ... 99
5.3.1 General procedures and assumptions ... 99
5.3.2 Proxy area analysis ... 100
5.3.3 Projection of deforestation under the baseline scenario ... 104
5.3.4 Emission characteristics in the baseline scenario ... 107
5.3.5 Baseline emissions from microbial decompositions of peat, peat burnings and water bodies in peatlands 114
5.3.6 Baseline emissions from deforestation ... 131
5.3.7 Baseline emissions from ARR activities ... 137
5.3.8 Significant sources of baseline emissions ... 144
5.4 Project Emissions (CL2) ... 145
5.4.1 General procedures and assumptions ... 145
5.4.2 Emission characteristics in project scenario ... 145
5.4.3 Project emissions from aboveground biomass due to deforestation and forest degradation ... 152
5.4.4 Carbon enhancement from forest growth ... 154
5.4.5 Project emissions from peat and water body ... 156
5.4.5. Project emissions from ARR activities ... 167
5.5 Leakage (CL3) ... 171
5.5.1 Estimation of emissions from activity shifting for avoiding planned deforestation and planned degradation (LK-ASP) ... 172
5.5.2 Estimation of emissions from displacement of pre-project agricultural activities (LK-ARR) ... 180
5.5.3 Estimation of emissions from ecological leakage (LK-ECO) ... 180
5.6 Summary of GHG Emission Reductions and Removals (CL2.2) ... 183
5.6.1 Uncertainty Analysis ... 183
5.6.2 Total net GHG emission reductions of the REDD project activity ... 184
5.6.3 Total net GHG emission reductions of the WRC project activity ... 185
5.6.4 Total net GHG removals of the ARR project activity ... 187
5.6.5 Calculation of the VCS Non-Permanence Risk Buffer Withholding ... 189
5.6.6 Calculation of Verified Carbon Units ... 192

5.7 Climate Change Adaptation Benefits ... 194
5.7.1 Likely regional climate change (GL1.1, GL1.2) ... 194
5.7.2 Climate change adaptation measures (GL1.3) ... 195

6 Community ... 195

6.1 Net Positive Community Impacts ... 195
6.1.1 Summary of net positive community impacts (CM1, CM2) ... 195
6.1.2 Mitigation measures for any negative impacts on HCV attributes (CM1.2, CM2.2, CM2.3, CM2.4) ... 201
6.2 Other Stakeholder impacts (CM3) ... 202
6.3 Exceptional Community Benefits (GL2) ... 202

7 Biodiversity ... 204

7.1 Net Positive Biodiversity Impacts ... 204
7.1.1 Summary of net positive biodiversity impacts (B1, B2) ... 204
7.1.2 Mitigation measures for any negative impacts on HCV attributes (B1.2, B2.3, B2.4) ... 208
7.1.3 Identification of species to be used in project activities and confirmation of status (B2.5, B2.6) ... 208
7.1.4 Use of non-native species, fertilizers, chemical pesticides and other inputs (B2.6, B2.7, B2.8) ... 208
7.1.5 Description of waste products management resulting from project activities (B2.9) ... 208
7.2 Offsite Biodiversity Impacts (B3) ... 209
7.3 Exceptional Biodiversity Benefits (GL3) ... 209

8 Monitoring ... 209

8.1 Description of the Monitoring Plan (CL4, CM4, B4) ... 209
8.1.1 Data management methods and structure ... 209
8.1.2 Procedures for handling internal auditing and non-conformities ... 210
8.1.3 Climate impact monitoring plan and methodological approach (CL4.1) ... 210
8.1.4 Community impact monitoring plan and methodological approach (CM4.1, CM4.2, GL1.4, GL2.3, GL2.5) 212
8.1.5 Biodiversity impact monitoring plan and methodological approach (B4.1, B4.2, GL1.4, GL3.4) ... 213
8.2 Data and Parameters Available at Validation (CL4) ... 214
8.3 Data and Parameters Monitored (CL4, CM4 & B4) ... 214
8.3.1 Climate impact monitoring parameters and relevant data ... 214
8.3.2 Community impact monitoring parameters and relevant data ... 216
8.3.3 Biodiversity impact monitoring parameters and relevant data ... 216

List of Appendicies ... 217

Appendix 1. FAUNA AND FLORA OF THE PROJECT ZONE ... 218
Appendix 2. VCS AFOLU Non-permanence risk analysis ... 242
Appendix 3. Copy of the ecosystem restoration concession lisence granted to PT. RMU ... 246
Appendix 4. STRATA CHANGES IN the BASELINE SCENARIO FOR WRC ACTIVITies ... 247
Appendix 5. Baseline stratification based on emission characteristics ... 254
Appendix 6. Default Values Used in Quantification of GHG Emissions ... 258
Appendix 8. List of Standard Operation Procedures (SOP) ... 268
Appendix 9. Climate MRV Tracker ... 270
The Climate MRV tracker lists all parameters available at validation and/or to be monitored and their monitoring frequency as required by the VCS methodology VM0007. They are presented in an Excel format and available to validators upon request. ... 270
Appendix 10. Community MRV tracker ... 271
Appendix 11. Biodiversity MRV tracker ... 272

List of annexes ... 273

Annex 1. Climate and hydrology of the project area ... 273
Annex 2. Communities in the project zone ... 273
Annex 3. Hcv assessment and biodiversity in the project zone ... 273

Annex 4. Climate parameters monitoring design 273
Annex 5. Method and result of 1d steady state water table modelling along cross section perpendicular to hantipan canal 273
Annex 6. Hydrological modelling method 273
Annex 7. Methods for measuring peat thickness and mapping peat distributions 273
Annex 8. Levelling and dem creation method 274
Annex 9. Drainability elevation limit mapping method 274
Annex 10. Peat bulk density measurement and statistical analysis method 274
Annex 11. Specific proxy development method 274
Annex 12. Uncontrolled burning analysis method 274
Annex 13. Subsidence calculation method 274
Annex 14. Combination-elimination process for identifying relevant WRC strata 274
Annex 15. Monitoring methods of aboveground biomass 275
Annex 16. Nasa modis fire hot spot locations in proxy areas 275
Annex 17. Uncertainty analysis 275

References 276

LIST OF FIGURES

Figure 1. Katingan Project framework 11
Figure 2. Monthly rainfall, potential evaporation and temperature in the project area 14
Figure 3. Typical vegetation condition in the mixed peat swamp forest 18
Figure 4. Typical vegetation condition in the freshwater swamp forest 19
Figure 5. Typical condition in the non-forest vegetation 19
Figure 6. Oranghutan in the project zone 21
Figure 7. Organizational structure of PT. RMU as of June 2015 25
Figure 8. Hantipan canal used for the main transportation route in the southern part of the project zone 30
Figure 9. Participatory community mapping process 33
Figure 10. FPIC process 41
Figure 11. Grievance handling process 43
Figure 12. Aboveground stratification process 58
Figure 13. Process of peatland and peat thickness mapping 64
Figure 14. Annual area burnt in baseline scenario 126
Figure 15. Annual area burnt with positive net GHG emissions from peat burning in baseline scenario 127
Figure 16. Regression analysis of cumulative HTI concession area licensed between 2001 and 2010 174
Figure 17. Potential barriers to benefits reaching the marginalized and vulnerable communities 203
Figure 18. Simple schematic of data management structure 210
Figure 19. Data management QA/QC procedures 210

LIST OF TABLES

Table 1. Land use and status within the project area and zone 17
Table 2. HCV attributes and findings 21
Table 3. Project proponent information 23
Table 4. Key skills required to implement the project, by activity 27
Table 5. Lifetime of project activities 35
Table 6. Summary of non-permanence risk assessment 36
Table 7. Capacity building and training 37
Table 8. Stakeholders in the project zone 39
Table 9. Summary of stakeholder consultations 41
Table 10. List of decrees and legal approvals 46
Table 11. List of community agreement and approval with the Katingan Project 48
Table 12. Summary of applicability conditions 49
Table 13. Satellite images used for stratification 59

Table 14. Land cover of the project area based on the Landsat and PALSAR analyses 60
Table 15. Final AGB stratification summary of the project area 62
Table 16. Indicators for the differentiation of peatland from non-peatland 63
Table 17. Decision matrix for peat stratification requirements 67
Table 18. Peat thickness stratification of the project area 67
Table 19. Summary of the PDT stratification of the project area 72
Table 20. Volume of AGB carbon stock in the project area at the project start 74
Table 21. Volume of peat carbon stock in the project area at the project start 76
Table 22. Summary of the area eligible for crediting from REDD and ARR activities 78
Table 23. Summary of the area eligible for crediting from WRC activities 84
Table 24. Summary of carbon pools 84
Table 25. GHG sources included in the REDD project boundary 85
Table 26. GHG sources included in the ARR project boundary 86
Table 27. GHG sources included in the WRC project boundary 86
Table 28. Description of the major alternative land use scenarios for the project area 87
Table 29. Consistency of alternative land use scenarios with laws and regulations 89
Table 30. Identification of barriers that would prevent the implementation of each scenario 90
Table 31. Summary of the concessions granted to the projected deforestation agents 93
Table 32. Projected land use within the concession areas of the deforestation agents 95
Table 33. Reference region selection criteria 100
Table 34. Summary of suitable reference regions 101
Table 35. Baseline stratification of peatlands and water bodies based on relative homogeneous emission characteristics 107
Table 36. Land cover changes strata in the baseline scenario for REDD 112
Table 37. Land cover changes strata in the baseline scenario for ARR 113
Table 38. Variables used in the schematization of quantification of GHG emissions from microbial decompositions of peat, peat burnings and dissolved organic carbon from water bodies in peatlands in the baseline scenario. 115
Table 39. A summary of the annual GHG emissions from peat microbial decomposition, uncontrolled peat burning and water bodies in the Project area under the baseline scenario ($tCO_2e.y^{-1}$) since the start of the project in 2010 118
Table 40. The stratification used for the calculation of GHG emissions per stratum, the area (ha) per each stratum and the CO_2 and CH_4 default factors used for the specific land use 121
Table 41. GHG emissions from microbial decompositions of peat in the baseline scenario in tCO_2-$e.y^{-1}$. 121
Table 42. GHG emissions from peat burning per stratum and per (repeated) burning 127
Table 43. GHG emissions from peat burning in the baseline scenario in tCO_2-$e.y^{-1}$. 127
Table 44. GHG emissions from Dissolved Organic Carbon in water bodies in the baseline scenario in tCO_2-$e.y^{-1}$. 130
Table 45. Projection of annual forest convertion in project area under the baseline skenario 132
Table 46.Carbon stock changes and emissions from deforestation in project area within project life time. 134
Table 47. The assumed annual planting and harvesting under ARR activities within the project periode 138
Table 48. Baseline net GHG removal from ARR activities in project area within project periode 142
Table 49. Stratification of project area based on relative homogeneous emission characteristics from peat and water body at project start date 148
Table 50. Changes in strata based on relative homogeneous emission characteristics from peat and water bodies in the project scenario 148
Table 51. Land cover changes strata in the baseline scenario for REDD in the project scenario 151
Table 52. Land cover changes strata in the baseline scenario for ARR in the project scenario 152
Table 53. Ex-ante Net carbon stock change as a result of deforestation during the project period 153
Table 54. Ex ante GHG emission from forest degradation during the project periode 154
Table 55. Ex-ante net carbon stock changes as a result of forest carbon stock enhancement in the project area 155
Table 56. Variables used in the schematization of quantification of GHG emissions from microbial decompositions of peat and dissolved organic carbon from water bodies in peatlands in the project scenario 157
Table 57. A summary of the annual GHG emissions from peat and water bodies under the project scenario up to 2070, in $tCO_2e.y^{-1}$. 159

Table 58. The stratification used for the calculation of GHG emissions per stratum, the area (ha) per each stratum and the CO_2 and CH_4 default factors used for the specific land use 162
Table 59. GHG emissions from microbial decompositions of peat in the project scenario in $tCO_2\text{-e.y}^{-1}$. 162
Table 60. GHG emissions from Dissolved Organic Carbon in water bodies in the project scenario in $tCO_2\text{-e.y}^{-1}$. 165
Table 61. Technical design of reforestation program 168
Table 62. Reforestation plan in the project boundary (Ha) 169
Table 63. Project net GHG removals by sinks from reforestation within project periode 170
Table 64. Applicability of leakage modules 172
Table 65. Official data on historic HTI concession licenses granted 173
Table 66. Deforestation by the baseline class of agents in the absence of the project in stratum 174
Table 67. New area of annual deforestation by the baseline class of deforestation agents at which no leakage is occurring 175
Table 68. Deforested and forested area in HTI acacia and unlicensed HP areas at the project start 177
Table 69. Summary of peat thickness and average carbon stock loss at tPDT and average carbon stock loss in all HTI areas in Indonesia 177
Table 70. Projection of undrained peatland in HP areas as alternative areas for leakage to peatland 179
Table 71. Estimated emission factors of leakage to peatland 179
Table 72. Proportion of undrained peatland areas in the alternative area 179
Table 73. Total net GHG emission reductions of the REDD project activity 184
Table 74. Total net GHG emission reductions of the WRC project activity 185
Table 75. Total net GHG removals of the ARR project activity 187
Table 76. Annual non-permanence risk buffer withholding 190
Table 77. Calculation of estimated verified carbon units 192
Table 78. Likely climate change impacts 194
Table 79. Livelihood assets and key criteria 196
Table 80. Summary of net positive community benefits, based on CCB critera 196
Table 81. Summary of net positive biodiversity benefits 204

LIST OF MAPS

Map 1. Location of the Katingan Project in Kalimantan, Indonesia 12
Map 2. The location of the project area and project zone 13
Map 3. Historical change in land designation in the region of the project. Yellow indicates State Production Forest ('Hutan Produksi'); Pink indicates forest designated for conversion ('Hutan Produksi Konversi'); Purple indicates areas designated as conservation areas; Green indicates protection forest ('Hutan Lindung'); and White indicates areas removed from the national forest estate. 16
Map 4. HCV areas within the project zone 23
Map 5. Locations of reforestation plan 29
Map 6. Location of rewetting activities in the project area 31
Map 7. Community map of Kampung Melayu village 47
Map 8. Stratification of the project area based on the Landsat and PALSAR analyses 60
Map 9. Final AGB stratification of the project area 62
Map 10. Peat versus non-peat areas within the project area boundary 65
Map 11. Peat thickness stratification of the project area 67
Map 12. Drainability elevation limit of the project area 68
Map 13. Digital elevation model of the project area 70
Map 14. Peatland area subject to microbial decomposition and burning 71
Map 15. PDT of the project area 72
Map 16. Stratification of AGB carbon stock 74
Map 17. Stratification of peat carbon stock at the project start 75
Map 18. Eligible areas for crediting from REDD-ARR project activities 78
Map 19. Peat carbon stock in the baseline scenario at t = 100 79
Map 20. Peat carbon stock in the project scenario at t = 100 80
Map 21. Carbon stock difference between the baseline and project scenarios at t = 100 82
Map 22. Area eligible for crediting for WRC project activities 82

Map 23. Active commercial logging concessions (HPH) in Central Kalimantan ... 89
Map 24. Ministry of Forestry indicative map 2009 ... 91
Map 25. Ex-logging concessions (Ex-HPH) in the area ... 91
Map 26. Three deforestation agents projected to operate in the project area under the baseline scenario ... 93
Map 27. The projected land use within the concession areas of the deforestation agents ... 95
Map 28. Geographic location of the Katingan Project and reference regions for the baseline deforestation rate calculation ... 102
Map 29. Baseline scenario map ... 105
Map 30. Baseline stratification of the project area for CUPP activities ... 108
Map 31. Stratification changes in the baseline scenario for CUPP activities ... 110
Map 32. Stratification of aboveground biomass in the baseline scenario for REDD ... 112
Map 33. Stratification of above ground biomass in the baseline scenario for ARR REDD ... 113
Map 34. Map of possible burning area (left) and annual area burnt (right) in the baseline scenario. ... 125
Map 35. Projected emissions from deforestation in the project area ... 135
Map 36. Pojected spatial GHG removal from ARR under baseline scenario ... 144
Map 37. Master project scenario map ... 147
Map 38. Strafication based on emission characteristics for WRC ... 149
Map 39. Strata changes in the project scenario ... 150
Map 40. ARR emission characteristic stratification under project scenario ... 151
Map 41. Reforestation area in project boundary ... 168
Map 42. Alternative areas for activity shifting leakage overlaid with peatland coverage ... 178
Map 43. Illustration of cascade canal block positions and dipwell locations for ecological leakage monitoring ... 181

LIST OF ACRONYMS

APD	Avoiding Planned Deforestation
AFOLU	Agriculture, Forestry, and Other Land Use
AGB	Above Ground Biomass
ANR	Assisted Natural Regeneration
APL	Non-Forest Estate
ARR	Afforestation, Reforestation, and Revegetation
BAU	Business-As-Usual
BIG	Geospatial Information Bureau of Indonesia
C	Carbon
CDM	Clean Development Mechanism
CH_4	Methane
Co	Alluvial sediment
CO_2	Carbon dioxide
COP	Conference of the Parties
CR	Critically endangered species
CUPP	Conservation of Undrained and Partially drained Peatland
CV	Coefficient of Variation
DBH	Diameter at breast height (1.3 meter)
DEL	Drainability Elevation Limit
DEM	Digital Elevation Model
DF	Deforestation
DG	Forest Degradation
DM	Dry Matter
DOC	Dissolve Organic Carbon
EF	Emission Factor
ER	Endangered species
ERC	Ecosystem Restoration Concession
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
FORDA	Indonesian Forest Research and Development Agency
FPIC	Free, Prior and Informed Consent
GHG	Greenhouse Gas
GIS	Geographic Information System
GoI	Government of Indonesia
GPS	Global Positioning System
GWP	Global Warming Potential
Ha	Hectare
HCV	High Conservation Value
HCVF	High Conservation Value Forest
HPH	Commercial Logging Concession
HPK	Conversion Production Forest
HTI	Industrial Timber Plantation
IDR	Indonesian Rupiah

IEC	Information, Education and Communication
IEPB	Initial Estimate of Peatland Border
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUPHHK-RE	Ecosystem Restoration Concession License
LCL	Lower Confidence Limit
LiDAR	Light detection and ranging (an optical remote sensing technology)
LULC	Land Use and Land Cover
LULUCF	Land Use, Land-Use Change and Forestry
MDD	Methodology Design Document
Mg	Mega gram = 1 metric tonne
MMU	Minimum Mapping Unit
MoF	Ministry of Forestry Indonesia
MRV	Monitoring, Reporting and Verification
MT	Metric Tonne
N_2O	Nitrous Oxide
NDVI	Normalized Difference Vegetation Index
NER	Net Greenhouse Gas Emission Reduction
NGO	Non-Government Organization
NTFP	Non-Timber Forest Products
PD	Project Document
PDT	Peat Depletion Time
PRA	Participatory Rural Appraisal
PT. RMU	PT. Rimba Makmur Utama
QA/QC	Quality Assurance / Quality Control
REDD	Reduced Emissions from Deforestation and forest Degradation
REDD+	Reducing Emissions from Deforestation and Degradation Plus carbon stock enhancement
RePProt	Regional Physical Planning Program for Transmigration
RDP	Rewetting of Drained Peatland
RKT	Annual Workplan
RSA	Firefighting Team
SOC	Soil Organic Carbon
SOP	Standard Operation Procedure
SRTM	Shuttle Radar Topography Mission
tCO_2e	Metric tonne of Carbon Dioxide equivalent
TM	Landsat Thematic Mapper
TOd	Dahor formation
UKL-UPL	Environmental Management and Monitoring Programme
UNFCCC	United Nations Framework Convention on Climate Change
UU	National Act/Law
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit
WB	Water Bodies
WRC	Wetland Rewetting & Conservation

1 GENERAL

1.1 Summary Description of the Project

1.1.1 Project summary

Tropical peatlands support fundamental ecological functions and store massive amounts of carbon, with stocks below the ground making up upto 20 times the amount stored in trees and vegetation. When cleared, drained and burned to make way for plantations and other developments, this carbon is released into the atmosphere as carbon dioxide (CO_2) along with other greenhouse gases (GHG). Indonesian Borneo, known as Kalimantan, encompasses approximately 5.7 million hectares (ha) of peatland [1]. By 2020, the expansion of industrial plantations on peatlands in Kalimantan alone is estimated to contribute to 18–22% of Indonesia's total GHG emissions [2].

The Katingan Peatland Restoration and Conservation Project ('The Katingan Project') seeks to protect and restore 149,800 hectares of peatland ecosystems, to offer local people sustainable sources of income, and to tackle global climate change – all based on a solid business model. The project lies within the districts of Katingan and Kotawaringin Timur in Central Kalimantan Province, and covers one of the largest remaining intact peat swamp forests in Indonesia. The area stores vast amounts of CO_2, and plays a vital role in stabilizing water flows, preventing devastating peat fires, enriching soil nutrients and providing clean water. It is rich in biodiversity, being home to large populations of many high conservation value species, including some of the world's most endangered; such as the Bornean Orangutan (*Pongo pygmaeus*) and Proboscis Monkey (*Nasalis larvatus*). It is surrounded by villages for which it supports traditional livelihoods including farming, fishing, and non-timber forest products harvesting.

The project area is located entirely within state-designated production forest. Without the project, the area would be converted to fast-growing industrial timber plantations, grown for pulpwood. The Katingan Project prevents this fate by having obtained full legal control of the production forest area through an Ecosystem Restoration Concession license (ERC; Minister of Forestry Decree SK 734/Menhut-II/2013), blocking the applications of plantation companies.

The Katingan Project implements a variety of activities through a holistic approach in order to achieve its objectives (see Sub-section 1.1.2). All activities are implemented with a full consideration of internationally credible science and standards, conservation priorities, Indonesian laws and regulations, land tenure, socio-economic needs, and community consultation based on free, prior and informed consent principles. The Katingan Project is performance-based, and at its core, is financed by its achieved GHG emission reductions and sequestrations against a baseline scenario during the initial crediting period of 60 years. Through the planned activities described in Sub-section 2.2.1, the project is expected to reduce an average of 7,451,846 tons of GHG emissions annually during the initial 60 year crediting period.

The Katingan Project is managed by the Indonesian company PT. Rimba Makmur Utama and is designed to ensure that all benefits are real, long-lasting, and passed on to local communities, the region, and to the wider State of Indonesia in which it operates. The Katingan Project aims to bring positive change over the next 60 years by conserving the integrity of remaining peat swamp forest, and by playing a crucial role for Indonesia as it sets out to fulfil its emission reduction commitments in the years ahead.

1.1.2 Project objectives (G1.2)

The goal of the Katingan Project is to develop and implement a sustainable land use model through reducing deforestation and degradation, habitat and ecosystem restoration, biodiversity conservation, and increasing economic opportunities for the local people of Central Kalimantan. The Katingan Project is designed to achieve this through a series of objectives, considered in turn below:

D) Climate objectives

- To deliver credible GHG emission reductions through avoided deforestation and forest degradation, prevention of peat drainage and fires
- To enhance ecological values at the landscape scale through ecosystem restoration
- To conduct research and development (R&D) activities as to implement the latest science, research and management practices

E) Community objectives

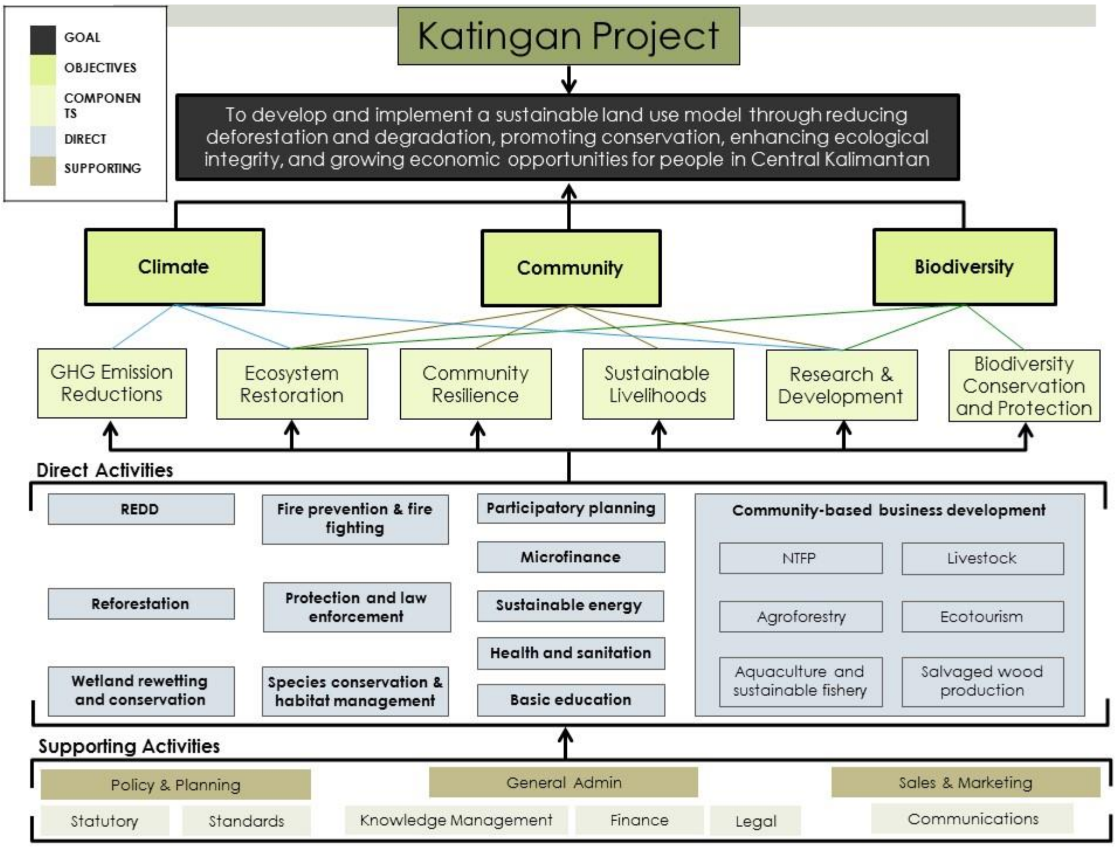
- To enhance the quality of life and reduce poverty of the project-zone communities by creating sustainable livelihoods options and economic opportunities
- To strengthen community resilience by increasing capacity to cope with socio-ecological risks
- To maintain and enhance ecosystem services for the overall well-being of the project-zone communities through ecosystem restoration
- To conduct research and development (R&D) activities as to implement the latest science, research and management practices

F) Biodiversity objectives

- To eliminate drivers of deforestation and forest degradation and to stabilize and maintain healthy populations of faunal and floral species in the project zone through biodiversity conservation and protection
- To maintain natural habitats and ecological integrity through ecosystem restoration
- To conduct research and development (R&D) activities as to implement the latest science, research and management practices

Figure 1 is a project framework which describes the project's planned activities and explains their relevance to achieving the project's objectives. A more detailed description of these project activities is then presented in Sub-section 2.2.1.

Figure 1. Katingan Project framework

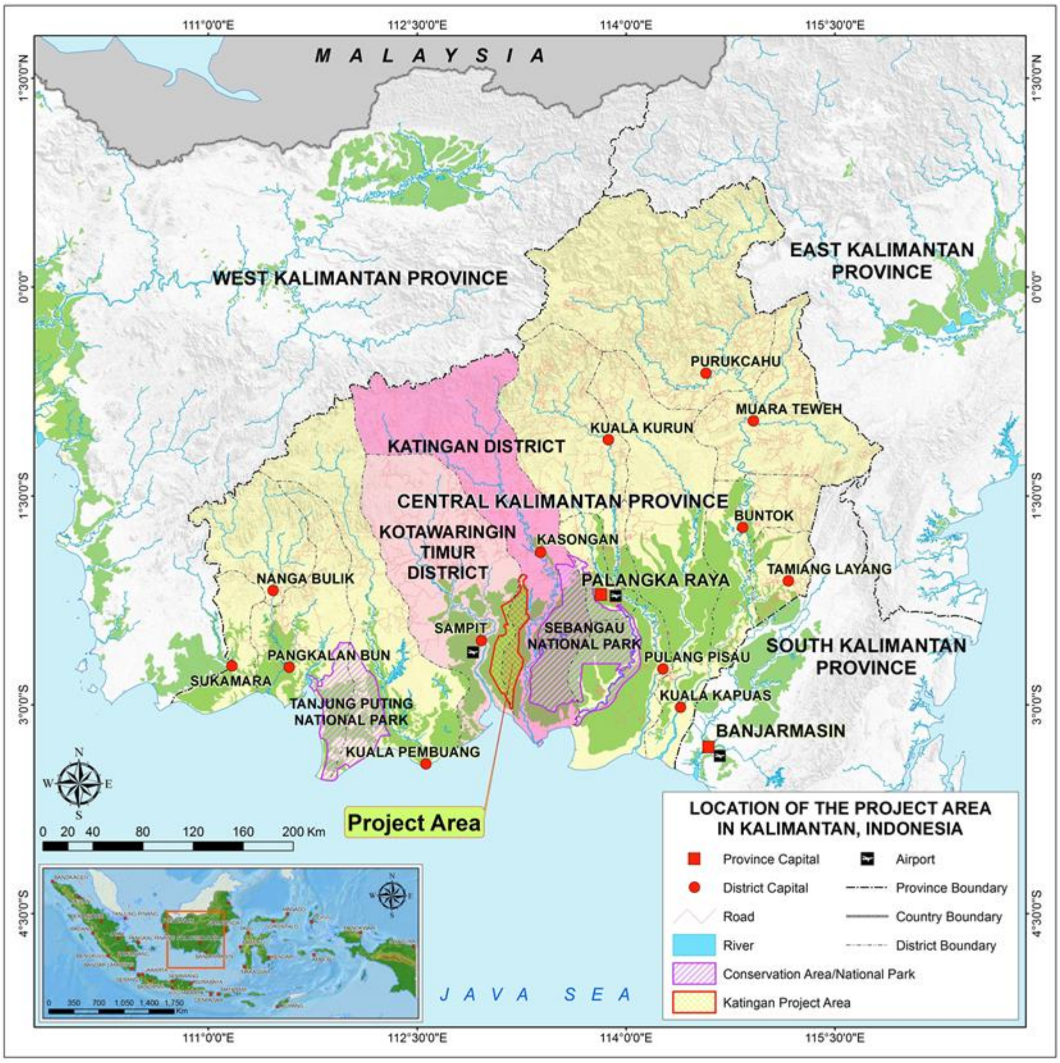


1.2 Project Location

1.2.1 Project geographic boundaries (G1.3)

The project is located in the Mendawai, Kamipang, Seranau and Pulau Hanaut sub-districts of Katingan and Kotawaringin Timur districts, Central Kalimantan, Republic of Indonesia (see Map 1). The project lies within the following geographic boundaries: S2° 32’ 36.8" to S3° 01' 43.6" E113° 00' 29.7" to E113° 18' 57.4".

Map 1. Location of the Katingan Project in Kalimantan, Indonesia



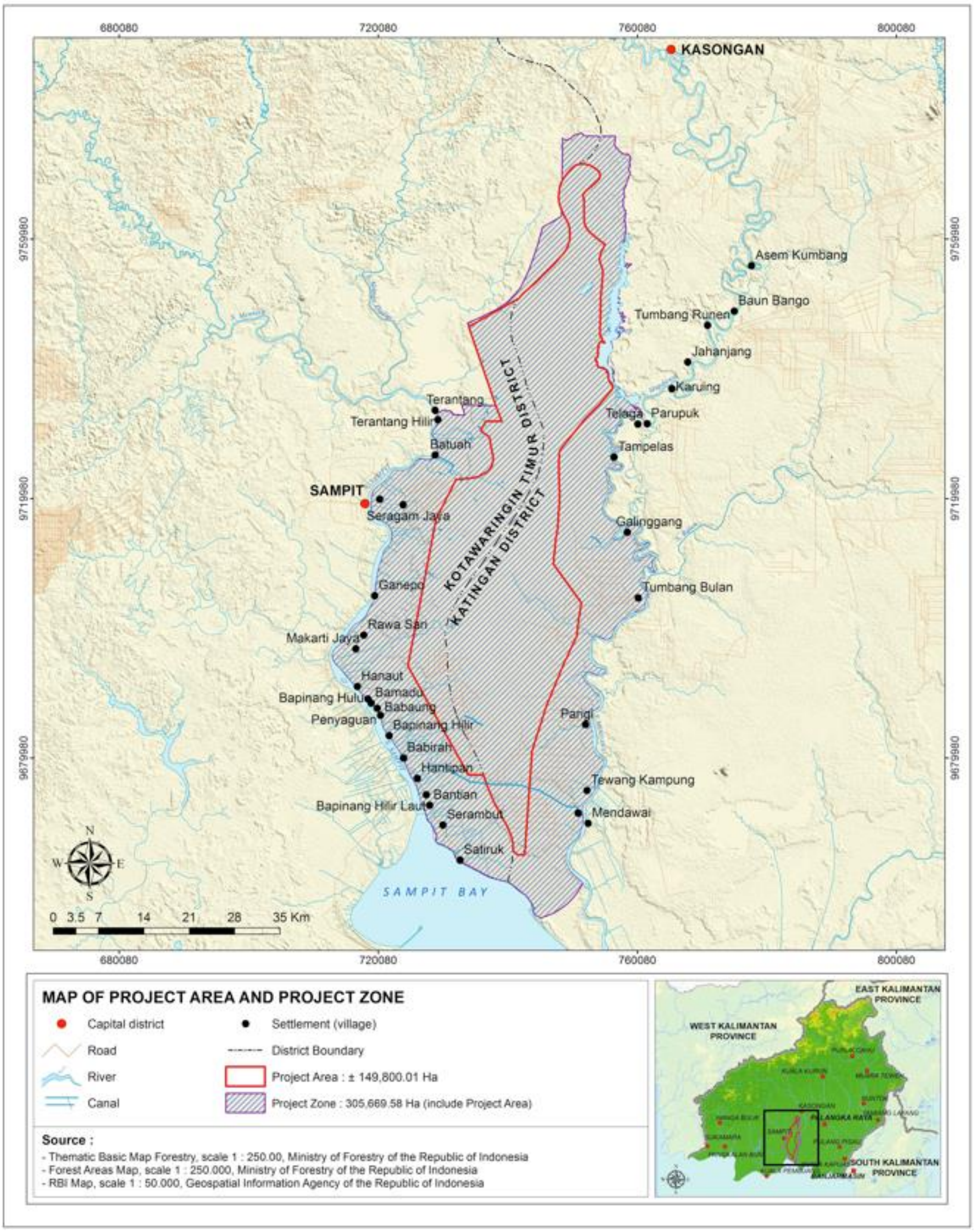
1.2.1.1 Project area (G1.4)

The project area, defined by the ecosystem restoration concession (ERC) license, encompasses 149,800 ha of land with a total perimeter of 254.12 km (see Map 2). The project area boundary delineates the area in which GHG emission reductions are quantified. The Project area is described in more detail below.

1.2.1.2 Project zone (G1.4)

The wider project zone represents the extent of the area in which the project activities described in Sub-section 2.2.1 are implemented. It extends to the banks of the Mentaya River in the west and the Katingan River in the east, and encompasses bordering areas to the north and south of the project area, covering an area of 305,669 ha (see Map 2). The project zone was selected based on the dominant ecological, landscape and socio-economic features and in particular to include the main river catchments and to encompass the land of 34 villages likely to be affected by the project. The project zone is described in more detail in Sub-section 1.3.2.

Map 2. The location of the project area and project zone



1.2.2 Basic physical parameters (G1.3)

1.2.2.1 Geology and soils

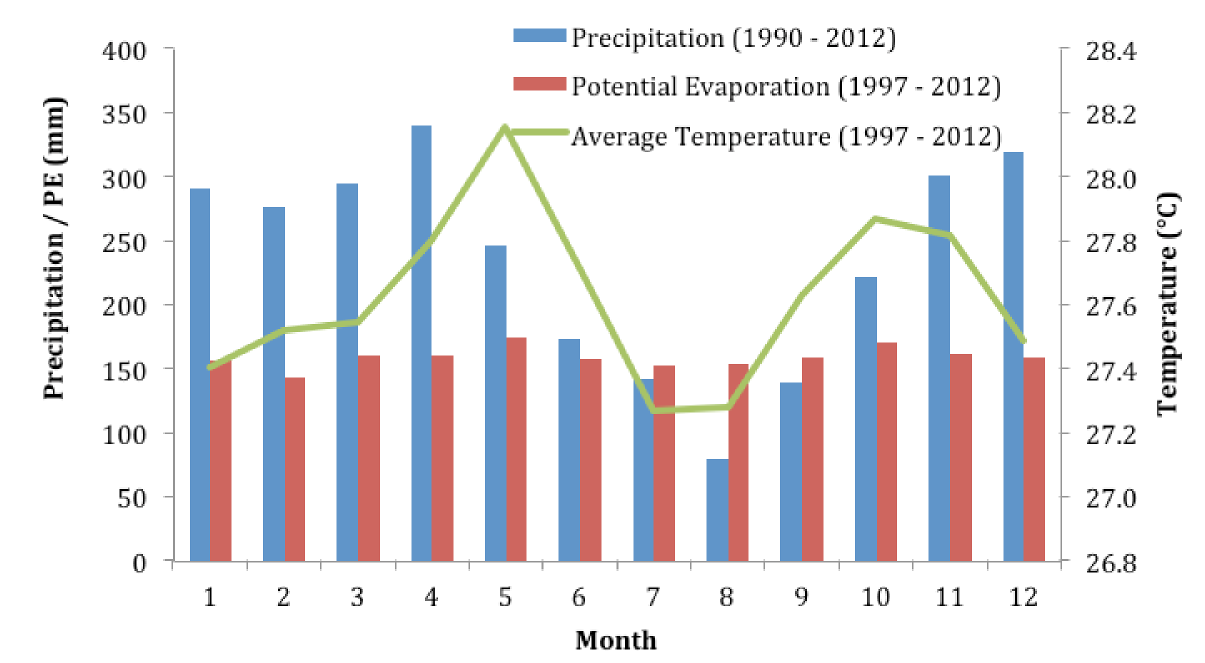
The project area is almost entirely based on peat soils (97%), with the remainder made up of exposed alluvial deposits of sand silt, kaolinite clay and gravel. Peat soils are defined as organic soils with at least 30% organic matter and a minimum thickness of 50 cm. They were formed by a process that began thousands of years ago and which continues to the present day. The formation of peat soil is a result of constant conditions of water logging above mineral soil and a lack of oxygen, in which a large amount of organic residues are accumulated at a higher rate than they can be decomposed [3]. Peat layers in the project area store an enormous amount of organic matters, and play an important role as an ecological reservoir for greenhouse gasses such as CO_2, nitrous oxide (N_2O), and methane (CH_4).

Underlying the peat, the project area has two distinct geologies. Stretching from north to south over the eastern part of the project, the underlying geology is made up of alluvial deposits, while in the north-western part of the project area the underlying geology is predominantly dahor formations consisting of quartz sandstone, lignite and limonite soft clay [4].

1.2.2.2 Climate

The project area has a wet tropical climate with an average annual precipitation of around 2,820 mm and approximately 196 rainy days per year (monthly record from Haji Assan Sampit Airport Station 1990 – 2012). Precipitation is highly seasonal with the highest average monthly rainfall typically occurring in November – April (wet season), while the lowest average monthly rainfall occurs in August (see Figure 2). Daytime temperatures are very stable year-round, averaging around 27.6°C (min 21°C, max 32°C), as is humidity, averaging 83%. Dry seasons usually last from June to September, when potential evaporations are close to or exceed precipitations. More about climate of the area is given in Annex 1.

Figure 2. Monthly rainfall, potential evaporation and temperature in the project area



1.2.2.3 Hydrology

The project area is situated on top of the Katingan peat dome. Hydrology in the project area is characterized by the seasonal recharge in the wet season and recessive discharge in the dry season. Due to the raised nature of the inter-lying peat dome, the flood plains of the two major rivers – Katingan and Mentaya rivers – extend only a short distance from the riverbanks into the forest. The inter-lying peat dome therefore receives little nutrient influx from these river floodplains, and therefore can be classified as an “ombrogenous” peat swamp [5]. In such peat swamps the source of nutrient is often limited to aerial precipitation (i.e., rain and dust), with small amounts of nutrient influx from microbial nitrogen fixation and animal faeces. While brackish backwater may contribute to the small portion of ground water recharge, it is limited to the southern part of the project area close to the sea.

The peat layer serves as the main aquifer in which precipitation input is stored and slowly released to blackwater streams during the dry season. Natural drainage shows a radial pattern, typical to the convex land form, with an enormous number of creeks along the footslope of the peat dome. The Mentaya and Katingan rivers serve as major tributaries to the drainage system in the project zone.

Inundation in the project area is a combined feature of seasonal excess precipitation and diurnal tidal rise. While tidal rise does not normally cause inundation, it may amplify the magnitude of recharge in the wet season. This happens when the sheer volume of blackwater discharge meets lowered head gradients downstream, leading to water level rise in tributaries due to the combined effects of the tidal and seasonal high river flows.

Output components of water balance are dominated by evapotranspiration, as indicated in Figure 2. The overland flow contributes the major portion of the annual river flow in wet season, while the ground water flow contributes to the minor portion.

For a detailed description of the hydrology of the area, see in Annex 3.

1.3 Conditions Prior to Project Initiation

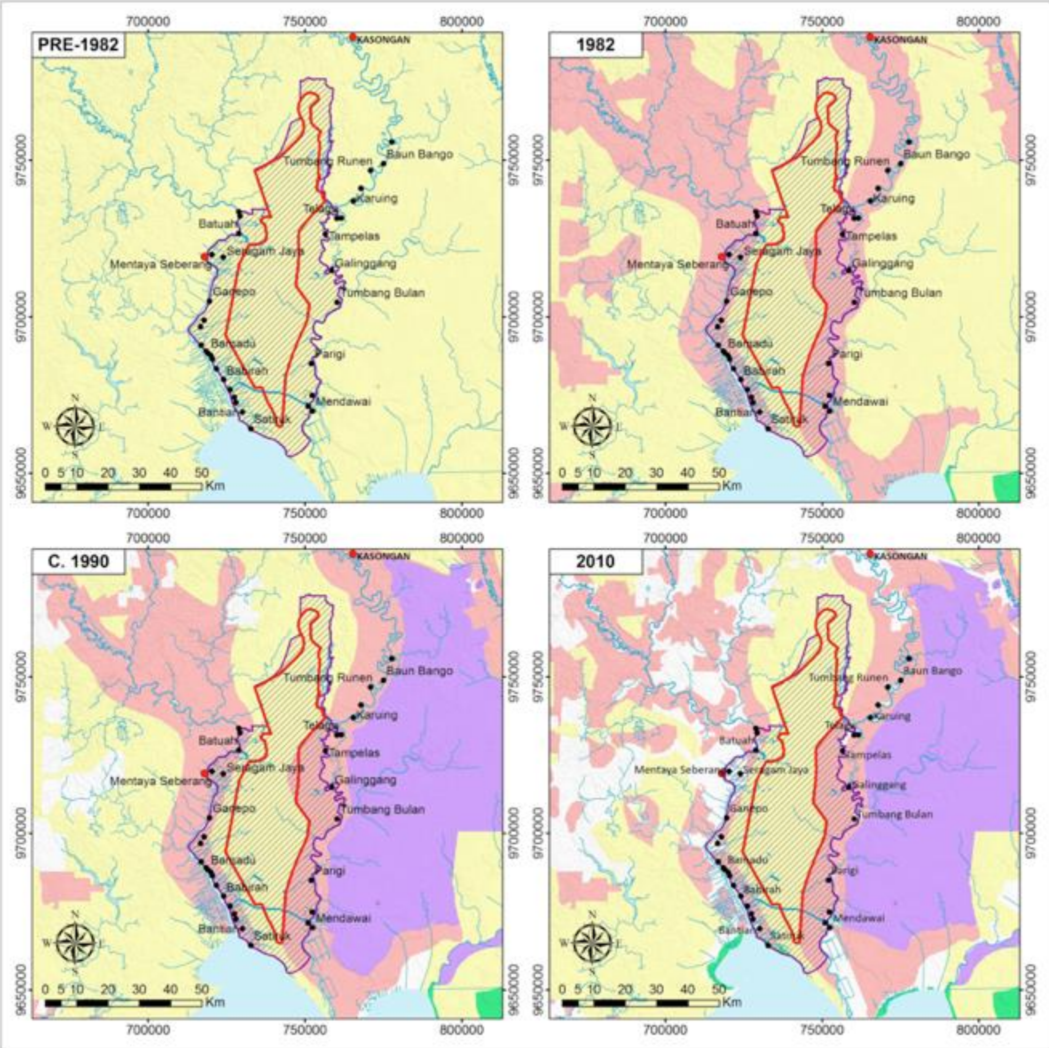
1.3.1 Historical land use change and conditions in the project zone (G1.3)

Historic land use patterns in the Katingan area were originally largely determined by physical conditions, but have shifted over time to accommodate changes ranging from forestry policies, market trends, economic needs, and migration to changing population sizes.

Small local communities have existed in the area for generations, relying on a river and forest-based economy. Such villages were (and to a large extent remain) exclusively located along the banks of the main rivers, or in areas where raised sand ridges allowed some agriculture. Livelihoods were typically supported by fishing, and to a lesser extent by small-scale logging, non-timber forest product harvesting, farming, hunting, and smallholder agroforestry. At this time the vast interior peat swamp forests would have been almost entirely uninhabited by permanent settlements.

As time has passed the distribution of villages and village land has remained essentially the same, but the interior forests have increasingly been targeted for commercial exploitation. This began in earnest in the early 70s and continued through to the early 2000s, and witnessed a number of companies being granted licenses by the government to log the interior forests (see Section 4.5 for a more detailed review of commercial exploitation). Legal land use designations evolved in parallel to the commercial exploitation. Originally all land within the project zone was simply designated as lying within state forests and open to commercial exploitation (see Map 3), irrespective of the presence of people of customary land claims. While companies largely tended to avoid land occupied by local villages, this was usually for pragmatic reasons rather than legal ones.

Map 3. Historical change in land designation in the region of the project. Yellow indicates State Production Forest ('Hutan Produksi'); Pink indicates forest designated for conversion ('Hutan Produksi Konversi'); Purple indicates areas designated as conservation areas; Green indicates protection forest ('Hutan Lindung'); and White indicates areas removed from the national forest estate.



As the commercial exploitation continued, so did the legal land designations evolve. Commercial logging left behind degraded forest, typically being most degraded nearest to the rivers where access was the easiest. This led to the designation of a swathe of land along both rivers being designated as forest estate land suitable for commercial conversion to non-tree crops, coinciding with the booming increase in oil palm in Indonesia. Only the interior forest remained designated for commercial logging. In parallel, across the broader region, the revision of land status maps also began to recognize the existence of some customary land by excising such areas from the forest estate, although the process was far from comprehensive (Map 3).

As the late 2000s approached the effect of the changing legal designations predictably saw an increase in palm oil agriculture in those areas bordering the rivers for which it had been made legally permissible. The impact of this has been greater in areas outside of the project zone (for example to the north, and west), but its effect was also felt within those areas designated for conversion within the project zone, with a number of applications by companies being lodged, some of which remain in process to date (for example the oil palm company, PT PEAK). Meanwhile, within the interior forests where commercial conversion to oil palm was not permissible the commercial interest switched from logging to mono-culture plantations. By 2010 these interior areas designated as 'production forest' were being earmarked for conversion and already subject to pending commercial applications (for a detailed review of see Section 4.5). By 2010 further land status reform was in the pipeline which saw the retention of the interior forests as production forest while excising further areas of the 'conversion forest' belt along the rivers from the forest estate. This was partly to reflect a greater recognition of the distribution of villages and village land (which had increased, but which was essentially unchanged in distribution) and, outside of the project zone in particular, to reflect the presence of new commercial oil palm plantations (Map 3).

This is the context within which the Katingan Project started. As an ecosystem restoration concession, the project was able to target only the interior production forest area, in what is now the project area, but in doing so could avoid the threat of these forests being commercially converted to monoculture plantations (see Section 4.5). Meanwhile, the areas closer to the rivers remain a mix of state forest land slated for conversion, areas already subject to commercial plantations, and land either legitimately owned by local villages or at the least being exploited by them.

1.3.2 Current land use in the project zone (G1.3)

Current land status and use within the project zone is summarised in Table 1 below. More detailed information on the project area is then given below in Sub-sections 1.3.3 and 4.4.1. As described in the previous section, there is a greater diversity of land status and land use within the wider project zone compared to the project area.

Table 1. Land use and status within the project area and zone

Land cover	Area within project area (ha)	% of total project area	Area within project zone (ha)	% of total project zone
Peat swamp forest	143,095	96%	180,370	59%
Fresh water swamp forest	1,683	1%	7,574	2%
Non-forest vegetation	4,659	3%	78,637	26%
Bare soil	363	<1%	11,273	4%
Plantation	0	0%	27,815	9%
Total	**149,800**	**100%**	**305,669**	**100%**
Land Status	Area within project area (ha)	% of total project area	Area within project zone (ha)	% of total project zone
Protection Forest (*Hutan Lindung*)	0	0%	1,442	<1%
Production Forest (*Hutan Produksi*)	149,800	100%	205,395	67%
Conversion Forest (*Hutan Produksi Konversi*)	0	0%	82,212	27%
Non-Forest Estate (APL)	0	0%	13,156	4%
No-Status/Water Body (*Badan Air/Danau*)	0	0%	3,464	1%
Total	**149,800**	**100%**	**305,669**	**100%**

1.3.3 Current condition and types of vegetation in the project area (G1.3)

The project area is classified into three vegetation types: mixed peat swamp forest; freshwater swamp forest, and; open degraded, scrub and grassland (see also Sub-section 4.4.1). Mixed peat swamp forest is by far the most dominant vegetation type, covering about 96.65% of the project area. Each of these vegetation classes is considered in turn below.

A) Mixed peat swamp forest

Peat swamp forest in the project area consists of mixed swamp vegetation, mainly inhabited by native tree species including terentang (*Campnosperma sp.*), bintangur (*Callophylum spp*), jelutong (*Dyera lowii/polyphylla*), punak (*Tertamerista glabra*), malam-malam/kayu hitam (*Diospyros sp.*), resak (*Vatica Rasak*), meranti rawa (*Shorea sp.*), balangeran (*Shorea balangeran*), kajalaki/parak (*Aglaia* *rubignosa*), nyatoh (*Palaquium spp.*), alau (*Dacrydium becarii*), kempas (*Kompassia malaccensis*), tumih (*Combretocarpus rotundatus*), ramin (*Gonystylus bancanus*), and gemor (*Alseodaphne coriácea*). Among these species, ramin and gemor are both economically and ecologically valuable, and are very rare in the project area today due to over exploitation in the past. Besides tree species, mixed peat swamp forest is inhabited by non-tree species as well. The common palm species found in this type of forest are asam payo (*Eloidoxa conferta*), palem merah (*Cyrtoctachys lakka*), and rattan (*Calamus sp*. and *Khortalsia sp.*). Amid standing trees, there are many types of herbaceous plants and sedges such as *Rhapidophora spp*., *Cryptocoryne sp*., *Liparis spp*., *Freycinetia spp*., *Thoracostachyum sp*., and *Schleria sp*. In the deep peat areas, pitcher plants locally known as kantung semar (*Nepenthes sp.*) are abundant on the forest floor. Figure 3 shows a typical condition of the mixed peat swamp forest.

Figure 3. Typical vegetation condition in the mixed peat swamp forest

B) Freshwater swamp forest

Freshwater swamp forest occupies small areas in the eastern part of the project area adjacent to rivers. Freshwater swamps form where periodic flooding causes water logging on soils. The soil in this type of forest is much less acidic than that in peat swamps, and it is among the most nutrient-rich tropical soils due to frequent deposition of silts and organic matters. Freshwater swamp forest is dominated by swampy tree species such as perupuk (*Lophopatalum multinervium*), jambu-jambu (*Syzygium sp.*), gelam tikus (*Eugenia spicata*), ara (*Ficus microcarpa*), *Archidendron clyperia*, and *Elaiocarpus sp*. Other tree species include *Shorea belangeran* and *Combretocarpus rotundatus*. Common riverine species such as *Barringtonia spp*., *Pandanus helicopus* and *Thoraxostachyum spp*. are abound along the river or creek. Figure 4 shows a typical condition of the freshwater swamp forest.

Figure 4. Typical vegetation condition in the freshwater swamp forest

C) Non-forest vegetation

Within the project area are small areas of non-forest vegetation that include shrub land, fernland, grass land, and bare land. These areas are dominated by ferns such as pakis (*Selaginella sp.*), paku jampa (*Nephrelopsis sp.*), kelakai (*Stenochlaena palustris*), *Pteridium sp*, and *Glechnium spp*. Sedges and grasses such as *Scleria purpurescens*, *Hymenachne acutiguma*, and alang-alang (*Imperata cylindrical*) are also abundant. Some woody species including galam (*Melaleuca sp.*), tumih (*Combretocarpus rotundatus*), senduduk (*Melastoma malabathricum*), *Tetractomia tetranda*, gerunggang (*Cratoxylon arborescens*), and *Trema orientalis* grow as well in some areas. These are pioneer tree species which grow quickly after fire events in the project area. Figure 5 shows a typical condition of the non-forest vegetation areas.

Figure 5. Typical condition in the non-forest vegetation

1.3.4 Current carbon stocks (G1.3)

The volume of total aboveground biomass and peat carbon stocks in the project area at the project start was quantified to be **14,254,599 ton of carbon (tC)** and **546,767,493 tC**, respectively. For a full description of current carbon stocks, see Chapters 4 and 5.

1.3.5 Communities in the project zone (G1.3)

The project area contains no permanent human settlements. This distribution is no accident, as for reasons described in Sub-section 1.3.1, the project area is essentially defined as the area that was not occupied by communities or was targeted for excision from the forest estate. The wider project zone outside of the project area, on the other hand, encompasses 34 village communities and a population estimated in 2010 to be 43,000 people living in 11,475 households [6] [7]. These villages fall under the territorial administration of Mendawai and Kamipang sub-districts of Katingan District, and Seranau and Pulau Hanaut sub-districts of Kotawaringin Timur District (see Map 2). These communities typically make their living from the land and from the rivers, predominantly relying on small-scale agriculture and traditional fisheries. Rice, rubber, coconut, rattan, fruits, non-timber forest products (gemor, jelutong, honey, medicinal plants) and freshwater fish are among the most common livelihood commodities in the project zone (see Figure 6).

Figure 6. Communities in the project zone

For a detailed description of project zone communities, including demographic and socio-economic data, see Annex 2. This is discussed further in relation to project activities in Sub-section 2.2.1, to stakeholders in Section 2.7, and to the project's net positive community benefits in Chapter 6.

1.3.6 Land rights and conflict (G1.3, G5.5)

The centralistic land tenure policies of the 70's and 80's led to both confusion and conflict among local communities, as lands they had traditionally recognised as their own were designated as lying within the national forest estate and were therefore open to commercial exploitation (see Sub-section 1.3.1). As time has passed the situation has slowly improved, with more and more village land being progressively excised from the forest estate as land tenure and planning practices have improved. Outstanding issues do remain however, particularly within those areas lying between the project area and the rivers, which remains designated as commercial conversion forest. Further land conflict within the wider project zone has also been sparked by progressive waves of transmigration. For further details see Annex 2.

The Katingan Project is designed and implemented to fully recognize customary rights and community land tenure. The project has facilitated participatory land-use mapping and demarcated land-use boundaries in the project-zone villages based on customary rights. While this process has allowed a formal consensus to be reached on the project *area*, the process has also helped local communities to resolve conflicts within the wider project *zone.* The outcomes can then feed directly into local planning processes and get formal recognition. For further details see Sub-section 2.2.1 and Section 2.7.

1.3.7 Current biodiversity (G1.3)

In total, field surveys identified 67 mammal, 157 bird, 41 reptile, 8 amphibian, 111 fish, and 314 floral species in the project zone [8] [9]. Of these, two species are considered as Critically Endangered, 11 are Endangered, and 31 are Vulnerable [10], while 14 are endemic to Borneo, and 63 are protected under Indonesian law (see Appendix 1). Preliminary estimates also indicate an estimated population of almost 4,000 Orangutan, almost 10,000 Bornean Gibbon and over 500 Proboscis Monkey (see Figure 7). These populations all represent over 5% of the remaining global population of these species, classifying the project area as a Key Biodiversity Area by this criteria alone.

Figure 7. Oranghutan in the project zone

Full details of the biodiversity assessment can be found in (Harrison, et. al, 2010 [8] and Harrison, et. al, 2011 [9]). Key species identified by the survey, including all those considered of high conservation value, endangers, protected or endemic, are listed in Appendix 1. Measures implemented to protected and enhance the site's biodiversity are discussed further in relation to project activities in Sub-section 2.2.1, and in relation to the project's net positive biodiversity benefits in Chapter 7.

1.3.8 Identification of high conservation values (HCV) (G1.3, G1.7)

In addition to the biodiversity assessments described above, a rapid assessment of high conservation value (HCV) areas was conducted in collaboration with the Katingan Project by a team from the Indonesian Forest Research and Development Agency (FORDA). The assessment was based on the high conservation value forest (HCVF) identification toolkit for Indonesia [11] in conjunction with data collected from field surveys (available upon request) and the evaluation of secondary data. The assessment sought to identify the existence of HCV species and prominent threats to them, as well as to produce indicative maps of the area's forest land systems and HCV species. A full report of the results are available in the reference [4], and are summarized in Annex 3. The assessment identified areas within all six HCV classes, as shown below in Table 2, each of which is mapped (see Map 4 and Annex 3 for further details).

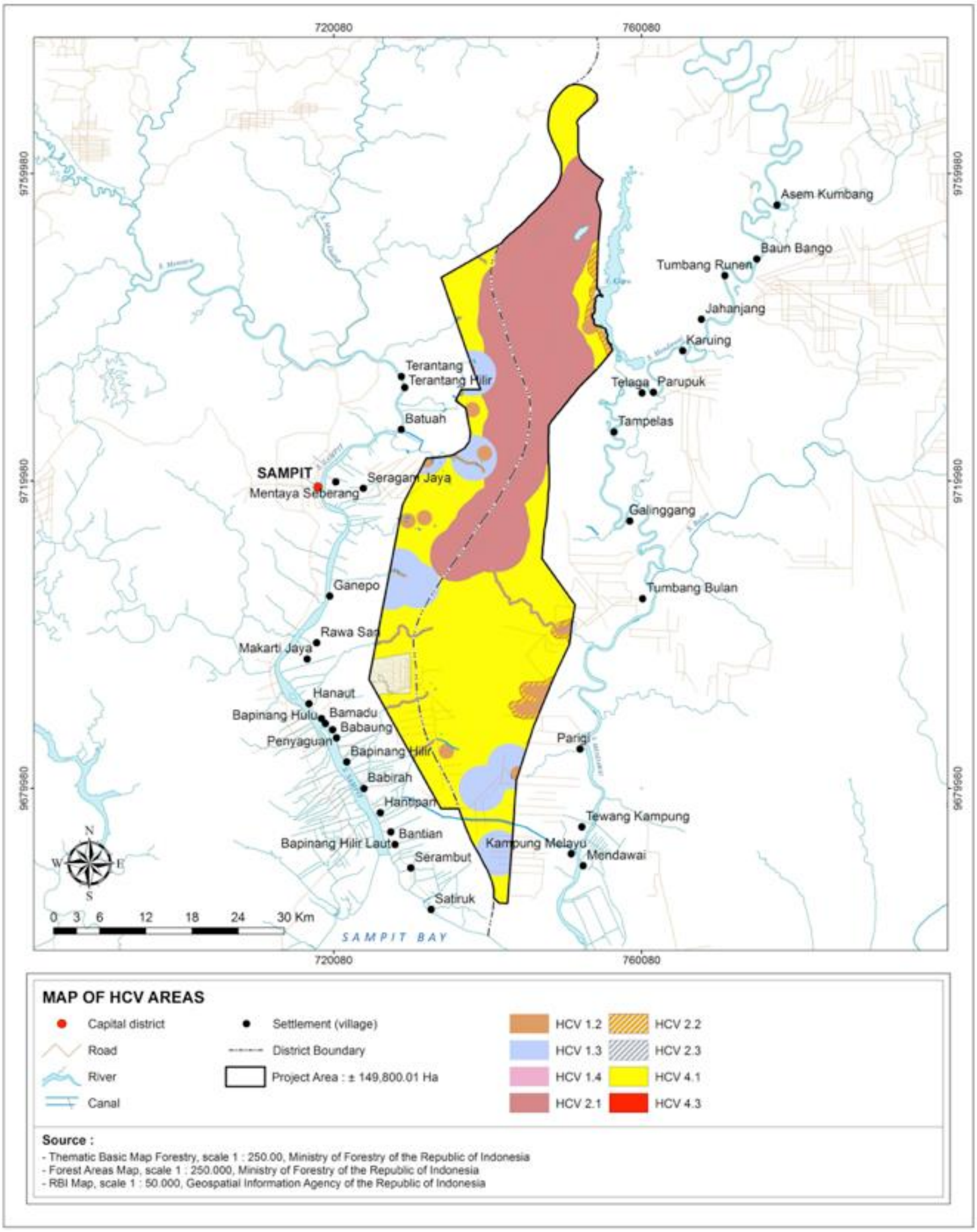
Measures implemented to protected and enhance the site's high conservation value areas are discussed further in relation to project activities in Sub-section 2.2.1 and Section 2.4, and in relation to the project's net positive community and biodiversity benefits in Chapters 6 and 7 respectively.

Table 2. HCV attributes and findings

Class	Sub-class	Key Question	Results
HCV 1 Areas with important levels of biodiversity	1.1	Does the project area contain or provide a function to support biodiversity for protected or conservation areas within or nearby?	Yes
	1.2	Does the project area contain critically endangered species?	Yes
	1.3	Does the project area contain areas used as habitats for viable population of species, which are threatened, restricted ranged or protected?	Yes
	1.4	Is the project area used as a temporary place/habitat for a species or a congregation of species?	Yes
HCV 2 Natural landscapes and dynamics	2.1	Is the project area a part of large natural landscapes with a capacity to maintain natural ecological dynamics?	Yes
	2.2	Is the project area a part of landscapes that contain two or more contiguous ecosystems?	Yes
	2.3	Is the project area a part of landscapes containing population of most naturally occurring species?	Yes
HCV 3 Rare or endangered ecosystems	3	Is the project area a part of landscapes containing rare or endangered ecosystems?	Yes
HCV 4 Environmental services	4.1	Is the project area considered a part of landscapes important for the provision of water and prevention of floods for downstream communities?	Yes
	4.2	Does the project area hold areas important for the prevention of erosion and sedimentation for downstream communities?	No
	4.3	Is the project area a part of landscapes that function as a natural break to the spread of forest or ground fire?	Yes
HCV 5 Natural areas critical for meeting the basic needs of local people	5	Does the project area play an important role for meeting the basic needs of local communities?	Yes
HCV 6 Areas critical for maintaining the cultural identity of local communities	6	Does the project area contain areas critical for maintaining the cultural identify of local communities?	Yes[1]

[1] Identified subsequent to the initial assessment, see Section 6 for further details.

Map 4. HCV areas within the project zone



1.4 Project Proponent

1.4.1 Contact information and roles of the project proponent (G1.1)

The Katingan Project is developed and managed by the ecosystem restoration concession (ERC) holder, PT. Rimba Makmur Utama (RMU). By collaborating with the project-zone communities and partner organizations, PT. RMU takes full responsibility to manage, finance and implement project activities for the duration of the project. Table 3 shows the project proponent's information.

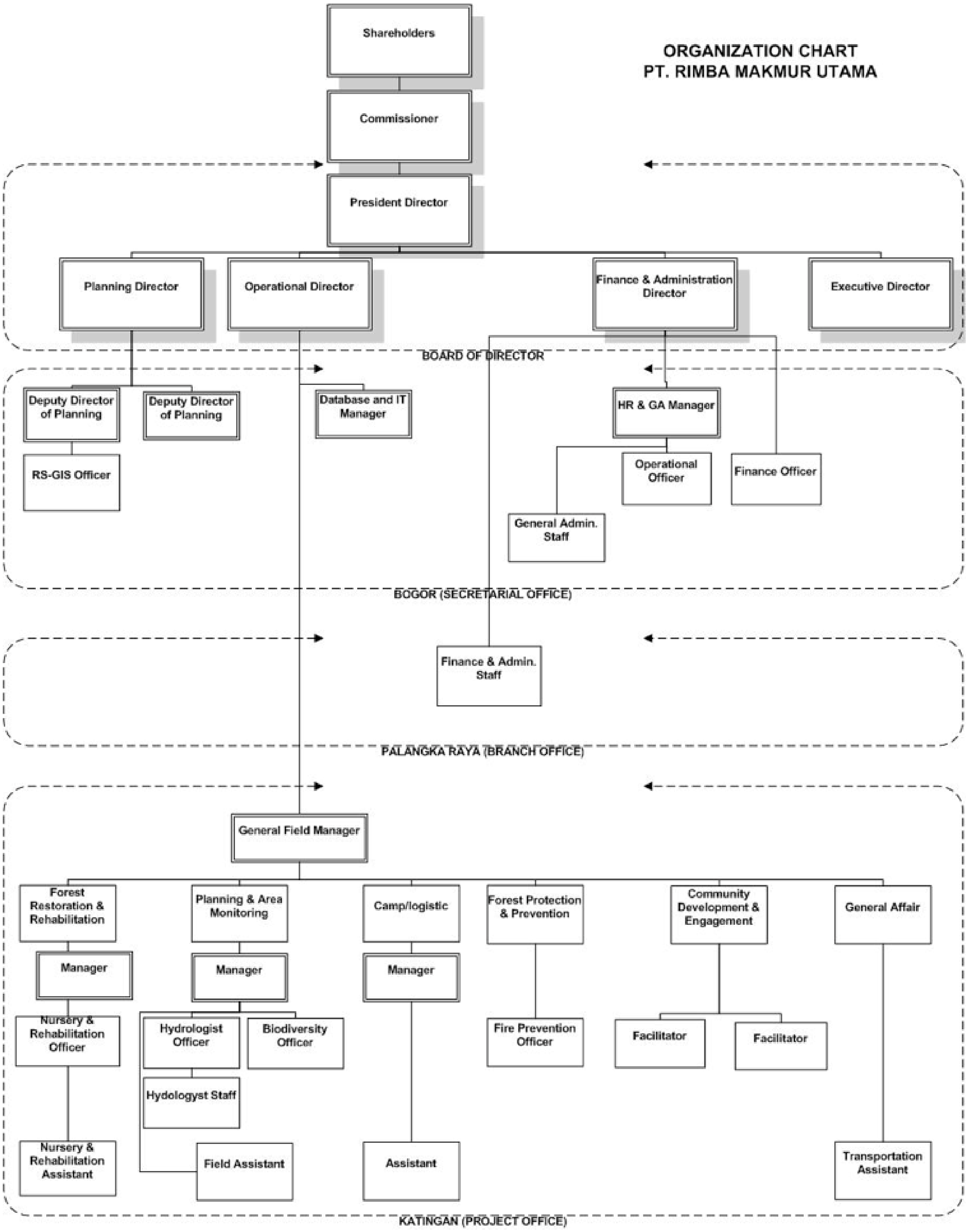
Table 3. Project proponent information

Organization	PT. Rimba Makmur Utama (PT. RMU)
Organizational category	Private company
Contact person	Dharsono Hartono, Director
Address	Menara BCA, Fl. 45, Jl. MH Thamrin No. 1, Jakarta, Indonesia Phone: +62 (0)21 2358 4777; Fax +62 (0)21 2358 4778; Mobile: +62 (0)816-976-294 dharsono@ptrmu.com
Organization's profile	PT. RMU was founded in 2007 with a mission to restore and conserve peatland in Central Kalimantan Province through a land-use permit, IUPHHK-RE, also known as ecosystem restoration concession (ERC). By using the ERC business model, PT. RMU seeks to reduce greenhouse gas emissions within the concession site and generate carbon offset credits under REDD+ mechanisms.
Project roles	PT. RMU is the project developer, ERC license holder and lead implementer. It is responsible for the overall management, financing and implementation of the Katingan Project. Proposed project activities are to be carried out in collaboration with communities in the project zone and project partners as described below Sub-section 1.5.1.
Project management team	**Mr. Dharsono Hartono, Chief Executive Officer** Dharsono is the Chief Executive Officer (CEO) of PT Rimba Makmur Utama, an Indonesia-based company that is developing the Katingan Project. Since 1998, he has worked for multinational companies such as PricewaterhouseCoopers and JP Morgan in New York, handling merger acquisition, debt management and financing and raising capital. His role in PT Rimba Makmur Utama includes managing all the company's activities, especially marketing and financing in the carbon market. Dharsono obtained a bachelor's degree in Operation Research, and a Master of Engineering from Cornell University in Financial Engineering. **Mr. Rezal Kusumaatmadja, Chief Operating Officer** Rezal is the Chief Operating Officer (COO) of PT Rimba Makmur Utama. Before joining PT RMU, he was involved in the Katingan Project as co-founder of Starling Resources where he led the development of the project activities since 2008. He has more than 15 years of experience in natural resource management, community-based planning, forest conservation and sustainable forest management. Rezal is also actively involved in the international REDD+ initiatives serving as an advisory board member to the Climate and Land Use Alliance (CLUA) from 2010 until present, a member of the REDD+ Social Environmental Standards (REDD+ SES) international standards committee from 2009 to 2013, and a member of Advisory Committee VCS Jurisdictional and Nested REDD Initiative in 2012. Rezal holds a master's degree in urban and regional planning from the University of Hawaii and a bachelor's in City and Regional Planning from Cornell University.

1.4.2 Organizational structure (G4.1)

The organizational structure of PT RMU (as of Jun 2015) is shown below in Figure 8.

Figure 8. Organizational structure of PT. RMU as of June 2015



1.5 Other Entities Involved in the Project

1.5.1 Implementing and technical partners (G4.2)

Key implementing and technical partners are shown below.

Organization	Yayasan Puter Indonesia
Category	NGO
Contact Person	Yekti Wahyuni, Executive Director
Address	Jalan Ahmad Yani II, Nomor 11A, Bogor, 16151, Indonesia Tel/Fax: +62 (0)251-831-2836 Email: yektiwahyuni@gmail.com
Organization's profile	Yayasan Puter Indonesia is a not-for-profit organization based in Bogor with a core mission to develop and implement innovative approaches to people-based planning processes. Yayasan Puter is committed to assisting communities, CSOs, private companies as well as government agencies that share Puter's vision and mission.
Project roles	Community development activities, including: • Participatory land-use mapping • Community consultations and REDD+ awareness building • Livelihood programs

Organization	Wetlands International
Category	NGO
Contact Person	I Nyoman Suryadiputra, Director Indonesia Programme, Wetlands International
Address	Indonesia Programme office: Jl. Ahmad Yani No. 53 Bogor, 16161, Indonesia Tel: +62 251 8312189 Email: nyoman@wetlands.or.id Web: www.wetlands.org
Organization's profile	Wetlands International is an international NGO, dedicated to maintaining and restoring wetlands – for their environmental values as well as for the services they provide to people. The organization works through a network of offices (including a HQ based in the Netherlands and a Programme Office in Indonesia), with a global network of partners, specialist groups and associate experts. It receives funding from governments, private donors and a membership.
Project roles	Wetlands International leads technical aspects of MRV-related activities, including: • MRV methodology and platform development for monitoring above- and below-ground carbon emissions; • The provision of technical expertise including biodiversity management, fire management, land-use management and community development

Organization	Permian Global
Category	Company
Contact Person	Dr. Nick Brickle, Asia Director
Address	Savoy Hill House, 7-10 Savoy Hill London, WC2R 0BU, United Kingdom Tel: +44 20 3617 3310 Email: info@permianglobal.com Web: www.permianglobal.com
Organization's profile	Permian Global is an investment firm dedicated to the protection and recovery of natural forests to mitigate climate change. Permian Global comprises a team of experienced experts from the fields of science, forest conservation and asset management; committed to creating the best possible forest carbon projects.
Project roles	Technical advice and support, including: • MRV methodology design and technical support • Remote sensing • Carbon commercialization and marketing • Technical management advice including protection and restoration methods

1.5.2 Key technical skills required for project implementation (G4.2)

The project activities described in Sub-section 2.2.1 will be implemented primarily by the project proponent, PT. RMU. The company employs a large, highly-qualified and professionally-experienced staff, drawn from various backgrounds and with expertise including forest management, peatland biochemistry, conservation biology, silviculture, aquaculture, community development, financial management, business management, legal and technical regulation and policy. This team is based in headquarters in Bogor and Jakarta, within regional offices in Palangkarya, Sampit and throughout the project zone.

In addition to in-house experts, PT. RMU collaborates with a wide-range of institutions both as implementing partners and as sources of technical advice. This includes those partners listed in above in Sub-section 1.5.1 but also includes a range of other partners that assist the project on an issue-based or *ad hoc* basis, both *pro bono* and as contracted consultants. Amongst these partners are a range of nationally and internationally recognized scientific and technical experts, providing advice on issues ranging from climate science, to community development, practical site management and biodiversity conservation. Furthermore, local communities are also considered as one of the key collaborating experts since they are the source of a wealth of local and traditional knowledge.

Table 4 below summarizes some of the main project activity themes and some of the range of skills required for their implementation. For further detail see Sub-section 2.2.1. More details of the financial management of the project can be found in Section 2.5.

Table 4. Key skills required to implement the project, by activity

Project activity	Sub-project activity	Key skills required
Ecosystem Restoration	Hydrology management; reforestation; enrichment planting; MRV	Hydrology; Carbon MRV, GIS/remote sensing; silviculture; peatland biogeochemistry
Forest Resources Conservation	Protection and enforcement; Forest fire prevention and control; Habitat conservation and management	HCV mapping, forest conservation; Peat forest fire management; biodiversity conservation, biodiversity MRV
Research and Development	Knowledge management; MRV methods; restoration methods; biodiversity conservation methods	Carbon MRV, hydrology, silviculture, peatland biogeochemistry, forest conservation, biodiversity conservation
Livelihood Development	Non-timber forest products; Agroforestry; Ecotourism; Salvaged wood production; Aquaculture and sustainable fisheries	Community organizing, conflict resolution, participatory land-use mapping, business management; Agroforestry, peatland biogeochemistry
Community Resilience	Microfinance institutions and enterprises; Energy efficiency and production; Mother and child health care; Clean water and sanitation; Basic education support	Microfinance, community organizing, conflict resolution; Renewable energy, community organizing

1.6 Project Start Date (G1.9)

Following the VCS definition of start date (the date on which activities that lead to the generation of GHG emission reductions or removals are implemented), the **project start date is November 1, 2010.**

PT. RMU submitted a technical proposal to the Ministry of Forestry in 2008. The application was acknowledged and instructed to proceed with a partial environmental impact assessment of the project area (the status known as *SP-1*) in 2009, hence blocking any further applications. November 1, 2010 is the date when the Katingan Project commenced field survey activities inside the project area, and it also coincides with the time when baseline emissions would have started, had the project not blocked any further applications by reserving the project area applications (see Sections 4.5 and 5.3 for more details). Therefore, this date will be used as the calculation base for the historical reference period required for setting a baseline scenario, and for the project crediting period as required by the methodological standards of the VCS guidelines.

1.7 Project Crediting Period (G1.9)

The duration of the VCS **project crediting period is 60 years**, beginning on the project start date of **November 1, 2010** and ending on **October 31, 2070,** and credits will be calculated against the baseline scenario at the time the project start (see Section 1.6)**.** The project crediting period is renewable.

The project crediting period is set initially for 60 years, which is in line with the lifetime of the Katingan Project based on the term of the ecosystem restoration concession (IUPHHK-RE) held by PT RMU.

2 DESIGN

2.1 Sectoral Scope and Project Type

The Katingan Project is categorized as an Agriculture, Forestry and Other Land Use (AFOLU) project under the Reduced Emissions from Deforestation and Degradation (REDD) project category. The project activities are categorized under the VCS as a combination of REDD+WRC[2] and ARR[3]+WRC; specifically as Avoiding Planned Deforestation (APD) and Reforestation (ARR), in combination with Conservation of Undrained and Partially drained Peatland (CUPP) and Rewetting of Drained Peatland (RDP) activities. This is not a grouped project.

2.2 Project Activities

The Katingan Project conserves a vast ecosystem of mostly intact peat swamp forest which would have been converted to industrial acacia plantations in the absence of the project (see Sections 4.5 for a full analysis of the project's baseline scenario). Based on the project framework presented in Figure 1, project activities are implemented with a full consideration of science, research, field surveys and community consultation, and will reflect the condition of surrounding ecosystems, local land tenure, conservation priorities and livelihood options. The detailed description of project activities is presented in the following Sub-section 2.2.1.

2.2.1 Project activities (G1.8)

A) Avoided Deforestation and peat drainage (REDD + WRC)

At its heart, the project will avoid the deforestation, degradation and drainage of a vast area of peat swamp forest. This is achieved primarily by obtaining the legal licence to the project area, thereby preventing the area from being converted by an industrial acacia plantation company. The process of deforestation in the baseline and associated emissions which are avoided in the project scenario is described in more detail in Chapter 5.

B) Reforestation (ARR)

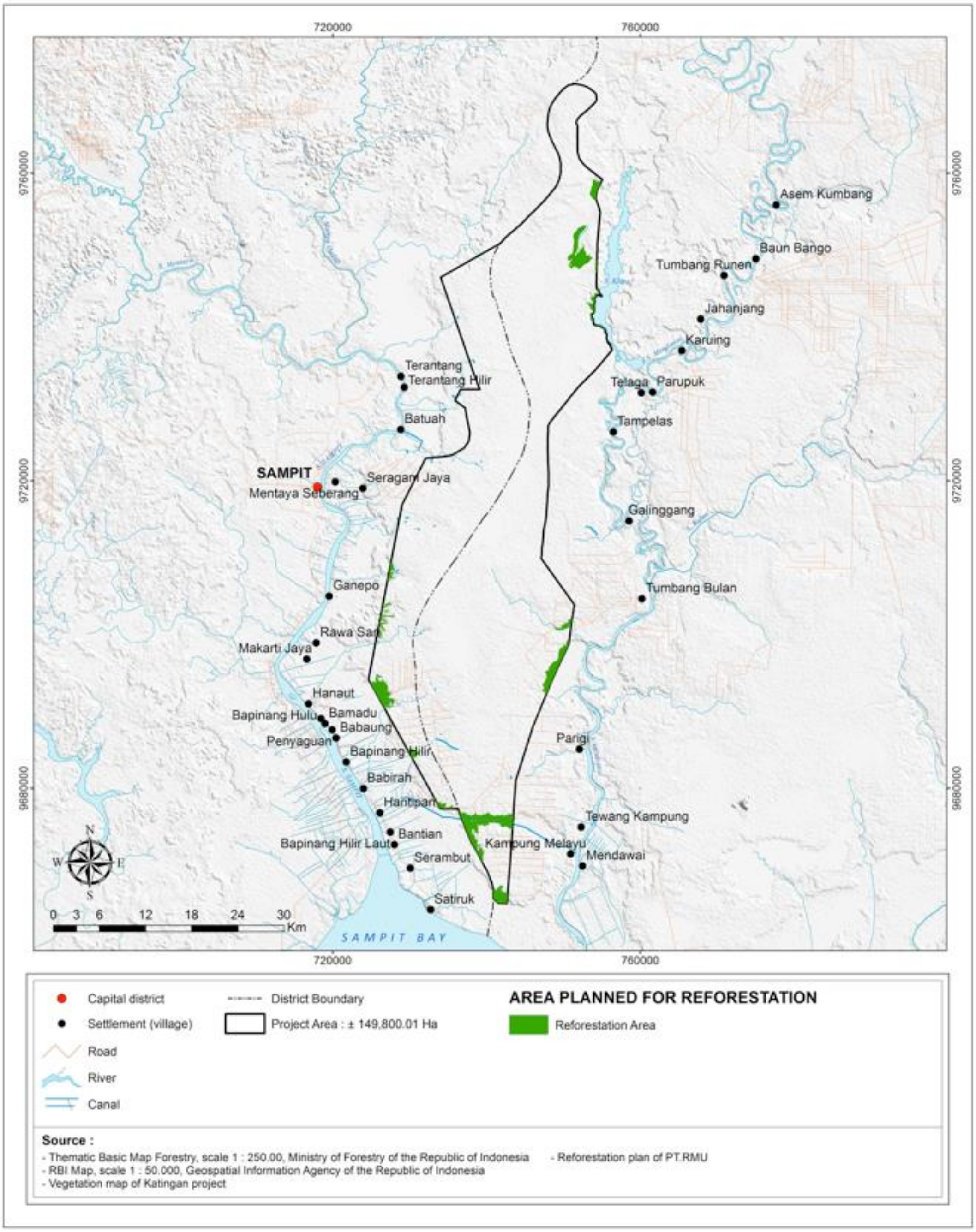
The Katingan Project aims to reforest total 4,433 ha of non-forest areas within the project area. Three designs are applied in the reforestation program; community-led agroforestry, fire break plantation and intensive reforestation. In all cases, saplings will be grown in on-site nurseries and regular

[2] Wetlands Restoration and Conservation

[3] Afforestation, Restoration and Revegetation

maintenance will be conducted to improve the rate of tree survival and to control fire risk. Map 5 indicates the locations of planned reforestation activities inside the project area.

Map 5. Locations of reforestation plan



The community-led agroforestry approach will focus on a small area alongside the transport canal in the south of the project area in areas claimed by local communities. Through the project's community-based business development program (see 2.2.1–H), two economically-valuable local species will be planted; Rubber trees (*Havea brasiliensis*) as demanded by the project-zone communities and Jelutong trees (*Dyera lowii*). When mature, these agroforests will generate incomes for local communities and also to lower the risk of fire incidents by providing the otherwise open areas with biomass cover.

Small fire-break plantations will be established along the east and west boundaries of the Hantipan canal areas. These areas will be planted with two local fire-resistant species; Galam (*Melaleuca spp*) and Tumih (*Combretocarpus rotundatus*), and are intended to prevent the spread of outside fires into the project area while it is being rehabilitated.

Intensive reforestation will be carried out in all remaining non-forest areas inside the project area. In these areas, three primary species will be planted; Jelutong (*Dyera lowii*), Belangiraan (*Shorea belangeran*), Pulai (*Alstonia spp.*), as well as other native peat swamp forest species (see Appendix 1).

C) Peatland rewetting and conservation (RDP)

Peatland rewetting and conservation activities are crucial to maintain the integrity of the peatland ecosystem. Rewetting of the drained peatland (RDP) will be conducted in areas where drainage canals already exist (see Map 6 and Figure 9), while the conservation of undrained and partially drained peatlands (CUPP) will take place in the rest of the project area.

Figure 9. Hantipan canal used for the main transportation route in the southern part of the project zone

There are two types of drainage canals in the project area – 1) small logging canals (narrower than 2 meters and shallower than 1 meter) typically made by loggers to access forest and transport logs; and 2) navigation or irrigation canals (wider than 2 meters) made by the local government for the purpose of transportation and irrigation for the nearby communities. Rewetting efforts will be achieved by reducing the water table head-gradient towards canals as well as by reducing and preventing water outflow. Combinations of different rewetting approaches are feasible, and the final technical design will be determined in 2016 through a consideration of field conditions, technical assessments, stakeholder involvement and expert judgments. Options include:

- Construction of a series of cascade sluices and/or dams in the main canals;
- Construction of membrane barriers along smaller canals and ditches for the prevention of water loss from the area;
- Blocking of ditches and small canals with local materials (e.g. peat, wood), and allow them to naturally fill and overgrow with sediments and vegetation.

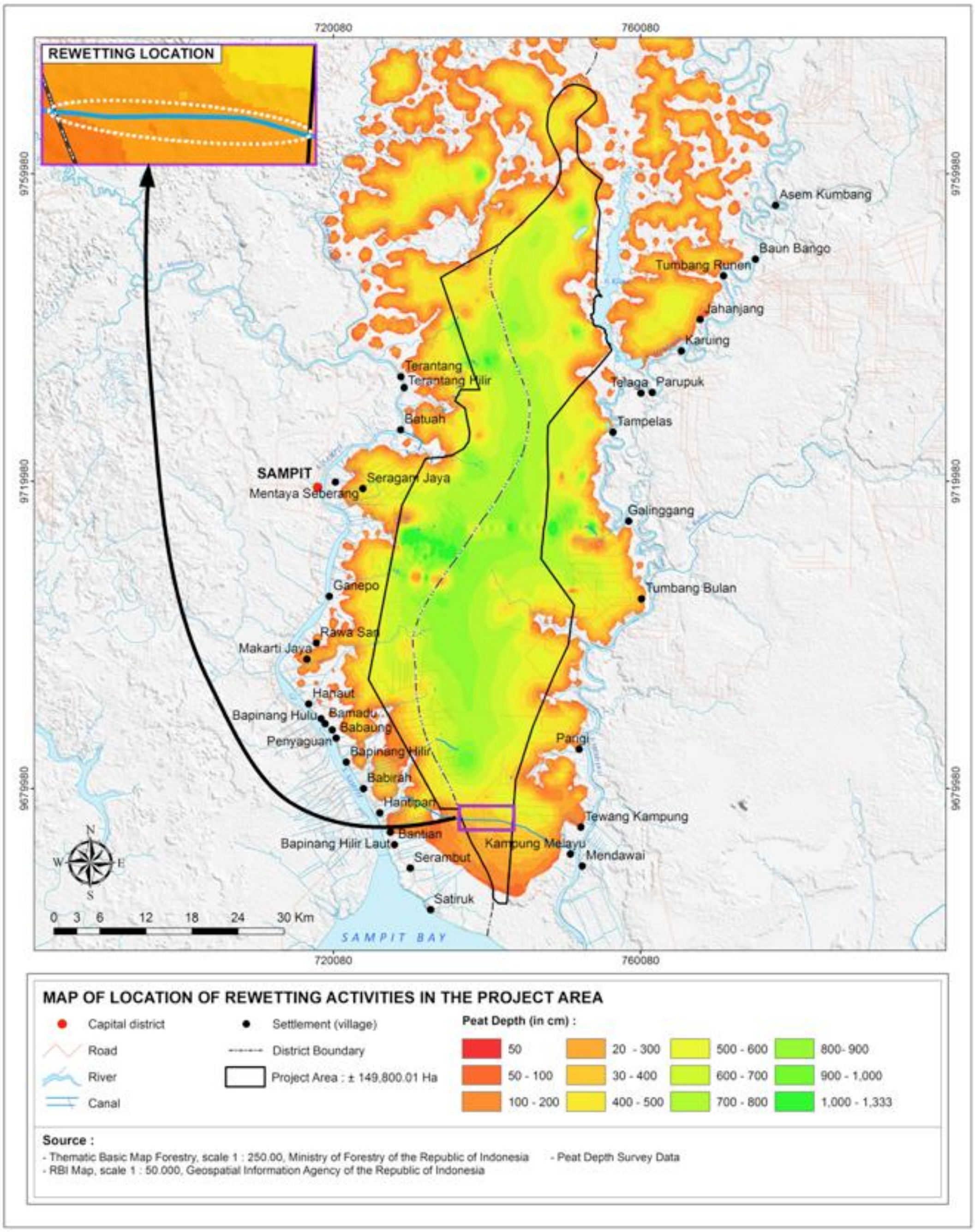
Together with A) REDD and B) reforestation (ARR) activities described above, RDP and CUPP activities will be implemented over four phases:

- Preparation phase (2016): Collection of hydrological information, feasibility study, development of the technical design, relevant stakeholder consultations, and financing

- Construction phase (2017): Procurement and mobilization of construction materials and workforce, and construction
- Post-construction evaluation phase (2017): Monitoring and evaluation of construction, and making improvements
- Maintenance phase (2017 – 2070): Regular monitoring of the structures and day-to-day maintenance of the blocks, if necessary

Protection and conservation measures will include protection against fire (see below D), protection against the creation of any new drainage, and protection against the loss of peat soil (erosion and oxidation) by maintaining and replanting tree vegetation in non-forest areas. This leads to the creation of a mild microclimate on the forest floor which in turn decreases wind speed on the forest floor, increases shading, lowers soil temperatures, and hence reduces microbial decomposition and fire risk.

Map 6. Location of rewetting activities in the project area



D) Fire prevention and suppression

Forest and peatland fires occur almost every year during the dry season on non-forest and drained peatland areas in the project zone. They can spread quickly and travel long distances, and pose immediate threats to all climate, community and biodiversity benefits of the project. They are typically caused by the extreme weather (drought) combined with unsustainable land-use practices primarily land clearing using fire. As a result, most fires spread from near settlements and adjacent agricultural land. Within the project area, the only region heavily affected by fires to date is the area adjacent to the transport canal in the south. This is the area now targeted for reforestation (see above). For a detailed description of emissions from uncontrolled burning, see Sub-subsections 5.3.5.5 and 5.4.3.4.

Given the highly damaging nature of fires, the Katingan Project takes fire prevention and response very seriously. Key activities throughout the project zone include:

- Participatory fire mapping to identify locations with potential risks to communities and the project zone;
- Development of early warning systems through continuous weather forecasting, water level monitoring, patrolling and community radio systems;
- Establishment of monitoring posts and watch towers in fire prone areas;
- Development of firefighting teams (*Regu Siaga Api* or RSA) staffed by local communities members and provision of fire extinguishing equipment and training; and
- Awareness building programs for communities in the project zone.

E) Protection and law enforcement

Protection and law enforcement activities will seek to prevent illegal exploitation of the project area, including illegal logging, poaching, encroachment, illegal gold mining, peat drainage and forest clearance with fire. This will be achieved through a combination of activities, including:

- Physical demarcation of the project boundary (based on community maps, see below project activity G);
- Identification of specific locations, agents, targeted species, methods, frequency and the typical season of improper activities to be monitored and refrained;
- Mobilization of forest rangers and patrol teams consisting of local community members;
- Development of community-led monitoring and reporting systems to enforce laws and village regulations;
- Community radio systems for effective monitoring, reporting and information sharing;
- Establishment of monitoring posts at main entry-exit points to the forest;
- Provision of necessary equipment and training to participating community members
- Awareness building programs for communities in the project zone to enhance their understanding on potential socio-ecological impacts of illegal resource extraction and unsustainable land-use practices.

F) Species conservation and habitat management

The vast majority of the biodiversity within the project zone requires no active management beyond the protection of their habitat and prevention of unsustainable exploitation or hunting. These objectives will be delivered through the activities described above and below. A comprehensive program of biodiversity monitoring (see Chapters 7 and 8) will provide feedback on population status of key species.

In a few cases more specific management may be required, such as if the incidence of crop-raiding by orangutan requires approaches to mitigate the potential conflict with local communities. See Chapter 7 for a summary of main project activities by key species.

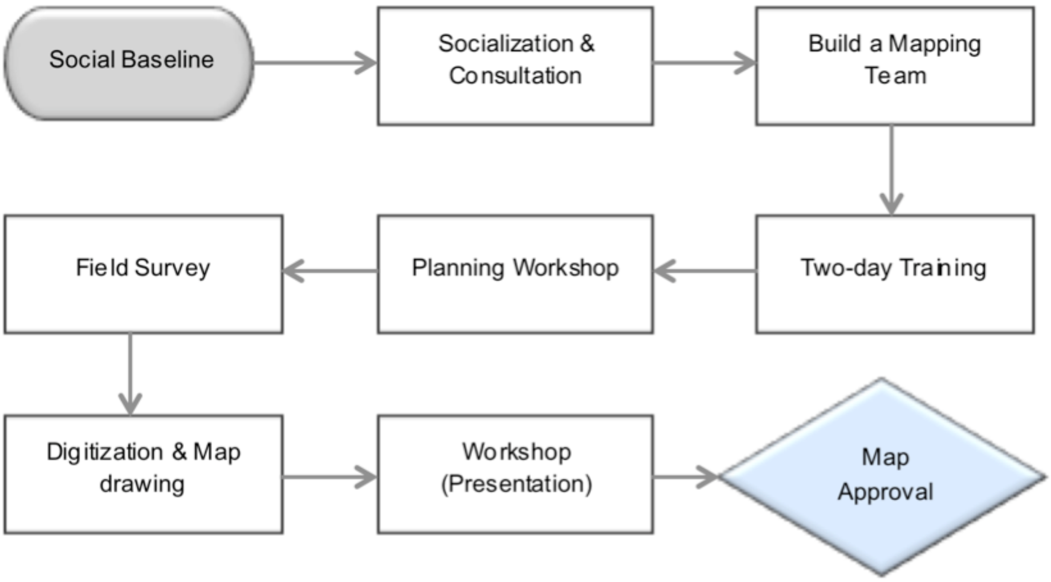
Through collaboration with other partners, it is also likely that the project area will be used to support the orangutan rehabilitation efforts of these partners. In such cases careful assessment will be made of suitable location for the potential release of rehabilitated animals and any releases will be made in full compliance with Indonesian law and adhering to IUCN guidelines for reintroductions and translocations [12].

G) Participatory planning

Participatory planning is a cornerstone of the Katingan Project's approach to activities designed to support local communities. It consists of two tenure-based methods: participatory community mapping and village planning.

Participatory community mapping transparently draws together important spatial information regarding the project-zone villages. This includes information such as village boundaries, the extent of cultivated land owned by community members, the extent of other land-uses, and other thematic information as relevant. All data points are ground-truthed together with the community and recorded by GPS to create a spatial map that is presented back to the community for approval. Figure 10 shows general steps in the community mapping process.

Figure 10. Participatory community mapping process



Participatory village planning is the second integral part of participatory planning processes. The Katingan Projects' community-based activities are designed to address needs which the project-zone communities have identified through the participatory village planning process. A variety of methodologies are used, including focus-group discussions, interviews, household surveys and others. The maps developed through the community mapping process are used as a basis for dialogue. Through the village planning process, local communities are to discuss and determine short- to medium-term development goals and plan specific activities that can be implemented between them and the Katingan Project. As such, participatory planning is an integral part of and leads to all project activities.

H) Community-based business development

Community livelihood development is a core priority of the Katingan Project. The goal is to bring substantial benefits to the project-zone communities through sustainable economic development and land use, through support for activities identified during the participatory planning process. Activities already identified include the development of non-timber forest products, agroforestry, ecotourism, livestock, salvaged wood production, and aquaculture and sustainable fisheries, each described in more detail below (also see Figure 11).

Figure 11. Community livelihoods in the project zone

Non-timber forest products: The Katingan Project works with local communities to develop the sustainable use of non-timber forest products, such as rattan, honey, coconut and jelutong. This includes helping to consolidate individual efforts to facilitate collaborative management and marketing of NTFPs, creating access to financing for businesses through microfinance, helping to develop small processing facilities, assisting to add value to produce and assisting access to value-added market access.

Agroforestry: The Katingan Project supports the development of village-owned agroforestry that provides revenues to local communities while being sympathetic to emission and fire-risk reduction and biodiversity conservation. Efforts are targeted on degraded lands mostly outside of the project area but including one small area within the project where fire risk is currently very high as described in B) Reforestation above. A variety of crop plants may be considered, including rubber, jelutong, rattan, pineapples, meranti and blangeran. In each case the project's support will be linked to the use of sustainable management systems that avoid peat drainage and support fire-risk reduction measures. As for non-timber products, the project will also support the development of local processing facilities where appropriate and assist communities to access value-added markets.

Ecotourism: The project area holds a great potential for tourism due to its aesthetic beauty, abundant forests, wildlife, clean rivers, and unique local culture. While accessibility is often one of the most challenging and crucial factors for the success of ecotourism, a network of roads and rivers within the project area provides fairly easy transportation from nearby cities (i.e., Palangkaraya, Sampit and Kasongan) to remote villages and forests. The Katingan Project seeks to develop ecotourism in the project zone in collaboration with experienced tour operators. This will help market the project to both national and international investors, and also to increase employment and livelihood opportunities to the project-zone communities in ways which do not compromise surrounding ecosystems and cultural heritage.

Livestock: Livestock production is still rare in the project zone, but has economic potential for local communities. The Katingan Project provides technical assistance and access to microfinance to purchase livestock such as cows, goats, chickens and ducks. Livestock can be raised within villages themselves or small pastures with agricultural land. As with other community-based business development activities, this program will focus on small community groups, with each group receiving support and capacity building ranging from animal husbandry to fund management to the production of organic fertilizers and biogas from animal manure.

Salvaged wood: As a consequence of the history of commercial forest exploitation in the project area, high-value salvageable wood is still common and can sell to export markets for high prices either as a raw or processed product, both with full certification of the origin. Much of the capacity needed already exists locally as a result of the area's past, while knowledge of and access to markets and of regulatory requirements now restrict development, all issues the Katingan project will seeks to develop while ensuring sufficient safeguards are in place to ensure the supply chain is based only on salvaged timber.

Aquaculture and sustainable fisheries: Similar to the agroforestry program, the Katingan Project will support and work with local fisherman groups to establish aquaculture platforms and promote sustainable fisheries. As many local communities depend on fisheries for their livelihoods and nutrient intake, this program aims to improve the efficiency and effectiveness of local fishing practices using traditional methods as well as fish pens. It also seeks to increase livelihood options and generate alternative income sources for a greater number of the project-zone communities. Specifically the Katingan Project will provide technical and financial support to create traditional fish traps (locally known as *karamba*) in the river and to develop aquaculture platforms (i.e., fish ponds) in villages; help develop networks for market access; help establish small processing facilities and facilitate training to fishermen's groups, and; conduct research to improve the productivity of fisheries and share lessons learned among fishing communities in the project zone.

I) Microfinance development

The Katingan Project seeks to assist sustainable local development by supporting the development of small to medium sized businesses, particularly those listed above in H). A variety of mechanisms will be used, including the direct provision of microfinance to facilitating access to government-backed financing schemes and grants. When implemented directly by the project microfinance will typically be channelled through local community groups known as *Kelompok Swadaya Masyarakat* (KSMs), often entirely made up of women.

J) Sustainable energy development

The Katingan Project promotes the use of sustainable and renewable energy sources using locally available resources. Through the community-based planning process, the project will seek to increase energy efficiency and the number of communities who have access to cleaner, renewable energy, while reducing the amount of fuelwood consumption. Initially the work will focus on a number of pilot villages, to learn and develop methods, and then will be expanded more widely. Sustainable energy sources that will be considered include biomass cook stoves, bio-gas, and solar lamps.

K) Improved public health and sanitation services

Currently, the project-zone communities only have close access to very basic health care. The Katingan Project will seek to improve this by working closely with local government to improve access to public services and to assist local government in providing health education at the village level, The Katingan Project will also seek to improve local sanitation practices, including the common practice of discharge of all waste into local rivers, which are in turn used for cooking, drinking and bathing. The Katingan Project will work with the villages together with local government agencies to bring awareness about and improve sanitation in each village, increase access to clean drinking water, and develop waste treatment facilities in each village.

L) Basic education support

Project-zone communities all have the right of access to basic education, however the accessibility and the quality of schools and teaching remains a challenge. Students in villages with no middle school often need to travel at their own cost to other villages to attend classes. The Katingan Project aims to support the local government's efforts to improve the quality of basic education and the number of enrolment, and encourage the youth to pursue higher education. The project will implement an open competitive scholarship programs to provide funding to selected students, and will assist to develop facilities at local schools. Capacity building and educational workshops for teachers will be conducted as well through various training programs.

2.2.2 Lifetime of the project activities

All activities described in Sub-section 2.2.1 will be initiated in the period 2010-2016 and be maintained for the duration of the project as shown in Table 5.

Table 5. Lifetime of project activities

Activity	Activity start year
APD+CUPP	2010
Reforestation (ARR)	2016
Peatland rewetting and conservation (RDP)	2016
Fire prevention and suppression	2014
Protection and law enforcement	2014
Species conservation and habitat management	2014
Participatory planning	2010
Community-based business development	2010
Microfinance development	2010
Sustainable energy development	2010
Improved public health and sanitation services	2014
Basic education support	2014

2.3 Management of Risks to Project Benefits

2.3.1 Non-permanence risk assessment (G1.10)

A non-permanence risk assessment was carried out in accordance with the most recent AFOLU Non-Permanence Risk Tool v.3.2. The resulting risk rating and non-permanence risk buffer is 10%. The summary of non-permanence risk assessment is provided in Table 6, and the full assessment is provided in Appendix 2. This assessment primarily addresses the risk to climate benefits but is equally applicable to the risks associated with community and biodiversity benefits (which for further details see Chapters 6 and 7).

Table 6. Summary of non-permanence risk assessment

VCS AFOLU non-permanence risk category	Score
Internal Risk	
Project Management (PM) Risk Value	-4
Financial Viability (FV) Risk Value	-1
Opportunity Cost (OC) Risk Value	2
Project Longevity (PL) Risk Value	0
	0
Total External Risk	
Total Land Tenure (LT) Risk Value	0
Total Community Engagement (CE) Risk Value	-5
Total Political (PC) Risk Value	2

	0
Natural Risk	
Fire (F)	2.5
Pest and Disease Outbreaks (PD)	0
Extreme Weather (W)	2
Geological Risk (G)	0
Other natural risk (ON)	0
	4.5
Total Overall Risk Rating	**4.5%**
Non-Permanence Buffer	**10%**

2.3.2 Measures taken to maintain and enhance benefits beyond project lifetime (G1.11)

The Katingan Project is based on a 60-year concession licence, extendable to 100 years. Project benefits are expected to extend beyond this time scale. The effective protection status of the forest and peatlands is anticipated to be maintained and extended, either through a further concession license or directly under state ownership as the global importance of the stored carbon stocks and biodiversity are fully recognised as a result of the project. In parallel the actions of the project to restore both hydrology and degraded areas will result in the project area being more resilient to the threat of fire. Similarly, activities targeting community benefits are all designed to be managed in the future by the local communities themselves, without the need for further external interventions. Finally, the project itself is anticipated to set an example of sustainable land use management in the region, leading to wider adoption of the practices it is pioneering. In this way the Katingan Project will contribute to wider region managed more sustainably with respect to carbon emissions, biodiversity conservation and equitable development of local communities.

2.4 Measures to Maintain High Conservation Values (G1.11)

High conservation value areas in the project zone are identified in Sub-section 1.3.8. Project activities designed to protect and enhance these values are described in detail above in Sub-section 2.2.1. Further detail of the anticipated impact of these activities on HCV criteria is provided below in Sub-sections 6.1.1 and 7.1.1. The combined outcome of these project activities is expected to provide overwhelmingly positive benefits to HCV areas within the project area and project zone, as demonstrated by the monitoring criteria given in Sub-section 8.1.5.

2.5 Project Financing (G1.12, G4.3)

PT RMU and the Katingan Project are financed with secure investment financing and will derive revenue through the sale of verified carbon units (VCUs). These mechanisms will ensure implementation of all described project activities. Audited financial statements and financial forecasts are available to the validators on request.

2.6 Employment Opportunities and Worker Safety (G3.9, G3.10, G3.11, G3.12)

The Katingan Project and PT. RMU operate in full compliance of Indonesia's labour law (UU No. 13/2003) and aims to set an example of best practice with respect to employment terms, conditions and practices. All policies relating to such matters have been compiled into the Employee Handbook available to all employees irrespective of their position. The Employee Handbook is available on request to the validators. Three aspects of employment practice are discussed in more details below.

2.6.1 Equal employment opportunities (G3.10)

The Katingan Project seeks to invest in people; in particular those who are living within the project zone, the wider region, and Indonesia as a whole. It provides employment opportunities irrespective of gender, age, social class or ethnicity and other factors, although the priority goes to the project-zone communities. Staff or contractors, whether employed on a long-term of short-term basis, are all entitled to employment terms based on similar types of work and working conditions in the area of employment.

2.6.2 Training and capacity building (G3.9)

The Katingan Project is committed to investment in training and capacity building, and this commitment extends from project staff, to project-zone communities, to local collaborators (both NGO and government). Such training can take many forms, from work shadowing, internships, *ad hoc* training, to formal classroom style teaching. Table 7 below summarizes some of the main aspects of the project's training and capacity building program, focusing on those aspects that incorporate local communities.

Table 7. Capacity building and training

Topic	Target	Description	Outcomes
Carbon MRV	Project-zone communities, employees	Field and classroom based Provide training and equipment for the monitoring of peat depth, biomass and water level.	MRV team formed and necessary equipment and facilities provided
Fire prevention and suppression	Project-zone communities, local governments, employees	Field and classroom based training on organizational management, strategy, equipment use, resource mobilization, risk assessment and communication.	Firefighting team formed, monitoring facility and firefighting equipment in place with proper resources and communication network
Silviculture / reforestation	Project-zone communities, employees	Field based training on nursery establishment and operation, planting and maintenance	Nursery facilities developed and operational, tree planting underway
Peat hydrology / rewetting	Project-zone communities, local government, employees	Field and classroom based training to share and transfer skills regarding managing water levels, canal blocking and peat rewetting	Major canals blocked, and monitoring team (i.e., water level) formed
Participatory planning	Project-zone communities, local/village governments, employees	Training on participatory land-use mapping and village planning	Community maps digitalized and village plans endorsed by the local governments and communities
Basic skills	Project-zone communities, employees	Classroom and on-the-job training on administration, finance, project management, leadership and foreign languages	Management team established, and project activities properly and effectively managed
Conflict mediation	Project-zone communities, local governments, employees	Classroom and on-the-job training provide training on formal conflict mitigation and resolution processes	Conflict resolution mechanism in place and understood by community stakeholders
Biodiversity survey methods	Employees and project-zone communities	Field based training on flora and fauna survey, phenology, identification and data recording.	Biodiversity survey team established and activities run effectively
Data and	Employees	Provide training on data	Data and information properly

Topic	Target	Description	Outcomes
information management		collection, storage and analysis	managed and easily accessed

2.6.3 Worker safety (G3.12)

Worker safety is the priority of the Katingan Project and will be ensured with respect to the labour law, UU No. 13/2003. Occupational safety and health are stipulated in the company safety regulation (available to validators upon request) and include:

- Providing workers with a first aid kit including anti-venom cream and insect repellent;
- Providing navigation and communication equipment such as GPS, compass and handheld transceivers;
- Enforcing a buddy system (minimum two persons in a group) for all field activities;
- Providing standard safety equipment such as microfiber mask, rubber boots, heavy-duty gloves, uniform, hat, harness, survival kit, portable water bottles/bags, and life jacket;
- Providing additional logistics such as fuel, propeller for a boat, and water and meals enough for three extra days; and
- Providing proper training on safety procedures, evacuation, communication, equipment use, and shelter making in order to ensure worker safety and mitigate potential risks inherent to certain field activities such as fire suppression and surveys.

In line with the company safety regulation, PT. RMU is currently developing and evaluating a formal risk assessment and management process. This is subject to periodical review and will be accommodated in its adaptive management.

2.7 Stakeholders

2.7.1 Stakeholder identification (G1.5, G1.6)

Stakeholder identification was based on social baseline surveys conducted using the following procedures:

A) Data collection
Data was collected through participatory rural appraisals (PRAs), transect walks, informal discussions, visits to schools, clinics, vendors and social gatherings, as well as semi-structured focus group discussions (FGDs), using standard questionnaires. Each FGD consisted of men and women from different community groups and with different age groups and social status. The Katingan Project also used a unique participatory approach brought by Photovoices International in order to reach out to community groups and document their livelihoods, socio-economic conditions, social dynamics, and relationships to the surroundings through pictures, and stories about the pictures collected by local village photographers.

B) Triangulation
The crosschecking of information obtained through PRAs and FGDs was conducted by interviewing different people who did not participate in the formal discussions. This was done through casual dialogues and village walks with community members.

C) Data analysis
Data collected through field surveys were analysed with reference to literature, relevant Indonesian regulations and village census in order to identify communities, community groups and other stakeholders in and around the project zone.

D) Results

Table 8 below shows a list of all stakeholders likely to be impacted by and/or involved in the implementation of the Katingan Project. Local communities are further classified by livelihoods, as these are the most common unit of alliance in the local social context. The majority of community group members engage in multiple livelihood activities rather than depending on a single source of income, and thus typically belong to more than one group.

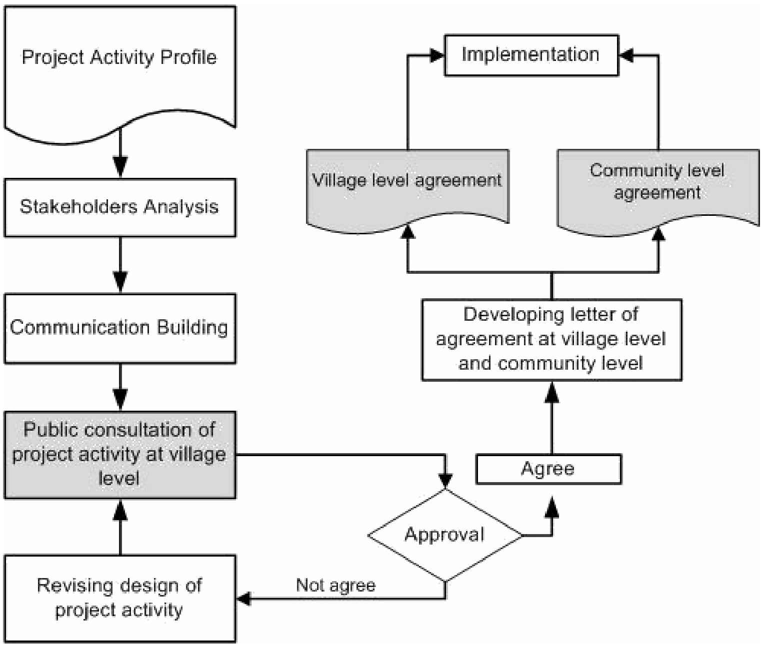
Table 8. Stakeholders in the project zone

Category	Stakeholder	Description
Communities	Project-zone village residents	All groups of people who live in the 34 project-zone villages located adjacent to the project area, and derive income, livelihood or cultural values from the project area. These groups of people are collectively referred as *project-zone communities*.
Groups	Farmers	Groups of people making a living from traditional farming (e.g. vegetables, rice), fruit gardens and agroforestry (e.g. cultivating and collecting rubber, rattan and/or jelutong).
	Fishermen	Groups of people making a living from traditional fisheries and/or aquaculture.
	Non-timber forest product (NTFP) collectors	Groups of people making a living from collecting non-timber forest products such as gemor, damar resin, rattan, jelutong and meranti saps, honey.
	Loggers	Groups of people making a living from the extraction of commercial timber and selling logs to middlemen or sawmills.
	Sawmill operators	Groups of people processing timber into construction materials
	Miners	Groups of people making a living from excavating gold and/or zircon.
	Water taxi (*kelotok*) operators	Individuals or groups of people providing water transportation services for people in the project zone.
	Middlemen / Traders	Groups of people purchasing products (e.g. household goods, handicrafts, jelutong and rubber saps, raw or half-finished rattan, fish and other agricultural crops) from farmers and fishermen and selling them at markets.
	Hunters	Individuals or groups of people who hunt wild animals (e.g. birds, deer, pig) for commercial purposes.
	Craftsmen	Individuals or groups of people processing wood, rattan, purun and other natural fiber into handicrafts, woven baskets, hats and mats.
	Women's KSM groups	Female groups who manage cooperatives and microfinance institutions
Other Stakeholders	PT. Sampit	A large company located in the city of Sampit, Kotawaringin Timur district, purchasing jelutong, rubber saps, rattan, and gemor from farmers, NTFP collectors, and middlemen.
	PT. Arjuna Utama Sawit	An oil palm plantation company holding a concession located adjacent to the project zone.
	PT. Ceria Karya Pranawa	A timber plantation company holding a concession located near to the project zone.
	District government	Governments of Kotawaringin Timur and Katingan districts, having authorities in district-level policies and regulations.
	Sub-district government	Governments having authorities in sub-district-level policies and regulations.
	Offsite residents and transmigrants	All groups of people living in villages and cities outside the project zone who derive income and livelihoods from the project area.
	Sebangau National Park	National park located adjacent to the project zone.

2.7.2 Free, prior and informed consent (FPIC) (G3.2)

The Katingan Project adopts FPIC principles in all community consultation processes (see Figure 12). This approach will also be maintained throughout the life of the project. It allows local people to critically consider potential impacts of the project and to negotiate based on mutual consensus without being forced or manipulated. The FPIC approach is also used for stakeholder consultations and communications, and further details of this in practice are given in the next sections.

Figure 12. FPIC process



2.7.3 Stakeholder consultations and community involvement (G3.4, G3.5, G3.6, G3.7)

2.7.3.1 Stakeholder consultations

Since 2007, the Katingan Project has conducted a series of stakeholder consultations at different levels – national, provincial, district, sub-district and village. Through this process, the project has disseminated information on the ecosystem restoration concession concept, planned activities, expected impacts from the project, management plans and project boundary setting processes, and has adapted feedback from the stakeholders into agreed plans and legal approval as presented in Sub-section 3.1.2. Table 9 provides a list of formal stakeholder consultations which were conducted by PT. RMU. Furthermore, a number of community meetings have also been conducted as part of stakeholder consultations. They are omitted from this list, but meeting minutes and attendance sheets are available upon request (also see Section 2.6).

Table 9. Summary of stakeholder consultations

Consultation type	Stakeholder	Jurisdiction	Date
Ecosystem restoration socialization and consultation	Village government and community members (Kampung Melayu, Tewang Kampung and Seranau); Forest Agency at the district level; district government	District (Kota Waringin Timur and Katingan)	January 15 – April 15, 2009
Ecosystem restoration socialization and consultation	Village government and community members (Seranau, Bapinang hulu, Bapinang hilir,Kampung	District (Kota Waringin Timur and Katingan)	18, 19, 23, 27 October, 2009

Consultation type	Stakeholder	Jurisdiction	Date
	Melayu, tewang kampung)		
UKL–UPL socialization and public consultation	Community members, sub-district government, district government	District (Kotawaringin timur)	27 January 2010
UKL–UPL socialization and public consultation	Sub-district government, village government	Sub-district (Tasik Payawan, Kamipang, mendawai)	19 – 21 December 2011
Ecosystem restoration socialization and consultation	Sub-district government, village government, and community members	Sub district (Mendawai)	1st – 3rd May 2012
Ecosystem restoration socialization and consultation	Sub-district government, village government, and community members	Sub district (Kamipang)	3rd – 7th May 2012
Ecosystem restoration socialization and consultation	Sub district and village government	Sub district, village (Seranau sub-district)	13th – 15th March 2013
Ecosystem restoration socialization and consultation	Sub-district government, village government and community members	Districrt (Kotawaringin timur)	25 – 26 February 2014
Ecosystem restoration concession (IUPHHK-RE SK.734/Menhut-II/2013) socialization and consultation	District, sub-district government, village government and community members	Sub-district (Kamipang, Mendawai), district (Katingan)	5-6 February 2014 at the sub-district level; 23 February – 3 March 2014 at the village level; and 4 March at the provincial level
IUPHHK-RE SK.734/Menhut-II/2013 socialization	Provincial government, District government, university, national and local NGOs	Province (Palangka Raya)	March 4th 2014

2.7.3.2 Community involvement during project design and implementation

As described above Sub-section 2.2.1–G), the vast majority of the Katingan Project's activities are both designed and implemented in close consultation and collaboration with local communities. This is key to achieving the long-term sustainability of the initiatives, without need for further external interventions. The consultation processes are ongoing. Regular meetings will be organized to evaluate the progress of each initiative and adapt initiatives to changing needs and conditions. The Katingan Project conforms to all relevant Indonesian laws and regulations throughout its lifetime, and thus will not be involved in or complicit in any form of discrimination or sexual harassment during the process of project design and implementation.

2.7.4 Procedure to publicize project documentation and monitoring plans (G3.1, G3.3, CM4.3, B4.3)

The Katingan Project will publicize a variety of project documentation and monitoring plans in both Indonesian and English languages through appropriate means by which local communities and stakeholders can have the opportunity to provide comments. They include a combination of media such as newsletters, workshops, meetings, and the project website.

PT. RMU will also take measures to communicate the project's validation and verification process to the project-zone communities and other stakeholders. In addition to posting this project design document (PDD) on the VCS-CCB website for a 30-day public comment period, a summary of the PDD has been prepared in the Indonesian language and will be disseminated to the local stakeholders for their comments. PT. RMU will conduct stakeholder meetings to collect their feedback following the submission of the PDD.

2.7.5 Feedback and grievance redress procedure (G3.8)

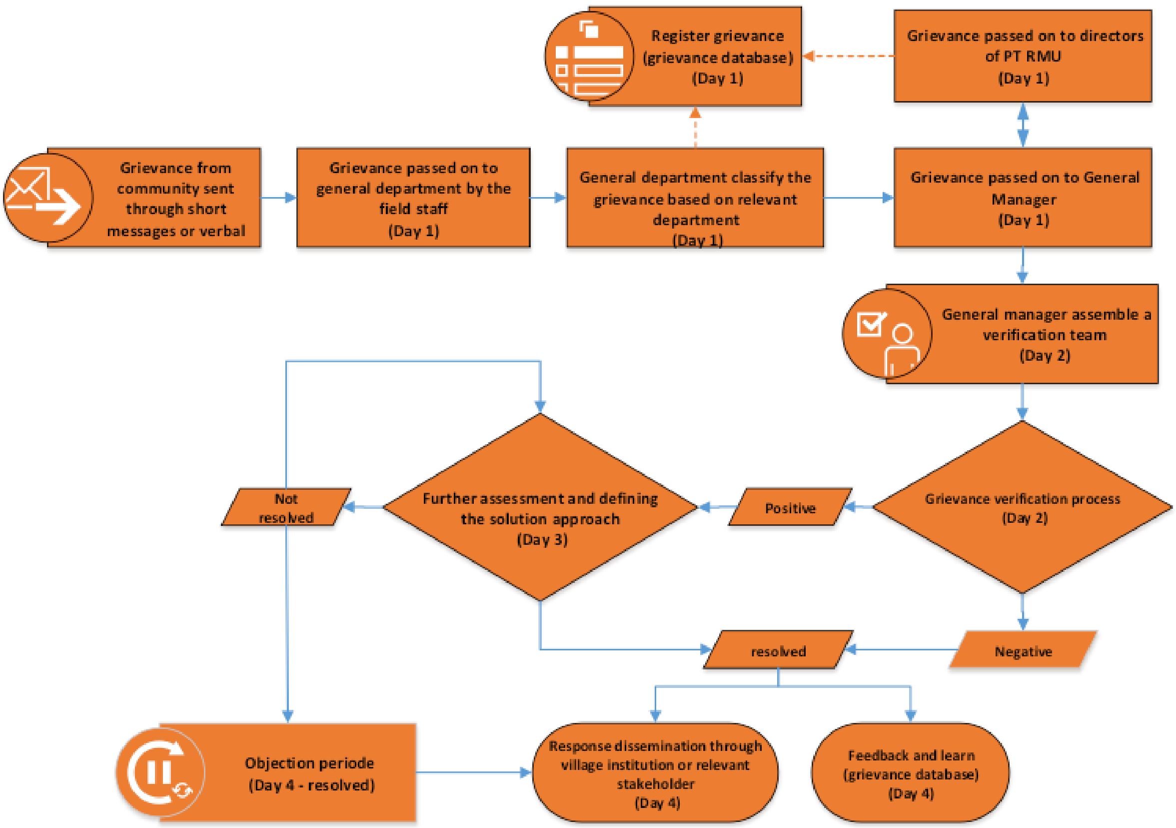
The Katingan Project will adopt a formal grievance and redress procedure to prevent and handle any conflicts with and among communities and other stakeholders which may arise during the implementation of project activities.

One of the most important elements of the grievance redress procedure is to prevent potential conflicts before they arise. Such precautionary approaches include the implementation of FPIC-based community consultations, participatory planning and regular communication. This helps to identifying underlying grievances well in advance and allow them to be addressed. The formal village level planning processes also helps to strengthen the bargaining position of project-zone communities when dealing with other stakeholders.

If any grievances occur and are reported from the project-zone communities and/or other relevant stakeholders in the form of letters, short messages or verbal communication, PT. RMU will quickly respond to them by following the formal handling process as shown in Figure 13. All reported cases will be assessed to identify and verify the cause, actors and scale of grievances, and PT. RMU's verification team will recommend resolution options based on the feedback from the stakeholders. The degree of intervention and process will depend on the nature of disputes, and PT. RMU will continue to monitor the cases.

In case where a grievance is not amicably resolved after this process, it will be submitted to an unbiased third party for a formal mediation and arbitration process, and subject to a hearing at which both disputing parties have the opportunity to testify. All cases will be referred and examined to the extent allowed by Indonesian laws and regulations of the relevant jurisdiction before decisions are made, and both parties are bound to satisfy the result of arbitration.

Figure 13. Grievance handling process



2.8 Commercially Sensitive Information

The following information is commercially sensitive and is not publically available:

- **Financial projections** – Detailed 30-year financial projections for the project which include all project-related costs and ex-ante carbon estimates
- **Computer model code for the hydrological model**
- **Electronic shape files of project areas, proxy areas and buffer zones** – GIS boundary shape files used to delineate the project area, proxy areas and buffer zones
- **Classified satellite imagery** – Used to determine land-use classes and forest strata within the project area and proxy area
- **Original data from biomass inventories and social assessments** – Hard copies and electronic copies of data sheets used to record field data for biomass inventories, social assessments and meeting minutes
- **Agreements between implementing, technical partners, communities and government** – All agreements between project proponents and other implementing partners governing the implementation of project activities
- **Models used to create carbon calculations** – Computer models to generate carbon estimates from all field data and remote sensing data
- **Project workplans and budgets** – Detailed implementation workplans

3 LEGAL STATUS

3.1 Compliance with Laws, Statues, Property Rights and Other Regulatory Frameworks (G5)

3.1.1 Compliance with laws and regulations (G5.6)

3.1.1.1 National and local laws and regulations

The Katingan Project is designed and implemented in full compliance with both national and regional laws of the Republic of Indonesia. This includes laws and regulations governing aspects of carbon emissions offsets, REDD+ and ecosystem restoration concession (ERC). In addition the project falls into line with the REDD+ National Strategy developed by the Government of Indonesia.

Relevant laws and regulations on land use, forestry, REDD+ and climate include:

- Law No. 6/1994 concerning the Ratification of United Nations Framework Convention on Climate Change
- Law No. 41/1999 concerning Forestry
- Law No. 5/1997 concerning Biodiversity
- Law No. 17/2003 concerning State Finances
- Law No. 17/2004 concerning the Ratification of Kyoto Protocol on the UN Framework Convention on Climate Change
- Law No. 25/2004 concerning National Development Planning System
- Law No. 17/2005 concerning Medium and Long Term National Development Plan (RPJP) 2005-2025
- Law No. 31/2009 concerning Meteorology, Climatology and Geophysics
- Law No. 32/ 2009 concerning Environmental Protection and Management
- Law No. 41/2009 concerning Sustainable Food Land Protection
- Government Regulation No. 6/2007 and its amendment No. 3/2008 concerning Forest Arrangement and Formulation of Forest Management Plan as well as Forest Exploitation

- Government Regulation No. 26/2008 concerning National Spatial Plan
- Government Regulation No. 10/2010 concerning Method of Change of Forest Area Allocation and Function
- Government Regulation No. 15/2010 concerning Implementation of Spatial Structuring
- Government Regulation No. 24/2010 concerning the Use of Forest Area
- Presidential Decree No. 5/2010 concerning National Medium Term Development Plan (RPJMN) of 2010-2014
- Ministry of Forestry Regulation P.68/2009 concerning Organization of Demonstration Activities for Reducing Emissions from Deforestation and Degradation
- Ministry of Forestry Regulation P.30/2009 concerning Mechanisms for Reducing Emissions from Deforestation and Degradation
- Presidential Decree No. 61/2011 regarding the National Action Plan for Reducing Green House Gas Emission
- Ministry of Environment Regulation No. 13/2010 regarding Environmental Management and Monitoring Effort
- Ministry of Environment Regulation No. 16/2012 regarding the Guidelines on the Development of Environmental Document

Relevant laws and regulations on Ecosystem Restoration Concession management include:

- Ministry of Forestry Regulation No. P.20/Menhut-II/2007 regarding Provision and Expansion of Business Licenses for Forest Timber Utilization in Natural Forest, Business Licenses for Ecosytem Restoration and Business License for Forest Plantation in Production Forest, revised by No. P.61/2008, No. P.50/2010, No. P.26/2012, and No P.31/Menhut-II/2014
- Ministry of Forestry Regulation No. P.56/Menhut-II/2009 regarding Business Planning for Ecosystem Restoration Licence, updated by No. P.24/Menhut-II/2011
- Ministry of Forestry Regulation No. P.8/Menhut-II/2014 regarding Limitation for the Allocation of the Concession Area for Business Licenses for Forest Timber Utilization in Natural Forest, Business Licenses for Ecosytem Restoration and Business License for Forest Plantation in Production Forest
- Ministry of Forestry Regulation No. P.64/Menhut-II/2014 regarding Application of Silviculture Tehniques within the Ecosytem Restoration Concession License in Production Forest
- Ministry of Forestry Regulation No. P.66/Menhut-II/2014 regarding the Procedures for Periodical Forest Inventory and Work Plan in Ecosystem Restoration Concesion License

As the majority of the project area is forested and situated on peatland, the Katingan Project must also comply with various regulations on the management of forest and peatland, including:

- Presidential Instruction INPRES No. 10/2011 regarding Suspension on the Issuance of New Licenses and Improved Management of Primary Forest and Peatlands", renewed by INPRES No. 6/2013 and No. 8/2015
- Government Regulation PP No. 71/2014 regarding Protection and Management of Peatland Ecosystem

While there are no laws specifically requiring FPIC in Indonesia, the Katingan Project has adopted the FPIC standard *Prinsip Persetujuan atas Dasar Informasi Awal tanpa Paksaan* (*PADIATAPA*) and the social safeguard standard called *Prinsip Kriteria dan Indikator Safeguards Indonesia* (*PRISAI*), which were developed by the Indonesian REDD+ Agency. The Katingan Project is among the first REDD+ projects in Indonesia which have adopted these standards in the process of project design and implementation. Indeed, PT. RMU and its project implementation partner, Yayasan Puter Indonesia contributed substantially to the development of *PRISAI* standards since 2010; providing input to their design and conducting a series of public consultations to test the standards at the Katingan Project site. This helped the Government of Indonesia integrate important safeguard standards in its national REDD+ policy framework development.

3.1.1.2 International treaties

In addition to complying with national and local laws, the Katingan Project will also comply with the requirements of international treaties and agreements. Treaties that are or may become relevant to the project include the following:

- Ramsar Convention on Wetlands of International Importance, 1971
- Convention on International Trade in Endangered Species (CITES) 1973
- Rio Declaration on Environment and Development 1992
- United Nations Framework Convention on Climate Change (UNFCCC) 1992
- Convention on Biological Diversity in 1992 and enactment 1993
- United Nations Convention against Corruption (UNCAC) 2003
- Kyoto Protocol in 1997 and enactment 2005
- Cartagena Protocol on Biosafety to the Convention on Biological Diversity 2004
- Bali Action Plan (COP 13) 2007
- Nagoya Protocol on Genetic Resources Access and Equal and Fair Benefit Sharing from the Utilization of the Biodiversity Convention 2013

3.1.2 Documentation of legal approval (G5.1, G5.2, G5.7, G5.8)

3.1.2.1 Legal approval from the national, provincial and district authorities

The Katingan Project has secured approval from the appropriate authorities to develop and implement project activities in the concession area. Table 10 is the list of legal approval and consensus documentation in relation to the project, and each copy is available to validators on request, and a copy of the concession (SK.734/Menhut-II/2013) is provided in Appendix 3.

Table 10. List of decrees and legal approvals

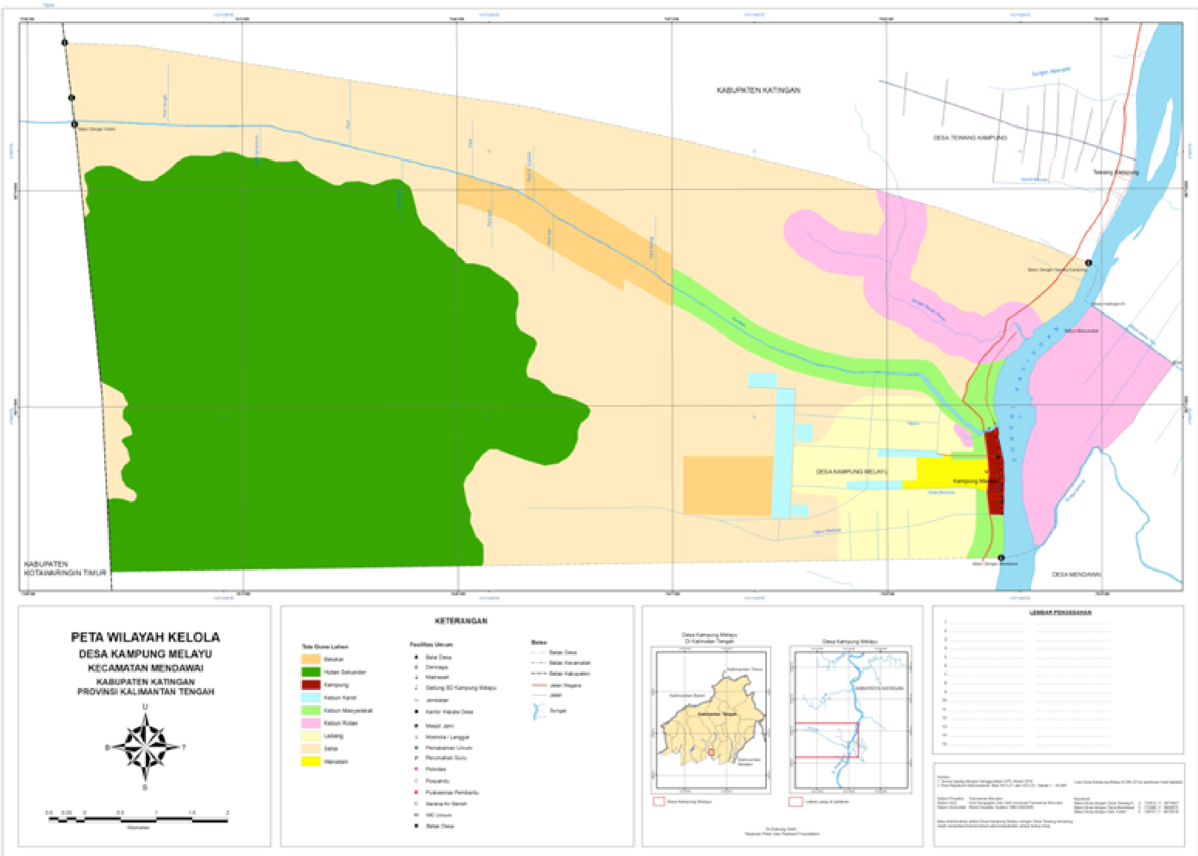
Decree / Approval No.	Description	Approval from	Date of issuance
08/RMU/XI/2008	Application letter from PT. RMU for IUPHHK-RE	N/A	November 10, 2008
S.442/Menhut-VI/2009	First order letter to do UKL-UPL (SP-1)	Minister of Forestry	June 12, 2009
522/185/Ek.	Legal support from The Governor of Central Kalimantan for PT RMU IUPHHK-RE	Governor of Central Kalimantan	February 17, 2010
660/89/II/BLH/2012	Approval of UKL-UPL and recommendation to proceed with the IUPHHK-RE licensing process	Environmental Agency, Central Kalimantan Province	February 13, 2012
S. 104/Menhut-VI/BRPUK/2012	Instruction to produce a working area map (SP-2)	Ministry of Forestry Directorate General of Forest Production Development	February 17, 2012
S. 320/VII-WP3H/2012	Issuance of working area map for PT. RMU's IUPHHK-RE concession	Ministry of Forestry, Forestry Planning Agency	March 15, 2012
S.295/VI-BRPUK/2012	Draft Concept Concession Decree for PT. RMU's IUPHHK-RE	Ministry of Forestry, Directorate General of Forest Production Development	April 27, 2012

Decree / Approval No.	Description	Approval from	Date of issuance
SK.734/Menhut-II/2013	**Issuance of IUPHHK-RE License to PT RMU for an area of 108,225 ha in District of Katingan, Central Kalimantan Province**	**Ministry of Forestry**	**October 25, 2013**
522.1.200/2156/Dishut	Technical Consideration for IUPHHK-RE for PT RMU	Forestry Provincial Office of Central Kalimantan Province	October 16, 2014
No. 522/0212/PTSP	Letter of Recommendation for PT RMU for IUPHHK-RE for an area of 49,497,9 ha	Governor of Central Kalimantan	March 2, 2015

3.1.2.2 Respect for rights to lands, territories and resources

The Katingan Project designs and implements all project activities in participation with project-zone communities and based on full consultation and FPIC principles (see Sub-sections 2.7.2 and 2.7.3). This includes the creation of agreed spatially accurate maps that define the agreed extent of village land and the agreed boundary of the project area, as well as recognition of other spatially explicit landscape features. These maps also allow the project-zone communities to understand their spatial positions in relation to the project area, and to be able to plan their future land use within their village boundaries without disputing other village territories or the project area. This tenure-based approach ensures that rights of the project-zone communities to lands, territories and natural resources are respected and protected. An example of community maps is provided in Map 7, and community maps of other villages are available to the validators on request.

Map 7. Example of the community map of Kampung Melayu village



3.1.2.3 Consensus and approval from village authorities

Mutual understanding of the goals and objectives of the Katingan Project between PT. RMU and the project-zone communities is crucial for long-term success. To this end, and as part of the company's commitment to FPIC and outreach activities having been conducted since 2010, PT. RMU has agreed, and now signed a memorandum of understanding (MoU) with each of 13 village authorities in the project zone (see Table 11; copy of each MoU is available to validators upon request). More villages are expected to follow in due course as agreements are negotiated and finalized. Each MoU is initially for a three-year period with opportunity for extension after review and evaluation by the village.

Table 11. List of community agreement and approval with the Katingan Project

Village	MoU No.	Partnership agreement No.	Date of agreement
Mendawai	081/RMU-I/V/2015	082/RMU-I/V/2015	May 22, 2015
Kampung Melayu	079/RMU-I/V/2015	080/RMU-I/V/2015	May 22, 2015
Tewang Kampung	077/RMU-I/V/2015	078/RMU-I/V/2015	June 4, 2015
Galinggang	073/RMU-I/V/2015	074/RMU-I/V/2015	May 21, 2015
Tumbang Bulan	075/RMU-I/V/2015	076/RMU-I/V/2015	May 21, 2015
Tampelas	071/RMU-I/V/2015	072/RMU-I/V/2015	May 20, 2015
Telaga	069/RMU-I/V/2015	070/RMU-I/V/2015	May 20, 2015
Perupuk	067/RMU-I/V/2015	068/RMU-I/V/2015	May 20, 2015
Tumbang Runen	061/RMU-I/V/2015	062/RMU-I/V/2015	May 19, 2015
Karuing	065/RMU-I/V/2015	066/RMU-I/V/2015	May 19, 2015
Jahanjang	063/RMU-I/V/2015	064/RMU-I/V/2015	May 19, 2015
Bahun Bango	059/RMU-I/V/2015	060/RMU-I/V/2015	May 18, 2015
Asem Kumbang	057/RMU-!/V/2015	058/RMU-I/V/2015	May 18, 2015

In addition to the MoUs, PT. RMU and the project-zone communities have developed cooperation arrangements through a partnership agreement (*Kesepakatan Kerjasama*). This agreement describes specific support which PT. RMU seeks to provide to the communities, and the communities propose priority activities to reach the objectives. The agreement is valid for one year, and will be evaluated and revised every year thereafter. The partnership agreements are a binding document which explains PT. RMU's commitment to ensuring net positive impacts and benefit sharing for the project-zone communities.

3.2 Evidence of Right of Use (G5.8)

PT RMU is the sole concession holder of the project area under Minister of Forestry Decree SK 734/Menhut-II/2013. This license grants a range of rights and responsibilities, of which is included the right to generate and sell carbon offset credits derived from forest and peatland protection and restoration. A copy of the license is provided in Appendix 3.

3.3 Emissions Trading Programs and Other Binding Limits (G5.9)

Activities carried out by the project are not covered by any emission trading programs or other binding limits in relation to GHG emissions.

3.4 Participation under Other GHG Programs (G5.9)

The Katingan Project has not been registered under any emissions trading programs, but may seek to do so in the future. In this case applicable requirements in the VCS Standard, AFOLU Requirements, and the Registration and Issuance process will be followed. The project will not claim credit for the same GHG emission reduction or removal under the VCS Program and another GHG program.

3.5 Other Forms of Environmental Credit (G5.9)

The Katingan Project currently only seeks carbon credits under the VCS program, and has not received other forms of environmental credits from its activities.

3.6 Projects Rejected by Other GHG Programs (G5.9)

The Katingan Project has not applied for or been rejected by any other GHG programs.

3.7 Respect for Rights and No Involuntary Relocation (G5.3)

The Katingan Project will undertake no involuntary relocations. The current project area contains no permanent human settlements.

3.8 Illegal Activities and Project Benefits (G5.4)

Illegal activities, including logging or mining within protected forests, hunting of protected species, or making use of fire for land clearing have been historically practiced in parts of the project zone. The Katingan Project aims to reduce and put an end to these activities by a combination of protection and enforcement, education and incentive, including strengthening tenure rights and providing sustainable livelihood options and employment opportunities (see Sub-section 2.2.1).

The Katingan Project will derive no benefits from illegal activities.

4 APPLICATION OF METHODOLOGY

4.1 Title and Reference of Methodology

The Katingan Project applies the latest version of approved VCS methodology VM0007 (version 1.5) [13], including all applicable modules as detailed in Section 4.2.

4.2 Applicability of Methodology

As detailed below Table 12, all applicability conditions of methodology VM0007 and its associated modules are met.

Table 12. Summary of applicability conditions

No.	Module	Applicability Condition	Comment
1	REDD+-MF, 4.2.1 - REDD	Land in the project area has qualified as forest (following the definition used by VCS) at least 10 years before the project start date.	Condition met. Land-use records indicate that all land subject to REDD project activities in the project area is covered by tropical forest on peatland and has qualified as such under the applicable definition for at least 10 years (see Section 4.4.1.2).
2	REDD+-MF, 4.2.1 - REDD	If land within the project area is peatland and emissions from the soil carbon pool are deemed significant, the relevant WRC modules (see Table 1) must be applied alongside other relevant modules.	Condition met. All relevant WRC modules have been applied to estimate emissions from peat soils.

No.	Module	Applicability Condition	Comment
3	REDD+-MF, 4.2.1 - REDD	Baseline deforestation and forest degradation in the project area fall within one or more of the following categories: • Unplanned deforestation (VCS category AUDD); • Planned deforestation/degradation (VCS category APD); • Degradation through extraction of wood for fuel (fuelwood and charcoal production) (VCS category AUDD).	Condition met. Baseline deforestation falls in the category of APD. See Section 2.2.1
4	REDD+-MF, 4.2.1 - REDD	Leakage avoidance activities must not include: • Agricultural lands that are flooded to increase production (e.g., paddy rice); • Intensifying livestock production through use of "feed-lots" and/or manure lagoons.	Condition met. The project does not promote either establishment of agriculture on flooded land or intensification of livestock production. See Section 2.2.1
5	REDD+-MF, 4.2.3 - APD	Conversion of forest lands to a deforested condition must be legally permitted	Condition met. See Section 4.5
6	REDD+-MF, 4.3 - ARR	Where exclusion of project activities on wetlands exist in the applicability conditions of methodologies and tools, these can be neglected for the purpose of their use within this Methodology Framework, as accounting procedures for the peat soil are provided in BL-PEAT and M-PEAT	Condition met. The project applies modules BL-PEAT and M-PEAT alongside all modules related to ARR.
7	REDD+-MF, 4.3 - ARR	The project area is non-forest land or with degraded forest.	Condition met. See Section 4.4.1 and 4.5
8	REDD+-MF, 4.3 - ARR	The project scenario does not involve the harvesting of trees. Therefore, procedures for the estimation of long-term average carbon stocks are not provided	Condition met. The project does not involve harvesting of trees or other vegetation. See Section 2.2
9	REDD+-MF, 4.3 - ARR	The project scenario does not involve the application of nitrogen fertilizers	Condition met. The project does not involve application of fertilizers of any kind. See Section 2.2.1
10	REDD+-MF, 4.4 - WRC	This methodology is applicable to RDP and CUPP activities on project areas that meet the VCS definition for peatland. The scope of this methodology is limited to domed peatlands in the tropical climate zone.	Condition met. The project area contains peatland according to the VCS definition (see Section 4.4.1.2) which would be drained in the baseline and which will be conserved and restored in the project scenario. The project therefore falls in the category of RDP and CUPP. The project meets the definition of domed peatlands (see Section 4.4.1.2) and is located in the tropical climate zone (see Section 1.2)
11	REDD+-MF, 4.4 - WRC	Fire reduction projects on peatland that exclude rewetting as part of the project activity are not eligible	Condition met. The project includes an extensive rewetting program (see Section C) in connection with REDD and ARR activities.
12	REDD+-MF, 4.4 - WRC	Rewetting of drained peatland and conservation of undrained or partially drained peatland may be implemented in combination with REDD project activities. REDD project activities on peatland must not increase drainage	Condition met. The project includes a combination of REDD, ARR, and WRC. REDD activities are related entirely to conservation/restoration and do not increase drainage (see Section 2.2.1)

No.	Module	Applicability Condition	Comment
13	REDD+-MF, 4.4 - WRC	Rewetting of drained peatland may be implemented as a separate activity or in combination with ARR project activities. ARR activities must not enhance peat oxidation and therefore this activity requires at least some degree of rewetting	Condition met. The project includes a combination of WRC and ARR. ARR activities are related entirely to restoration and are combined with an extensive rewetting program (see Section 2.2.1)
14	BL-PEAT	This module is applicable to RDP and CUPP activities on project areas that meet the VCS definition for peatland. The scope of this module is limited to domed peatlands in the tropical climate zone	Condition met. See #10 above.
15	BL-PEAT	It must be demonstrated by using the latest version of the CDM A/R methodological tool: "Tool for testing significance of GHG emissions in A/R CDM project activities" (T-SIG) that N2O emissions in the project scenario are not significant, or it must be demonstrated that N2O emissions will not increase in the project scenario compared to the baseline scenario, and therefore N2O emissions need not be accounted for	Condition met. The project does not cause increases in N2O emissions.
16	BL-PEAT	In the baseline scenario the peatland must be (partially) drained. At project start the peatland may still be undrained	Condition met. See Section 4.5
17	BL-ARR	The applicability conditions provided in A/R CDM consolidated methodology AR-ACM0003 (Afforestation and reforestation of lands except wetlands) and associated tools.	See #20-21 below.
18	BL-ARR	Where exclusion of project activities on wetlands exist in the applicability conditions of methodologies and tools, these can be neglected for the purpose of their use in this module, as accounting procedures for the peat soil are provided in Module BL-PEAT	Condition met. See #6 above.
19	BL-ARR	Where the ARR project activity is implemented on peatland, the peatland must be degraded in the baseline scenario as identified by the presence of drainage infrastructure (ditches, canals) and associated lowered water tables below the surface. In case of forested peatland, degradation may be identified by the removal or degradation of the tree cover before the project start date	Condition met. ARR project activities are only implemented on already degraded land which would be further degraded in the baseline as demonstrated in Sections 4.5 and 2.2.1.
20	ACM0003	This methodology is applicable under the following conditions: (a) The land subject to the project activity does not fall in wetland category; (b) Soil disturbance attributable to the project activity does not cover more than 10 per cent of area in each of the following types of land, when these lands are included within the project boundary: (i) Land containing organic soils; (ii) Land which, in the baseline, is subjected	Per #18 above, condition (a) can be neglected, as the project applies relevant wetland procedures. Condition (b) is not relevant, as the project does not cause soil disturbance.

No.	Module	Applicability Condition	Comment
		to land-use and management practices and receives inputs listed in appendices 1 and 2 to this methodology	
21	ACM0003	A project activity applying this methodology shall also comply with the applicability conditions of the tools contained within the methodology and applied by the project activity	Condition met. This table lists all relevant applicability conditions and describes how they are fulfilled.
22	BL-ARR	The project scenario does not involve the harvesting of trees. Therefore, procedures for the estimation of long-term average carbon stocks are not provided	Condition met. See #8 above.
23	X-STR	Any module referencing strata i must be used in combination with this module	Condition met. All modules using parameter *i* refer to module X-STR.
24	X-STR	In case of REDD, above-ground biomass stratification is only used for pre-deforestation forest classes, and strata are the same in the baseline and the project scenario. Post-deforestation land uses are not stratified. Instead, average post-deforestation stock values (e.g. “Simple” or “Historical area-weighted” approaches are used, as per Module BL-UP).	Condition met. See application of X-STR in Section 4.4.1. Post deforestation carbon stocks are taken into account as estimated in Section 5.3.3.
25	X-STR	For peatland rewetting and conservation project activities this module must be used to delineate non-peat versus peat and to stratify the peat according to peat depth and soil emission characteristics, unless it can be demonstrated that the expected emissions from the soil organic carbon pool or change in the soil organic carbon pool in the project scenario is de minimis	Condition met. See application of X-STR in Sections 4.4.1.2 and 4.4.1.3.
26	X-STR	In the case of peatland rewetting and conservation project activities, the project boundary must be designed such that the negative effect of drainage activities that occur outside the project area on the project GHG benefits are minimized	Condition met. The project is taking significant steps to maintain the intactness of hydrology in the project area and to restore hydrology in areas which have been disturbed by existing drainage. The project is monitoring areas outside the project are which could be under threat of disturbance in ordered to minimize potential impacts in terms of drainage. See Section 3.1.2.3

No.	Module	Applicability Condition	Comment
27	X-UNC	The module is mandatory when using VCS methodology VM0007. It is applicable for estimating the uncertainty of estimates of emissions and removals of CO2-e generated from REDD and WRC project activities. The module focuses on the following sources of uncertainty: • Determination of rates of deforestation and degradation • Uncertainty associated with estimation of stocks in carbon pools and changes in carbon stocks • Uncertainty associated with estimation of peat emissions • Uncertainty in assessment of project emissions	Condition met. X-UNC has been used throughout to estimate uncertainties associated with this project. See Section 5.6.1
28	X-UNC	Where an uncertainty value is not known or cannot be simply calculated, then a project must justify that it is using an indisputably conservative number and an uncertainty of 0% may be used for this component.	Condition met. In all cases where an uncertainty value is not known or cannot be simply calculated, the project provides a justification that the value used is indisputably conservative number (or an IPCC default value as instructed by VM0007).
29	X-UNC	Guidance on uncertainty – a precision target of a 95% confidence interval half-width equal to or less than 15% of the recorded value shall be targeted. This is especially important in terms of project planning for measurement of carbon stocks; sufficient measurement plots should be included to achieve this precision level across the measured stocks.	Condition met. Uncertainty requirements have been take into account in project planning and carbon stock calculations as per Sub-section 5.6.1.
30	E-BPB	This module is applicable to Avoiding Unplanned Deforestation or Degradation, Avoiding Planned Deforestation, and Avoiding Degradation, whether or not situated on peatland	Condition met. The project falls in the category of APD.
31	LK-ARR	This module is applicable under the following conditions: • Applicability conditions are provided in A/R CDM consolidated methodology AR-ACM0003 (Afforestation and reforestation of lands except wetlands) and associated tools. • Where exclusion of project activities on wetlands exist in the applicability conditions of methodologies and tools, these can be neglected for the purpose of their use in this module.	Condition met. See #17 and #18 above.
32	LK-ASP	The module is mandatory if Module BL-PL has been used to define the baseline and	Condition met. The project has used module BL-PL and per this table complies with all associated

No.	Module	Applicability Condition	Comment
		the applicability criteria in Module BL-PL must be complied with in full.	applicability conditions.
33	LK-ASP	The module is applicable for estimating the leakage emissions due to activity shifting from forest lands that are legally authorized and documented to be converted to non-forest land, including activity shifting to forested peatland that is drained as a consequence of project implementation. This tool must be used in countries where planned deforestation happens on forested peatlands regardless of the absence of peatland within the project boundaries. Under this situation, displacement of baseline activities can be controlled and measured directly by monitoring the baseline deforestation agents or class of agents.	Condition met. See Section 5.5
34	LK-ECO	This module is applicable under the following condition: • Leakage caused by hydrological connectivity is avoided by project design and site selection, as outlined in Chapter 5 (Procedures).	Condition met. Ecological Leakage does not occur in the project. See application of LK-ECO in Section 5.5.3
36	M-ARR	This module is applicable under the following conditions: • The applicability conditions provided in A/R CDM consolidated methodology AR-ACM0003 (Afforestation and reforestation of lands except wetlands) and associated tools. • Where exclusion of project activities on wetlands exist in the applicability conditions of methodologies and tools, these can be neglected for the purpose of their use in this module, as accounting procedures for the peat soil are provided in Module M-PEAT.	Condition met. See #17 and #18 above.
37	M-PEAT	This module is applicable to RDP and CUPP activities as defined in VCS AFOLU Requirements. The project area must meet the VCS definition for peatland. This module is limited to domed peatlands in the tropical climate zone.	Condition met. See #14 above.

No.	Module	Applicability Condition	Comment
38	M-PEAT	Furthermore, the following applicability conditions apply: • It must be demonstrated by using the latest version of the CDM A/R methodological tool: "Tool for testing significance of GHG emissions in A/R CDM project activities" (T-SIG) that N2O emissions in the project scenario are not significant, or it must be demonstrated that N2O emissions will not increase in the project scenario compared to the baseline scenario, and therefore N2O emissions need not be accounted for. • In the baseline scenario the peatland must be (partially) drained. At project start the peatland may still be undrained. • The Fire Reduction Premium approach is only applicable if human-induced peat fires do not occur in the project scenario. The use of fire as a management tool (non-catastrophic fires or human induced fires) in the project scenario is not allowed in the case that the Fire Reduction Premium approach is used to estimate emissions from peat fire. • Ecological leakage (see LK-ECO) must not occur.	Condition met. See #15 and #16 above. The Fire Reduction Premium is not claimed by the project. Per Section 5.5.3 Ecological Leakage does not occur in this project and all measures have been take to ensure Ecological Leakage remains = 0.
39	BL-PL	The module is applicable for estimating the baseline emissions on forest lands (usually privately or government owned) that are legally authorized and documented to be converted to non-forest land.	Condition met. See Section 4.5
40	BL-PL	Where, pre-project, unsustainable fuelwood collection is occurring within the project boundaries modules BL-DFW and LK-DFW shall be used to determine potential leakage	Condition not applicable. The project does not avoid unsustainable fuelwood collection.
41	M-MON	Strata as defined in the relevant baseline modules are fixed and may not be changed without baseline revision.	Condition met. Strata are fixed according to Section 5.3. Strata may be revised upon baseline adjustment at year 10.
42	M-MON	The module is always mandatory. Without application of this module the methodology shall not be used	Condition met. The module is applied per the requirement.

No.	Module	Applicability Condition	Comment
43	M-MON	Where selective logging is taking place in the project case: • Emissions from logging may be omitted if it can be demonstrated the emissions are de minimis using T-SIG. • If emissions from logging are not omitted as de minimis, logging may only take place within forest management areas that possess and maintain a Forest Stewardship Council (FSC) certificate for the years when the selective logging occurs. • Logging operations may only conduct selective logging that maintains a land cover that meets the definition of forest within the project boundary. • All trees cut for timber extraction during logging operations must have a DBH greater than 30 cm. • During logging operations, only the bole/log of the felled tree may be removed. The top/crown of the tree must remain within the forested area. • The logging practices cannot include the piling and/or burning of logging slash • Volume of timber harvested must be measured and monitored.	Condition not applicable. The project does not involve timber harvest.
44	CP-AB	This module is applicable to all forest types and age classes. Inclusion of the aboveground tree biomass pool as part of the project boundary is mandatory as per the framework module REDD-MF.	Condition met. The module is applied per the requirement.
45	CP-AB	Non-tree aboveground biomass must be included as part of the project boundary if the following applicability criteria are met (per framework module REDD-MF): • Stocks of non-tree aboveground biomass are greater in the baseline than in the project scenario, and • Non-tree aboveground biomass is determined to be significant (using the T-SIG module).	Condition met. Non-tree above ground biomass is excluded. It is greater in the project than in the baseline scenario.
46	CP-AB	Belowground (tree and non-tree) biomass are not required for inclusion in the project boundary because omission is conservative.	Condition met. See section 5.1.1. of module BL-PEAT. BGB is included in the peat component in areas subject to REDD+WRC and conservatively excluded in area subject to ARR+WRC.
47	T-ADD	The tool is applicable under the following conditions: • Forestation of the land within the proposed project boundary performed with or without being registered as the A/R CDM project activity shall not lead to violation of any applicable law even if the law is not enforced. • This tool is not applicable to small - scale afforestation and reforestation project activities.	Condition met. Reforestation activities do not violate any applicable laws indeed they are required under the project scenario. The reforestation activities are not classified as small scale.

No.	Module	Applicability Condition	Comment
48	T-SIG	The tool shall be used in the application of an A/R CDM approved methodology to an A/R CDM project activity: a) To determine which decreases in carbon pool and increases in emissions of the greenhouse gases measured in CO2 equivalents that results from the implementation of the A/R project activity, are insignificant and can be neglected b) To ensure that it is valid to neglect decreases in carbon pools and increases GHG emission by source stated as being insignificant in the applicability conditions of an A/R CDM methodology	Condition met. T-SIG was used, however no significance calculations needed to be performed as carbon pools and sources of GHG emissions were only neglected where it was demonstrably conservative.

4.3 Methodology Deviations

The project does not involve deviations from the methodology.

4.4 Project Boundary

4.4.1 Spatial boundary of the project area (G1.4)

The project area was stratified into discrete units of land that have relatively homogeneous emission and/or carbon stock characteristics (per VCS methodology VM0007 Module X-STR). This includes stratification by:

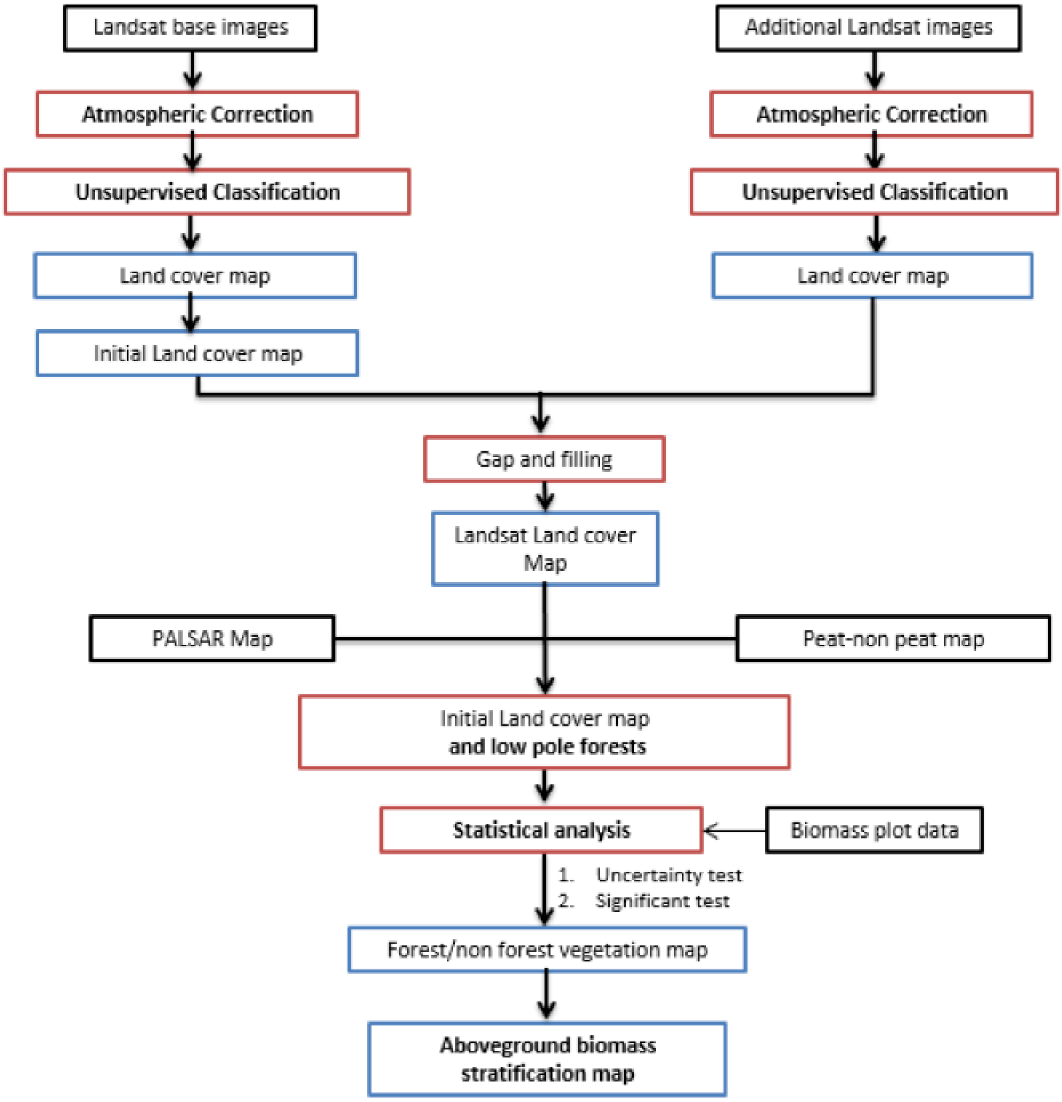
- Aboveground biomass (AGB) & vegetation types
- Soil types (peat or non-peat soils)
- Peat thickness and peat deplition time (PDT)
- Carbon stock
- Eligible area for crediting

Sub-subsections 4.4.1.1 through 4.4.1.7 describe the spatial boundary of the project area in more detail.

4.4.1.1 Aboveground biomass (AGB) stratification

The project area was stratified into homogeneus classes based on their aboveground carbon stock. Satellite imagery was used to delineate the project area based on vegetation types and structures as well as land cover features. Field data was used to quantify aboveground biomass (AGB) and carbon (C) in each stratum. The remote sensing and field data were subsequently cross-checked and calibrated where necessary. Figure 14 shows the process of AGB stratification.

Figure 14. Aboveground stratification process



Spectral data from 2010 Landsat imagery, downloaded from the USGS online database[4], was used to map the land cover classes. Due to significant data gaps caused by the Landsat 7 ETM+'s Scan Line Corrector's failure and cloud cover, additional 2010 imagery was used to fill the gaps. Additional remaining gaps were subsequently filled using imagery from 2009. The data acquisition, pre-processing, classification and accuracy assessment methods followed the steps outlined in Sub-section 5.3.2.

In addition to the Landsat imagery, the project also acquired two fully polarimetric ALOS PALSAR datasets from 28/04/2010 and15/05/2010. These have a 25m spatial resolution as well as a Fine Beam Double (FBD) Polarization dataset from 05/07/2010 with a 12.5m spatial resolution (all processed to level 4.1 products).The microwaves emitted by the ALOS PALSAR system interact differently with the earth's surface depending on their polarization [14] which makes them ideal for mapping forest characteristics such as vegetation structure. Both PALSAR datasets were classified using the entropy, representing the randomness of the signal's scattering, and the alpha angle, which is indicative for the dominant scattering mechanism. Given the FBD's limited polarimetric data, the fully polarimetric dataset produced more accurate classification results and was used to map the

[4] http://earthexplorer.usgs.gov

vegetation structure characteristics of the forest. This analysis identified a significant area of low pole forest in the center of the project area, which was subsequently added to the Landsat based AGB stratification. This analysis also identified small areas of freshwater swamp forest inside the project area.

Satellite images used for the stratification analyses are provided in Table 13. The result of the stratification based on the Landsat and PALSAR analyses is provided in Map 8 and Table 14.

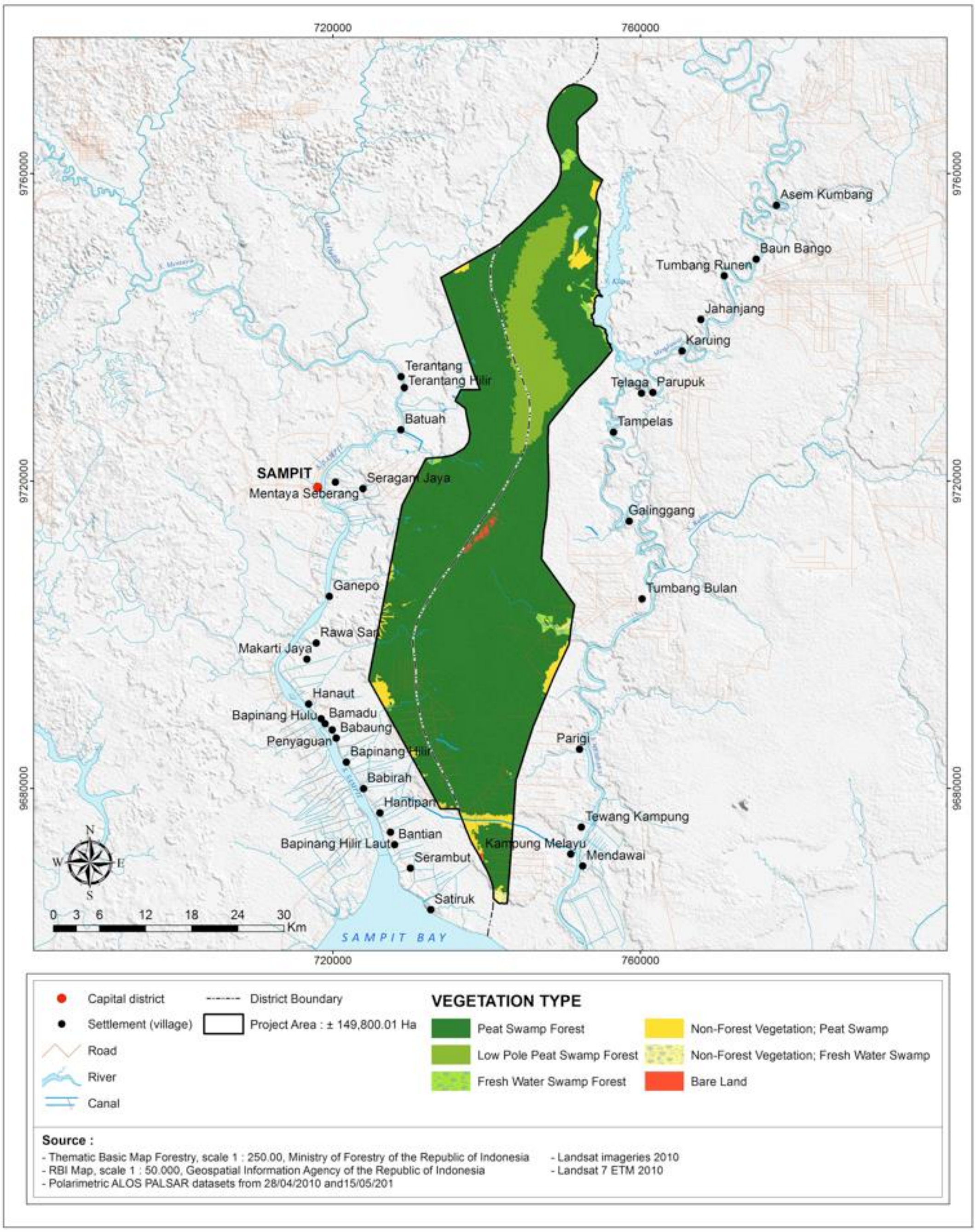
Table 13. Satellite images used for stratification

No	Satellite sensor	ID	Dated
A	Main images		
1	Landsat 5 TM	LT51180622010041BKT00	10-02-2010
2	Landsat 5 TM	LT51190612010016BKT00	16-01-2010
3	Landsat 5 TM	LT51190622010016BKT00	16-01-2010
B	Images for gap filling		
1	Landsat 7 ETM +	LE71190622008019EDC00	10-02-2010
2	Landsat 7 ETM +	LE71190622009213EDC01	16-01-2010
3	Landsat7 ETM +	LE71190612010040EDC01	16-01-2010
4	Landsat 7 ETM +	LE71190612010152EDC01	01-06-2010
C	ALOS PALSAR Images		
1	ALOS PALSAR	Full Polarimetry Mode dataset	28/04/2010
2	ALOS PALSAR	Full Polarimetry Mode dataset	15/05/2010
3	ALOS PALSAR	Fine Beam Double Polarization dataset	05/07/2010

Table 14. Land cover of the project area based on the Landsat and PALSAR analyses

No	Vegetation type	Hectares	%
1	Peat swamp forest	128,584	85.84
2	Low pole peat swamp forest	14,510	9.69
3	Freshwater swamp forest	1,683	1.12
4	Non-forest vegetation: freshwater swamp	469	0.31
5	Non-forest vegetation: peat swamp	4,189	2.80
6	Bare land	362	0.24
TOTAL		149,800	100.00

Map 8. Stratification of the project area based on the Landsat and PALSAR analyses

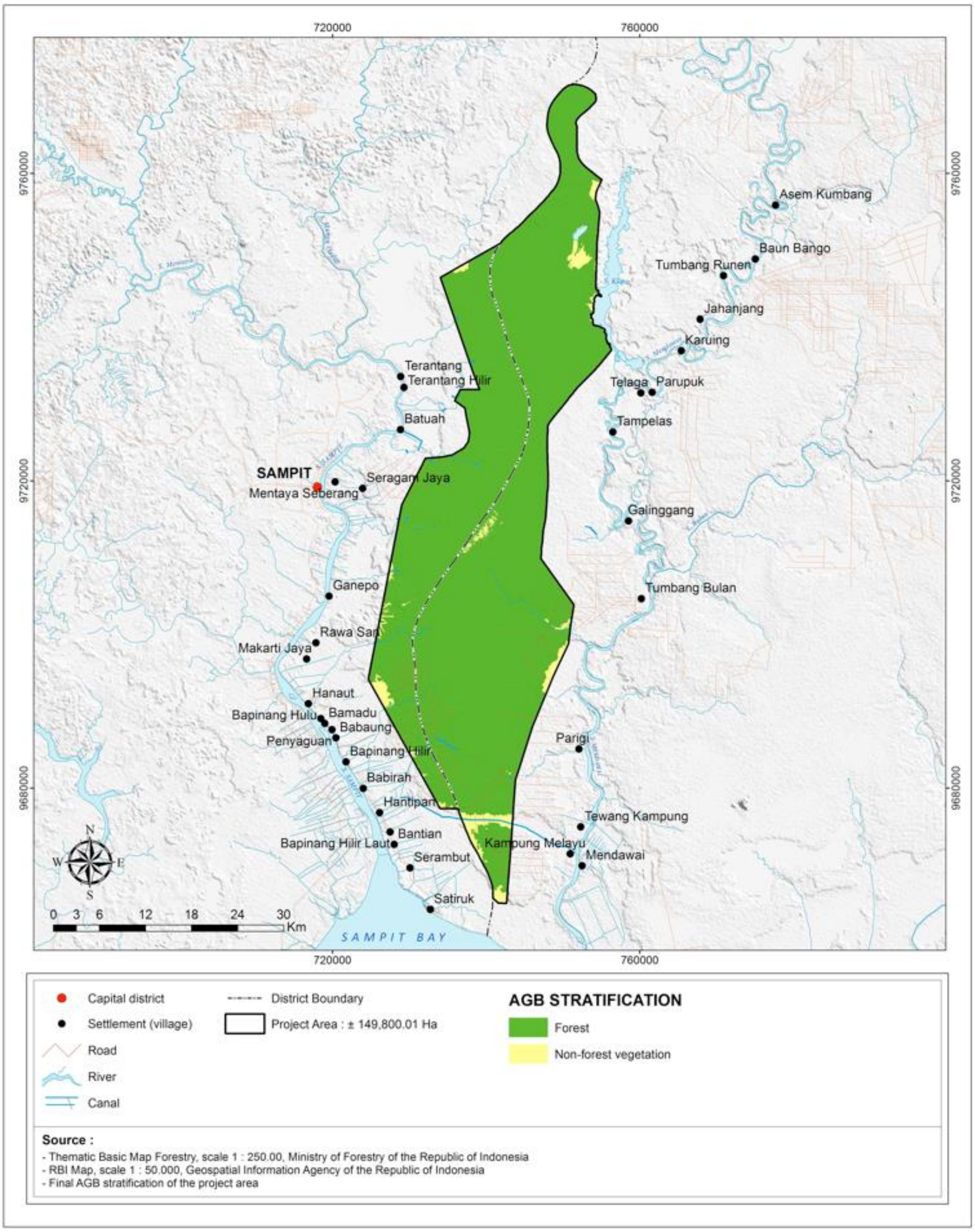


Above ground biomass was sampled using 91 sampling plots distributed across the project area (both randomly and systematically along two transects crossing the project area). The plot data were used to calculate the mean AGB for each stratum. Per VCS methodology VM0007 Module X-STR, all strata with means within 20% of each other were merged into single strata, resulting in the peat swamp forest and low-pole peat swamp forest strata being combined. Since the Landsat and PALSAR data did not identify any difference in land cover and forest structures between the freshwater swamp forest and the surrounding peat swamp forest areas, these two classes were also combined. Furthermore, the non-forest vegetation strata was conservatively combined with the bare land strata, resulting in a final AGB stratification map consisting of forest and non-forest vegetation strata (see Map 9 and Table 15).

Table 15. Final AGB stratification summary of the project area

	Vegetation type	Hectares	%
1	Forest	144,778.26	96.65
2	Non-forest vegetation	5,021.75	3.35
TOTAL		149,800.01	100

Map 9. Final AGB stratification of the project area



As mandated in VCS methodology VM0007 module M-MON, the classification accuracy must be at least 90%. By applying a basic binary confusion matrix, the stratification map was estimated to have an accuracy level of 98.5%. This level of accuracy is also acceptable under the IPCC Good Practice Guidance 2003 [15]. An uncertainty analysis was carried out by using the VCS methodology VM0007 module X-UNC 'estimation of uncertainty for REDD project activities'. The uncertainty level was found to be 10.61%, which meets requirements of VSC methodology VM0007 module X-UNC.

4.4.1.2 Stratification of peatland and non-peatland

Mapping the peatland area and the peat thickness within the project area followed three general steps. The first step was to identify the general area of the peat dome in order to determine the 'Initial Estimate of Peatland Borders' (IEPB). This step uses several indicators as listed in Table 16. Once the IEPB was identified, the second step sought to delineate more refined borders following geomorphological and geostatistical analyses, including steps presented in Figure 15 and Annex 7. The third step was to subset (clip) the peatland area within the landscape with reference to the project boundary.

Table 16. Indicators for the differentiation of peatland from non-peatland

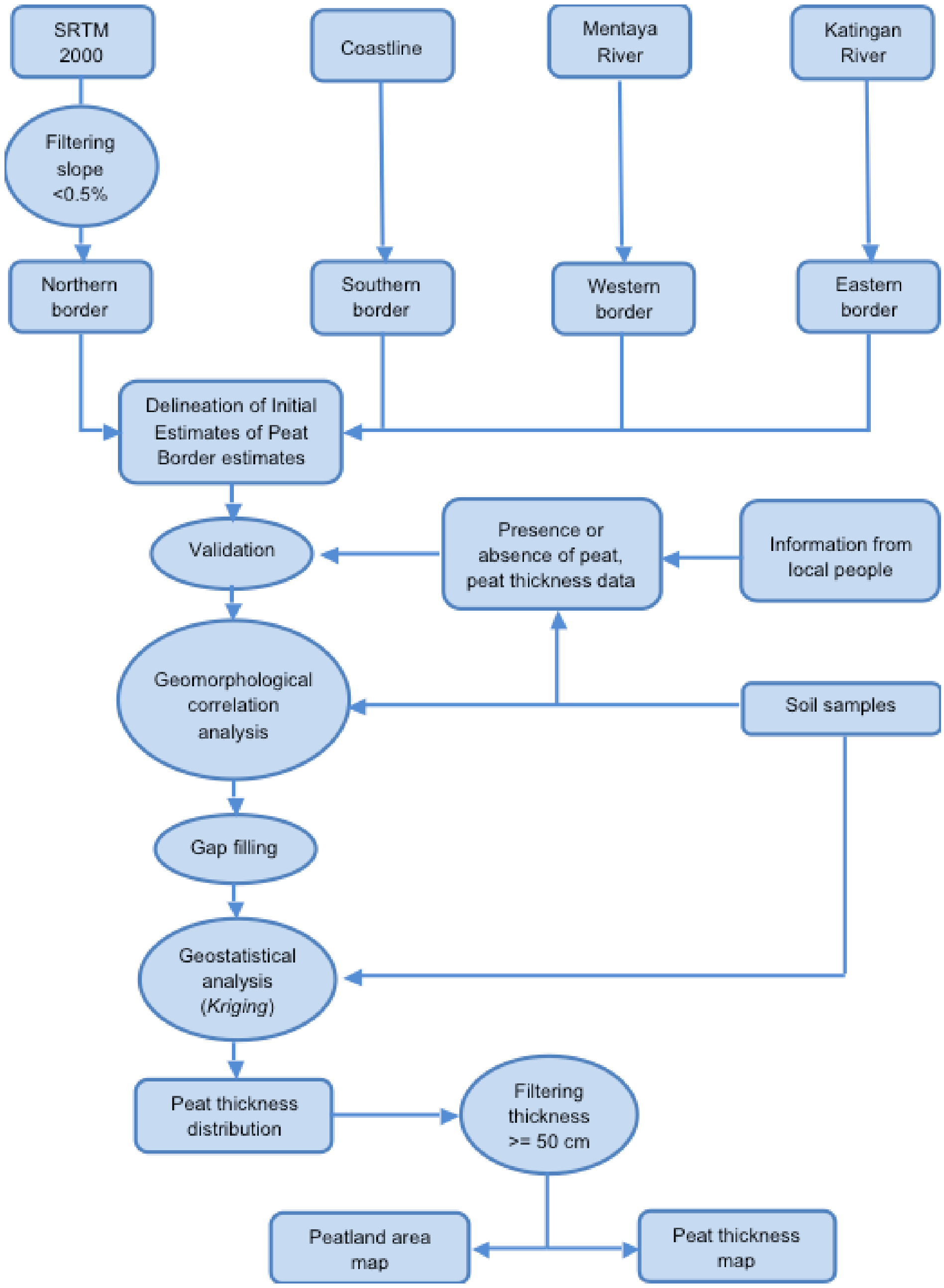
Indicators	Purpose	Source
Major rivers with mineral levees	Indicator for the absence of peat	Official BIG[5] river map[6] (2008)
Coastline	Indicator for the absence of peat	Official BIG river map (2008)
Heathland areas	Indicator for the absence of peat	SRTM 2000 (NASA)
Soil samplings	Indicator for the presence or absence of peat	Field data
Information from local people	Indicator for the presence or absence of peat	Local people

River networks, coastline and heathland were used as indicators to determine the peatland borders. Katingan and Mentaya rivers, which clearly show the presence of mineral levees, border the peat dome on the east- and western side of the project area respectively. The coastline to the south was used as the southern border.

To identify the northern heathland border, a surface slope map of the landscape was generated by using a NASA SRTM 2000 digital elevation dataset[7]. Since tropical coastal peatlands of Indonesia usually show flat surface pattern with less than 0.5 percent slope, filtering the dataset with slope values less than 0.5 percent provides an indication of the heathland boundary. The SRTM 2000 dataset also shows that the heathland features a more undulating surface, a feature which peatlands lack, and which therefore provided a visual confirmation of the northern heathland boundary.

[5] Badan Informasi Geospasial (Geospatial Information Bureau of Indonesia)
[6] This map also includes canal networks. The year of publication is still relevant, as main canals in within project area was constructed before 2000, and no new canals has been constructed post 2008.
[7] Available at: http://srtm.csi.cgiar.org/SELECTION/inputCoord.asp

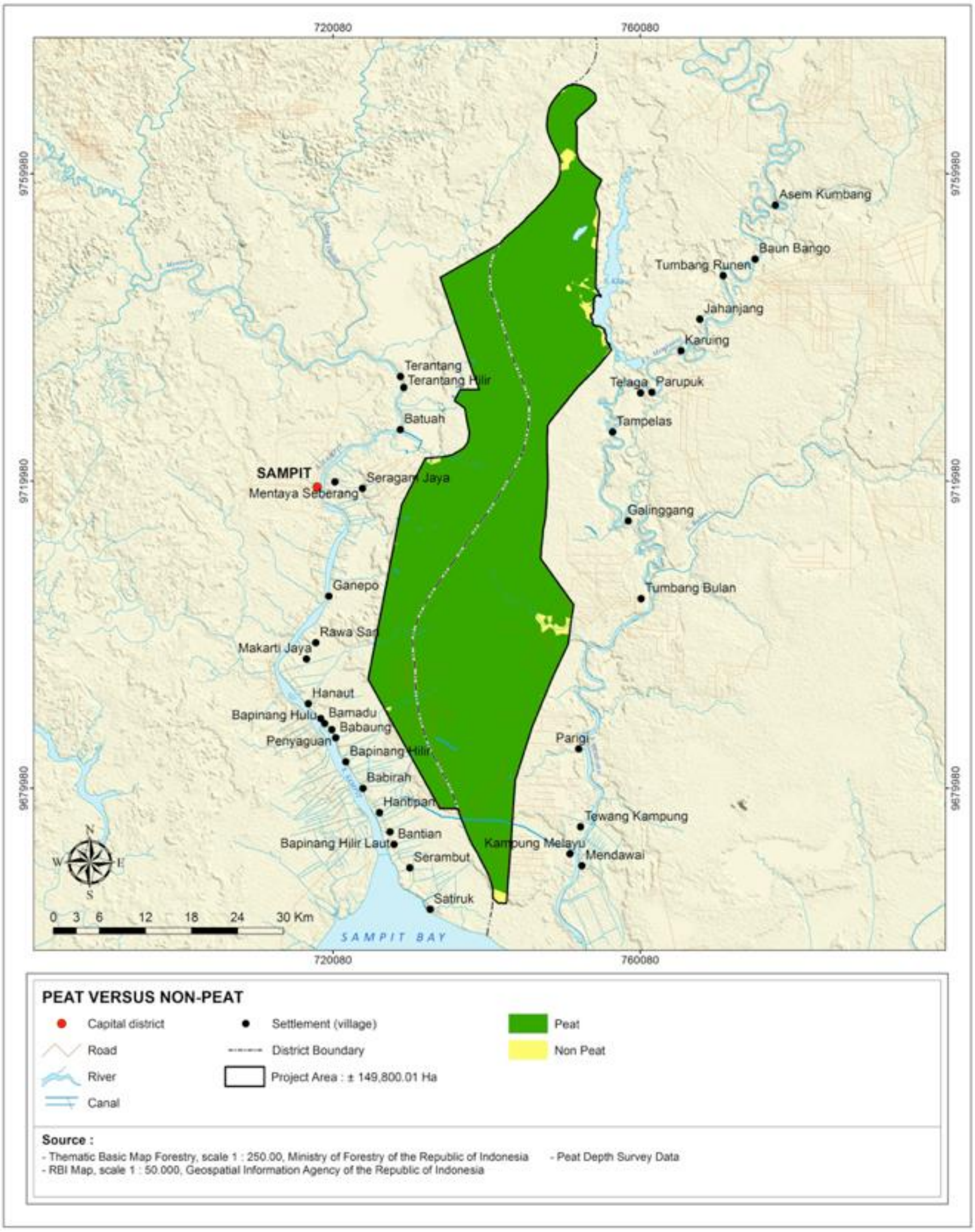
Figure 15. Process of peatland and peat thickness mapping



Additional data was collected in the field for validation of the IEPB including information on river networks with mineral levees other than Mentaya and Katingan rivers, the presence or absence of peat, peat thickness in the visited locations as shown from soil samplings, and information from local people on the presence or absence of peat near their villages. The validated IEPB was stored in ESRI[8] polyline shapefile format, and was used for further processing as described in Sub-subsection 4.4.1.3 (see also Figure 15) to produce a peat thickness distribution map. This map was further processed by filtering peat thickness ≥50 cm, and was used as the final peatland area map. The resulting peat and non-peat map is shown in Map 10.

[8] A geographic information system company. More information is available online at: http://www.esri.com.

Map 10. Peat versus non-peat areas within the project area boundary



4.4.1.3 Stratification of peat thickness and PDT

Because drained peat soils are subject to microbial decomposition and (uncontrolled) burning, in the baseline scenario, all peat at some locations in the project area may be depleted before the end of the crediting/project period. The time at which the peat in the project area would have been depleted (peat depletion time; PDT) in the most likely baseline scenario in the project area was calculated based on the following, which are then each considered in more detail below:

- Peat thickness;
- Drainability elevation limit;
- Surface elevation; and
- Subsidence related to microbial decomposition and burning.

A) Peat thickness

To determine peat thickness, over 390 peat core samples were taken using peat augers according to the method detailed in Annex 7. Sample locations were selected using a systematic design that included transects perpendicular to water bodies, the peat-non-peat perimeter, and contour lines. This sampling design fulfills the requirements described in the VCS methodology VM0007 modules M-PEAT and X-STR. Peat thickness was then modelled based on spatial interpolation (*Kriging*) of inputs from peat thickness points.

Peat thickness measurement points were plotted in the ArcGIS 10.1 platform[9]. The distances of each point to the nearest IEPB were calculated by using the built-in Euclidean Distance Tool. The IEPB was generated by process as previously described in Sub-subsection 4.4.1.2. Peat thickness data was then paired against distance to IEPB, and the best fit equation was analyzed:

$$P = aX^c \quad (1)$$

Where:
P : Thickness of peat (cm)
X : Distance to the nearest IEPB (m)
a, c : Constants

An array of approximate points were created manually to fill gaps (i.e. areas where peat thickness measurements were absent due to accessibility constraints). The distances of the approximate points to IEPB were also calculated using the same method as used for those of the actual measurement points. Estimated peat thickness at locations of the approximate points were calculated by using the above equation (1).

Actual measurement points and the approximate points were pooled together by using the Merge Tool in ArcGIS 10.1. The resulting points were then used in spatial interpolation (*Kriging*) to produce a peat thickness raster with 1 hectare spatial resolution. The raster was further processed by filtering peat thicknesses ≥50 cm and the resulting map was used as the final peat thickness map and as the source for peat thickness stratification. The area covered was used as the peatland area map, as outlined in Figure 11. The result shows that peatland with peat thickness ≥50 cm occupies 146,639 hectares (97.9%) of the project area.

Per VCS module X-STR, our initial analysis indicated that the entired peatland in the project area must be stratified, although stratification by peat thickness at a 50 cm resolution was not necessary (see Table 17). Therefore, a wider range of peat thickness was used, and the project area was stratified into 5 classes as presented in Table 18 and Map 11.

Table 17. Decision matrix for peat stratification requirements

No	Requirements per VM0007 module X-STR	Findings	Conclusion
1	When in more than 5% of the project area peat is absent or the thickness of the peat is below a threshold value (e.g., 50 cm); the map only needs to distinguish where peat thickness exceeds this threshold. It is conservative to treat shallow peat strata as mineral soil strata.	Peat ≥50 cm occupies more than 95% of the project area.	The entire peatland in the project area must be stratified.
2	When, using a conservative (high) value for subsidence rates, in more than 5% of the project area less *or equal* peat is available at t=100 years in the project scenario than in the same strata in the	In 12.56% of the project area, peat that remains in the project scenario equals that of the baseline	The peat thickness map only needs to distinguish these

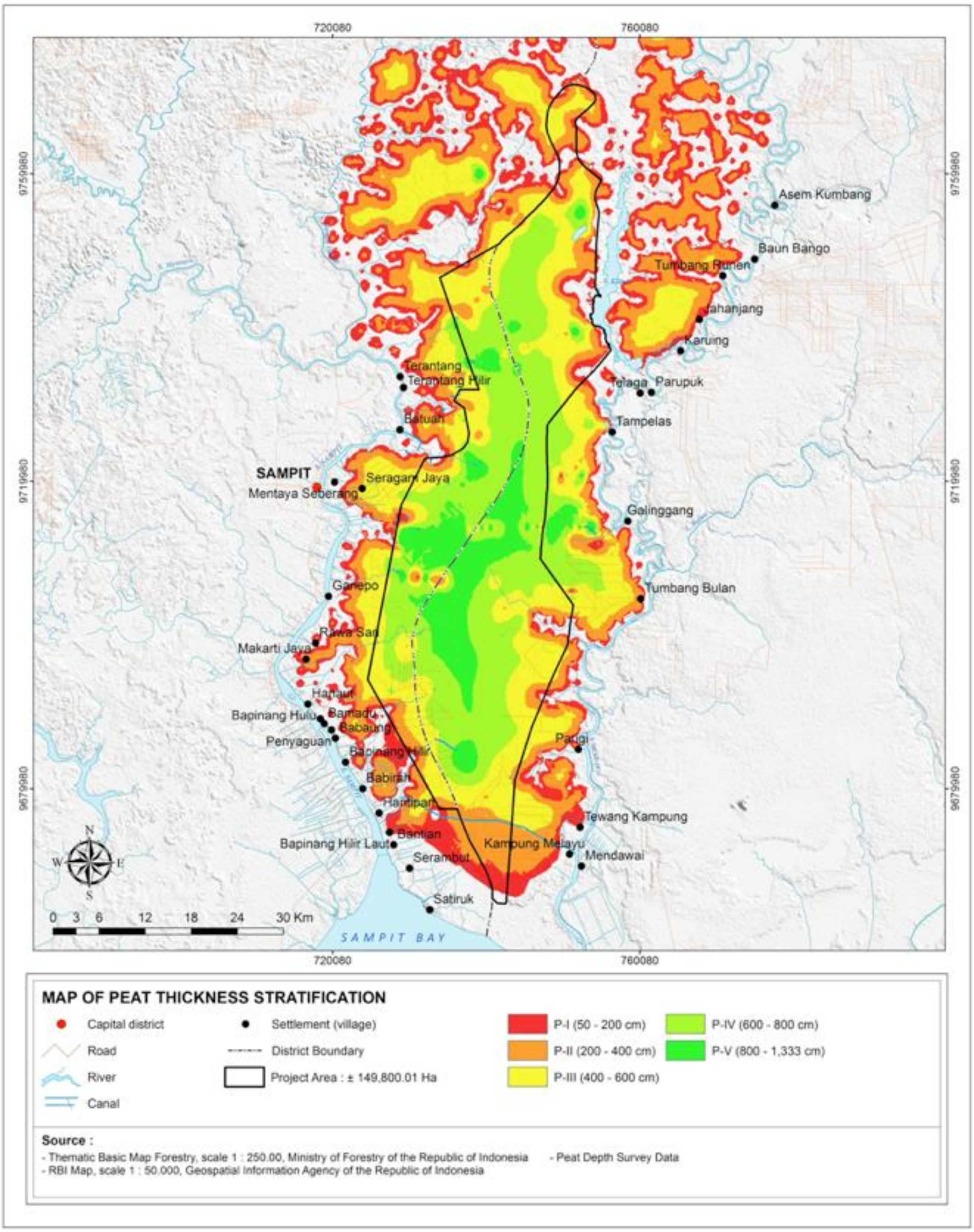
[9] ArcGIS is an integrated geographic information system developed by ESRI.

No	Requirements per VM0007 module X-STR	Findings	Conclusion
	baseline scenario, the peat thickness map only needs to distinguish these strata	scenario at t =100 years	strata.
3	When, using a conservative (high) value for subsidence rates, in the baseline scenario in more than 5% of the project area the project crediting period exceeds the peat depletion time (PDT); the peat thickness map must distinguish with a resolution of 50 cm strata where peat will be depleted within the project crediting period. Peat strata that will be depleted can be further stratified according to their peat depletion time. Areas where peat will not be depleted need not be further stratified.	Less than 5% of the project area where project crediting period (60 years) exceeds PDT (see Table 19).	The peat thickness map does not need to be distinguished with a resolution of 50 cm strata, where peat will be depleted within the project crediting period.

Table 18. Peat thickness stratification of the project area

Thickness Range (centimetres)	Class Symbol	Area (hectares)	% of the project area
50 – 200	PI	5,365	3.6
200 – 400	PII	16,113	10.8
400 – 600	PIII	41,508	27.7
600 – 800	PIV	61,849	41.3
800 – 1,333	PV	21,803	14.6
Total		146,638	97.9

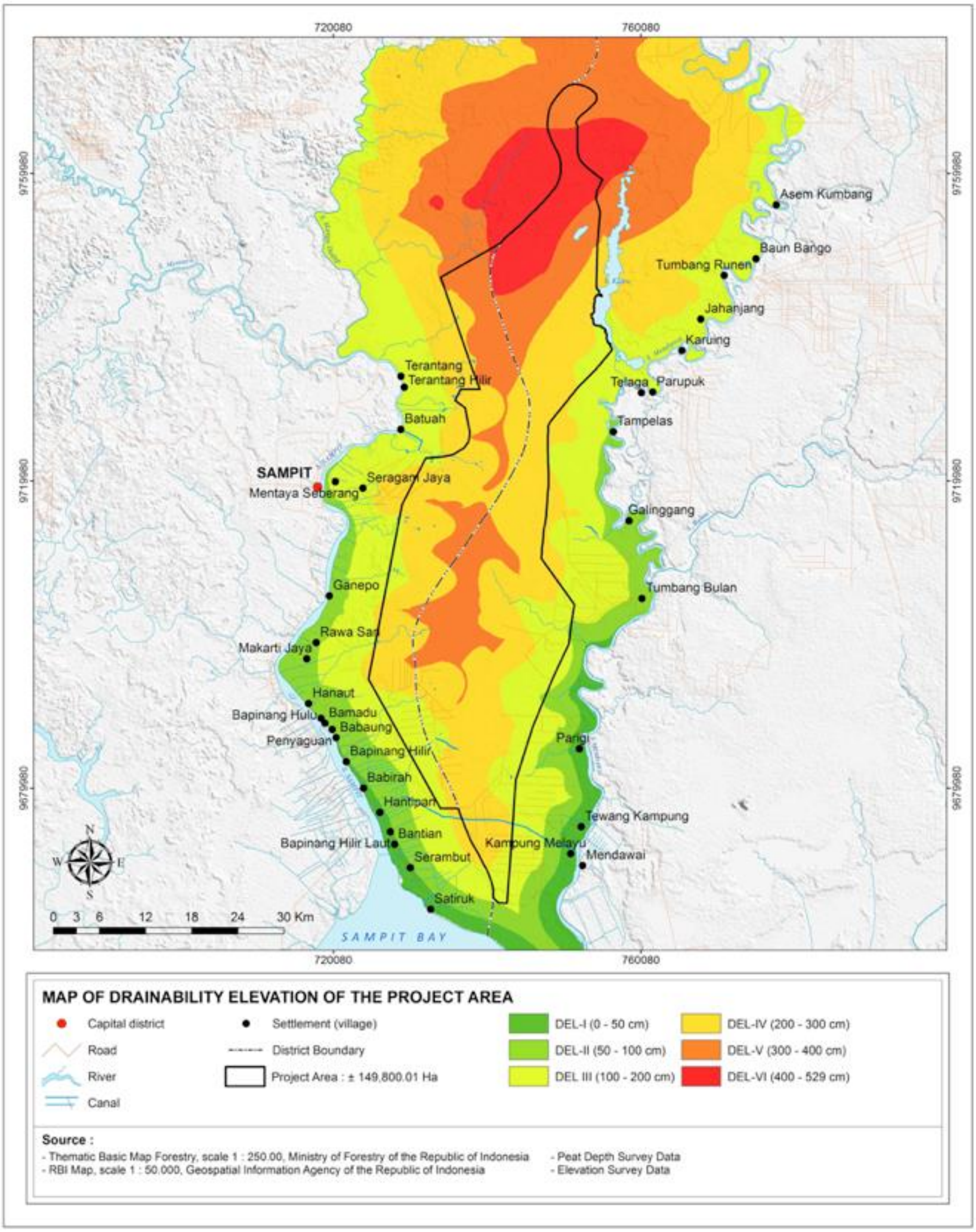
Map 11. Peat thickness stratification of the project area



B) Digital elevation model and drainability elevation limit

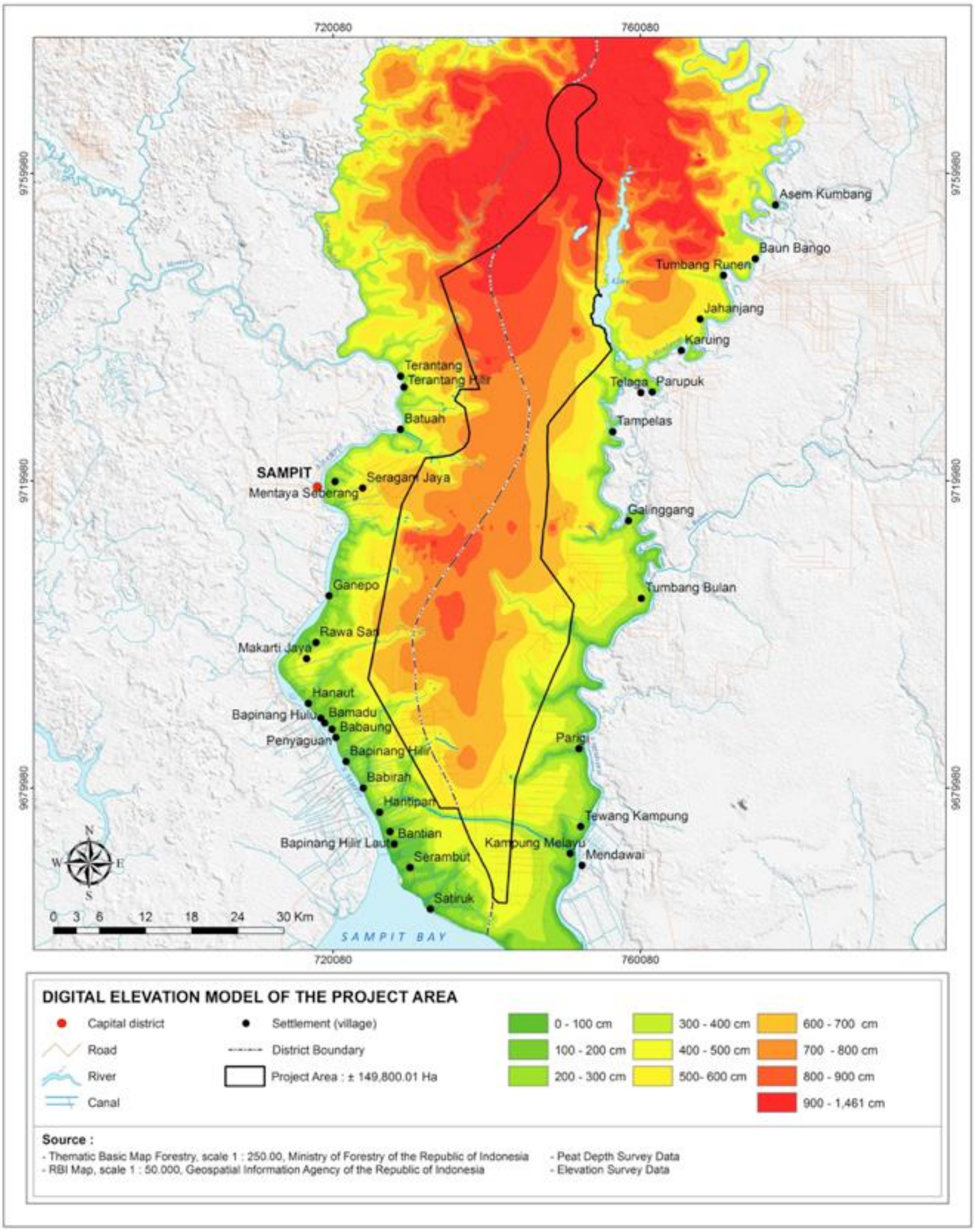
It was conservatively assumed that, in the baseline scenario, the deforestation agents will not practice mechanical pumping. Therefore the thickness of peat that may be lost is restricted by the Drainability Elevation Limit (DEL) – the elevation at which the peat cannot be drained any further without mechanical pumping, defined by the water level in the closest water body. Where, during the course of subsidence, land surfaces reach DEL, further drainage is prevented as the remaining peat layer stays waterlogged. A DEL map (see Map 12) was created by using estimated water levels in rivers and other water bodies in the Katingan landscape. Detailed methods are given in Annex 9.

Map 12. Drainability elevation limit of the project area



To create a surface elevation map (Digital Elevation Model, DEM), data was collected through a levelling survey and river bed slope data (see Map 13). This was combined with the application of geomorphological correlation analysis and geostatistical interpolation methods (*Kriging*), as described in Annex 8.

Map 13. Digital elevation model of the project area



Combining these three maps (see Map 11, Map 12 and Map 13) resulted in a map of peatland subject to microbial decomposition and burning (as shown in Map 14), based on the following rules (2) and (3):

Peat available for microbial decomposition and burning = DEM – DEL (2)

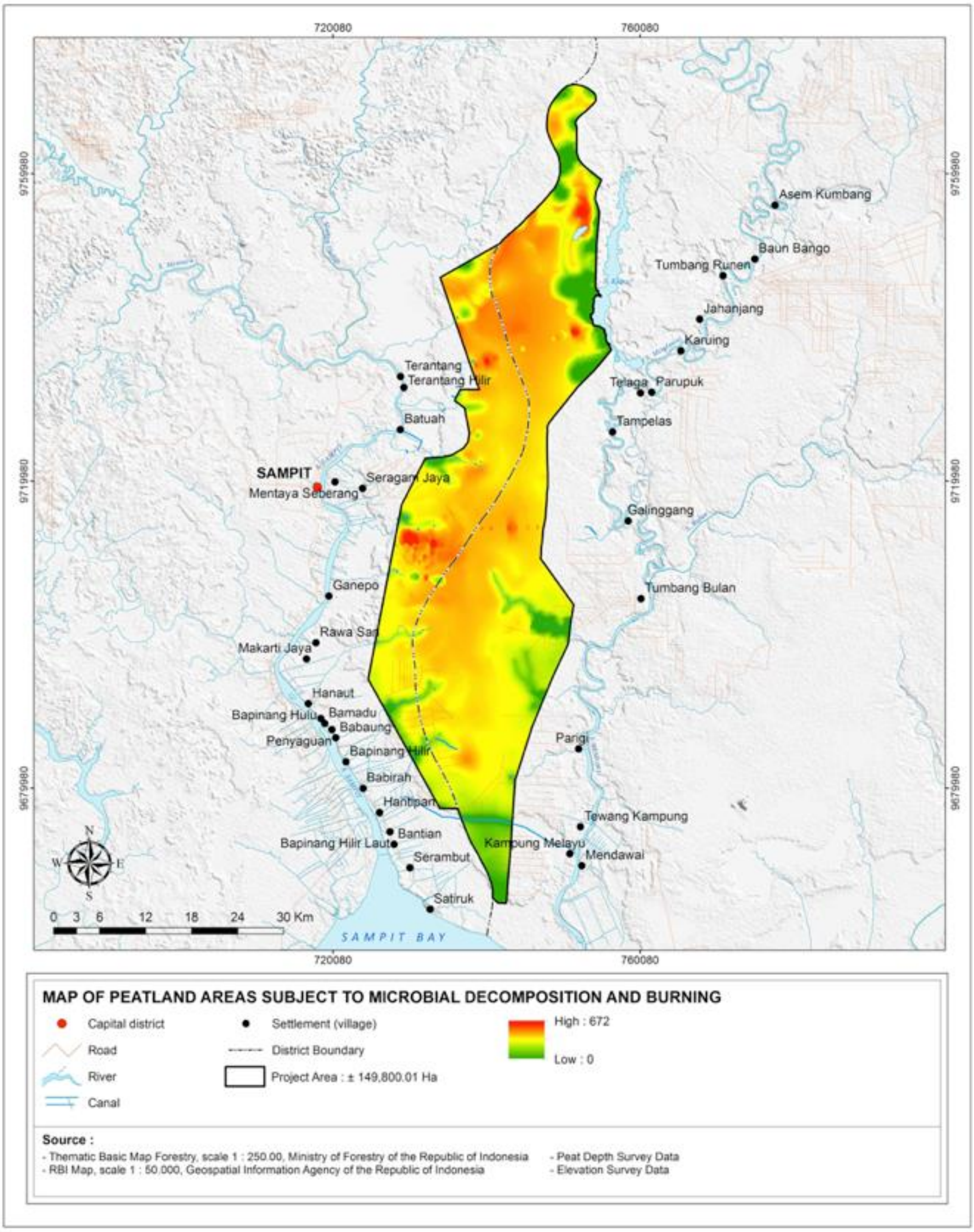
Where:
DEM – DEL ≤ Peat Thickness

Peat Available for Microbial Decomposition and Burning = Peat Thickness (3)

Where:

DEM – DEL > Peat Thickness

Map 14. Peatland area subject to microbial decomposition and burning



C) Peat depletion time (PDT)

Based on the resulting maps of peat thickness, the DEM and DEL, and the calculated peat subsidence in the baseline scenario (see Section 5.3), a map based on the peat depletion time (PDT) was created (see Map 15) by using the following equation (4). Table 19 presents the calculation of PDT stratification of the project area.

$$t_{PDT\text{-}BSL,i} = Depth_{peat\text{-}BSL,i} / Rate_{peatloss\text{-}BSL,i} \qquad (4)$$

Where:

$t_{PDT-BSL,i}$	Peat depletion time in the baseline scenario in stratum *i* in years elapsed since the project start (yr)
$Depth_{peat-BSL,i}$	Average peat depth in the baseline scenario in stratum *i* at project start (m). In this case = peat thickness available for microbial decomposition
$Rate_{peatloss-BSL,i}$	Rate of peat loss due to subsidence and peat burning in the baseline scenario in stratum *i*; (m yr^{-1})

Map 15. PDT of the project area

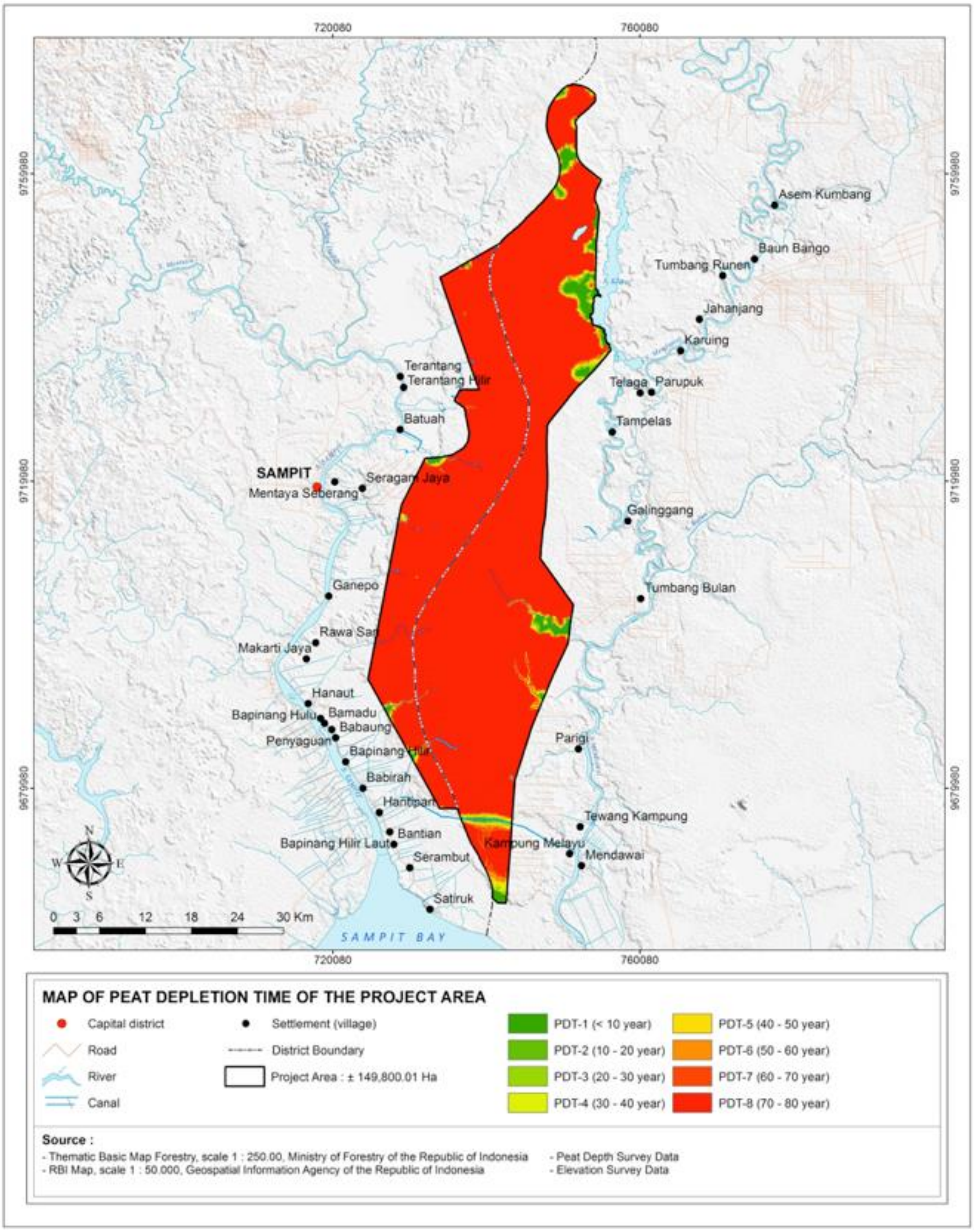


Table 19. Summary of the PDT stratification of the project area

Class Symbol	PDT Range (years)	Area (ha)	% of the peat area	% of the project area
PDT-1	<10	121	0.1	0.1
PDT-2	10 – 20	562	0.4	0.4
PDT-3	20 – 30	1,159	0.8	0.8
PDT-4	30 – 40	1,281	0.9	0.9
PDT-5	40 – 50	1,305	0.9	0.9
PDT-6	50 – 60	1,986	1.4	1.3
PDT-7	60 – 70	2,490	1.7	1.7
PDT-8	70 – 80	3,349	2.3	2.2
PDT-9	80 – 90	3,746	2.6	2.5
PDT-10	90 – 100	5,146	3.5	3.4
PDT-11	>100	125,494	85.6	83.8
Total		146,638	100.0	97.9

Less than 5% of the peatland in the project area are expected to deplete before reaching the 60-year crediting period, while more than 85% are likely to exceed the peat depletion time of 100 years.

4.4.1.4 Stratification based on carbon stock

A) AGB carbon stock

Based on the AGB map of the project area (see Map 9), carbon stock were quantified for each stratum by using the following equations (5).

$$C_{AB} = A_{AB,i} * C_{AB,i} \quad (5)$$

Where:

C_{AB} = Total aboveground biomass carbon stock; tC

$A_{AB,i}$ = Area of stratum *i*; Ha

$C_{AB,i}$ = Mean aboveground biomass carbon stock in stratum *i*; $tC.ha^{-1}$

This ultimately resulted in the AGB density of 98.38 Mg C ha^{-1} for the forest stratum and 2.16 Mg C ha^{-1} for the non-forest stratum. The final calculation estimated the total AGB carbon stock in project area to be **14,254,599 MgC**, in which 14,243,741 MgC (99.92%) was stored in forest areas and 10,858 MgC (0.08%) in non-forest vegetation. The stratification of AGB carbon stock in the project area at the project start is provided in Map 16, and the calculation based on each stratum is summarized in Table 20.

Map 16. Stratification of AGB carbon stock

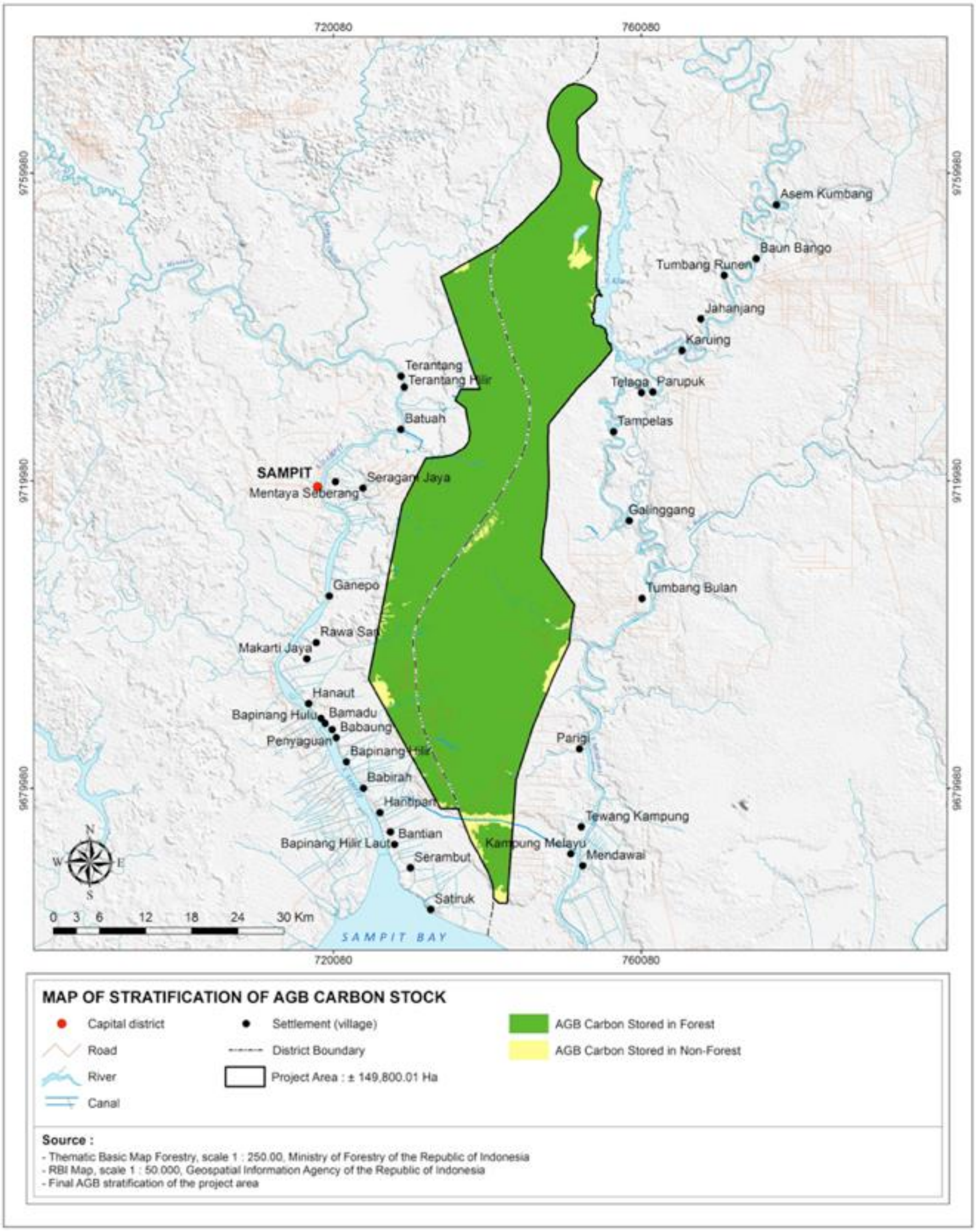


Table 20. Volume of AGB carbon stock in the project area at the project start

Strata	Strata	Area (ha)	Average AGB C stock ($tC.ha^{-1}$)	Total AGB C Stock (tC)
F0	Forest	144,778	98.38	14,243,741
NF0	Non Forest	5,021	2.16	10,858
Total		149,800	-	14,254,599

B) Peat carbon stock

Based on the peat thickness map (see Map 11), the volume of initial peat carbon stock at the project start date has been quantified by using peat bulk density of the project area and conservative carbon content value of 48 kgC.kg-1 dry mass of peat [16]. The bulk density measured by the project showed no significant variation either across horizontal or vertical directions (μ=127 kg.m^{-3}, SE=3.1 kg.m^{-3}, n=197, p=0.05). Details on the measurement methods and analyses are provided in Annex 10. The volume of peat carbon stock across strata in the project area were quantified by using the following formula (6):

$$C_{stock-i,t0} = \frac{48}{100} \times Depth_{peat-i,t0} \times BD_{i,t0} \times 10 \qquad (6)$$

Where:

$C_{stock-i,t0}$	Initial carbon stock of stratum *i* (at *t*=0) (t C ha^{-1})
$Depth_{peat-i,t0}$	Initial peat thickness of stratum *i* (at *t*=0) (m)
$BD_{i,t0}$	Initial bulk density of peat of stratum *i* (at *t*=0) (kg.m^{-3})

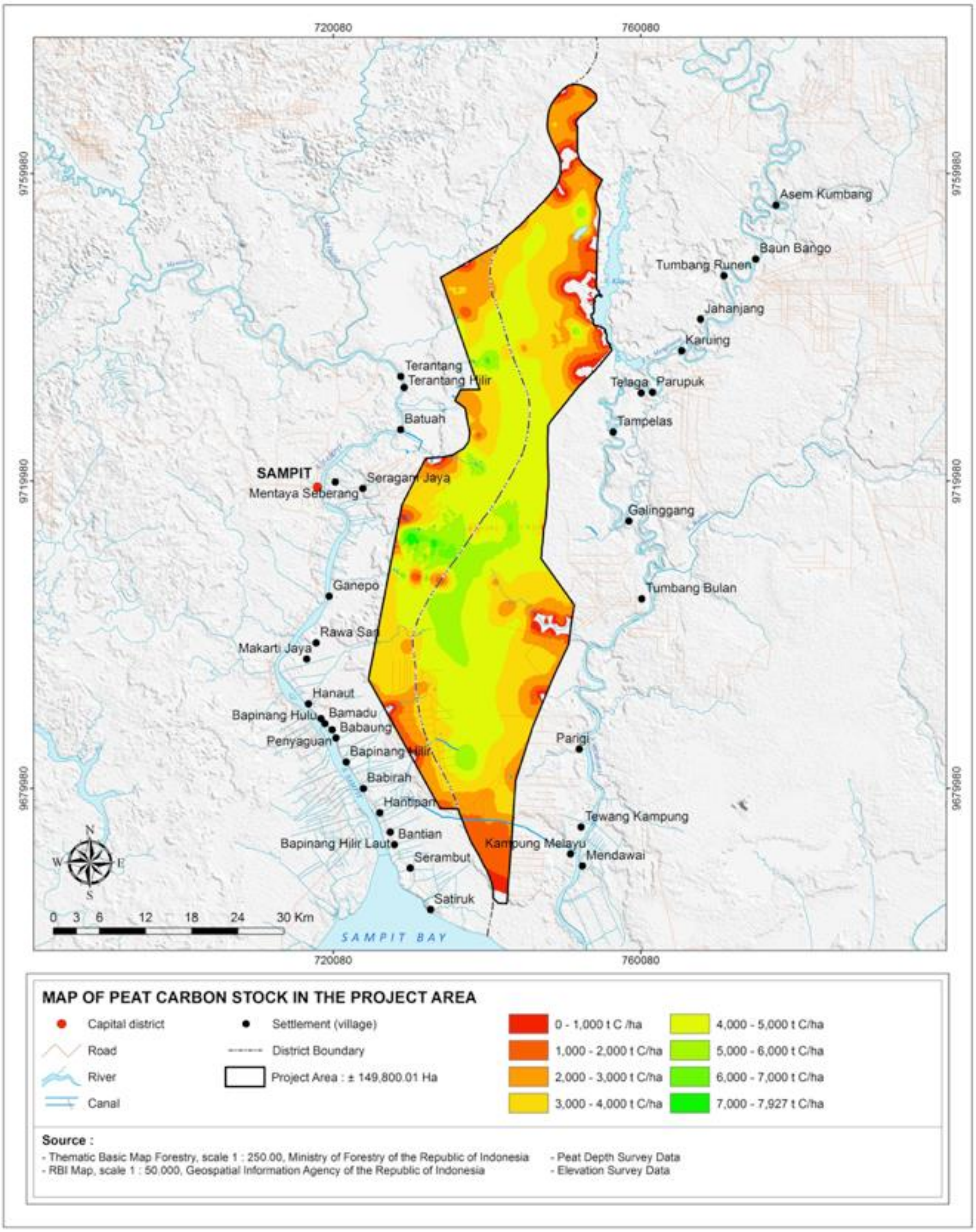
The final calculation estimated the total peat carbon stock in project area to be **546,767,493 MgC.** The stratification of peat carbon stock in the project area at the project start is provided in Map 17, and the calculation based on each stratum is summarized in Table 21.

Table 21. Volume of peat carbon stock in the project area at the project start

Strata	Area (ha)	Average peat carbon stock (tC.ha^{-1})	Total peat carbon stock (tC)
P1L0D0	3,172	2,597	8,043,633
P1L0D1	987	2,124	2,078,712
P1L1D0	141,910	3,738	535,294,904
P1L1D1	354	2,162	764,132
WB	216	2,685	586,113
NP[10]	3,162	-	-
Total	149,800	2,218	546,767,493

[10] Non peat-related strata

Map 17. Stratification of peat carbon stock at the project start



4.4.1.5 Stratification based on emission characteristics

Emission characteristics are highly dependent on the present and future land use and the drainage status of the project area under the baseline and project scenarios. Expected significant differences in emissions and carbon stock changes between different types of aboveground biomass and between different drainage statuses determine which strata are separated from others. The baseline and project scenarios as well as associated emissions are further described in Sections 5.3 and 5.4, which serve as a basis for calculating the area elible for crediting.

4.4.1.6 Eligible area for crediting

The determination of the area eligible for crediting followed VCS rules as set out in VM0007 module X-STR section 5.4, by using Total Stock Approach.

A) REDD and ARR project activities

The eligible area for REDD projects is the area of forest designated to be deforested. With acacia plantations as most likely baseline scenario, the eligible area refers to all area that is available for the developments of acacia plantations (69%), infrastructure area (2.2%), and community crops (5.3%). While for ARR projects, the area eligible for crediting is all non forest areas where the project would carry out reforestation within the project area (2.8 %). Based on the spatial analysis, **the area eligible for crediting from REDD and ARR activities is 114,689.64 ha and 4,227.72 ha respectively**. Map 18 indicates the REDD and ARR eligible area within the project area, and Table 22 is the summary of the area.

Map 18. Eligible areas for crediting from REDD-ARR project activities

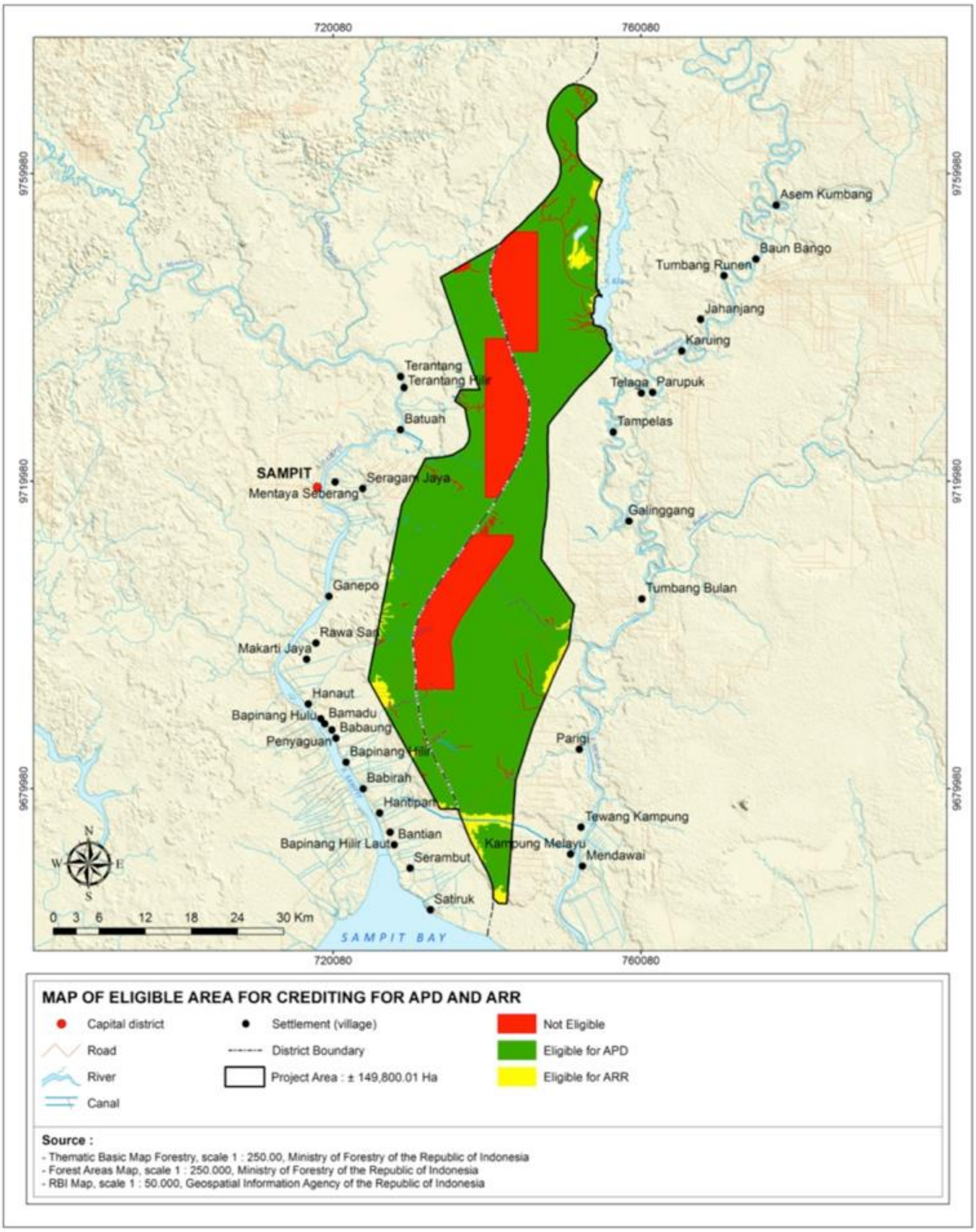


Table 22. Summary of the area eligible for crediting from REDD and ARR activities

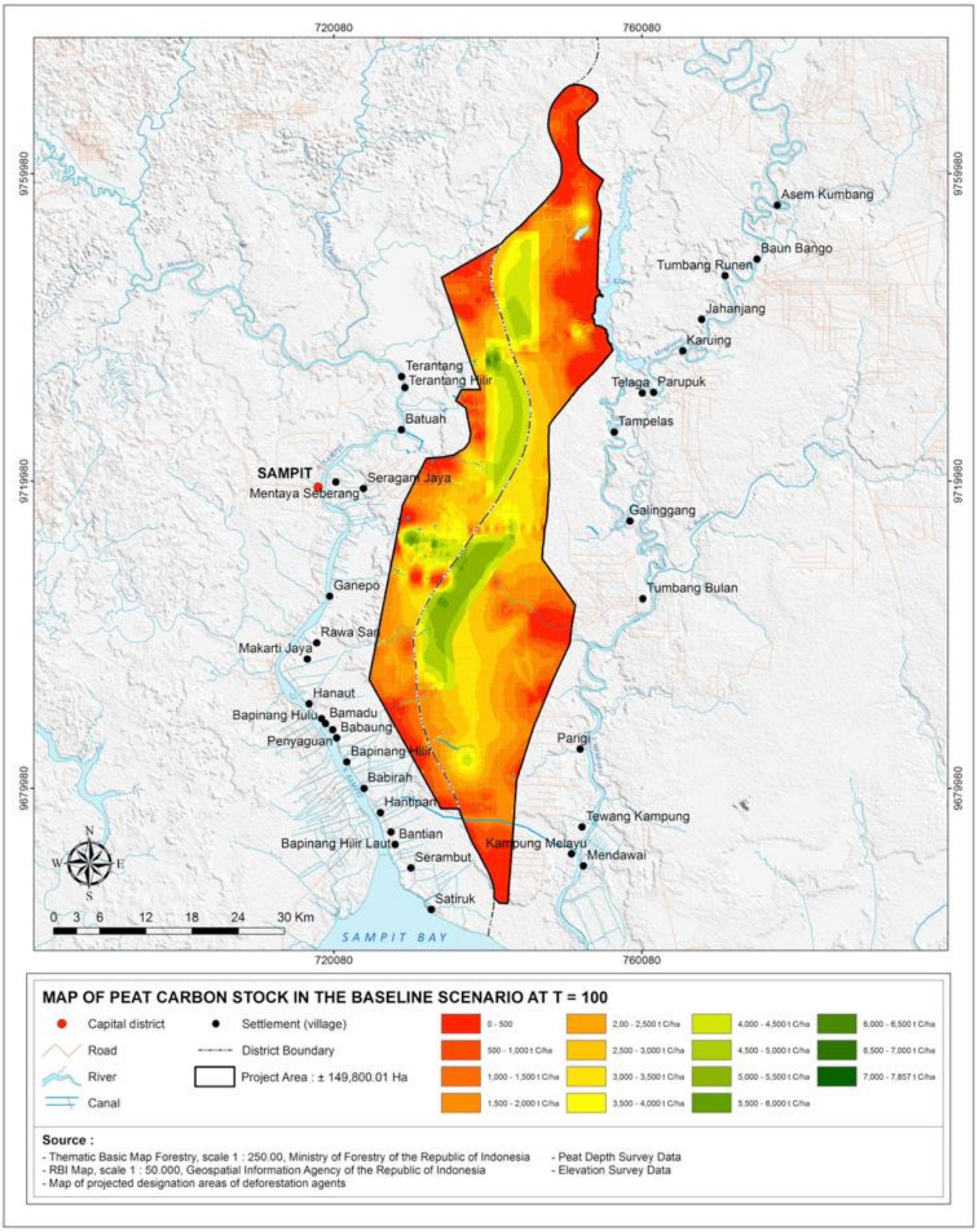
Description	Area (hectares)	Area (percent)
Project area	149,800.01	100
Eligible area for crediting for REDD	114,689.64	76.56
Eligible area for crediting for ARR	4,227.72	2.82
Area not eligible for crediting	30,882.65	20.62

B) WRC project activities
For WRC activities on peatlands, the area eligible for crediting is based on the PDT assessment for the baseline and based on the assessment of ‘not successful’ conservation of the peat layer (and thus peat depletion) in the project scenario. The eligible area for crediting is in close relation with the eligible project crediting period (the time for which GHG emission reductions or removals generated by the project are eligible for crediting with the VCS program).

Delineation of eligible area for crediting involved three steps as follows (also defined in more detail in VCS methodology VM0007 module X-STR, Section 5.4).

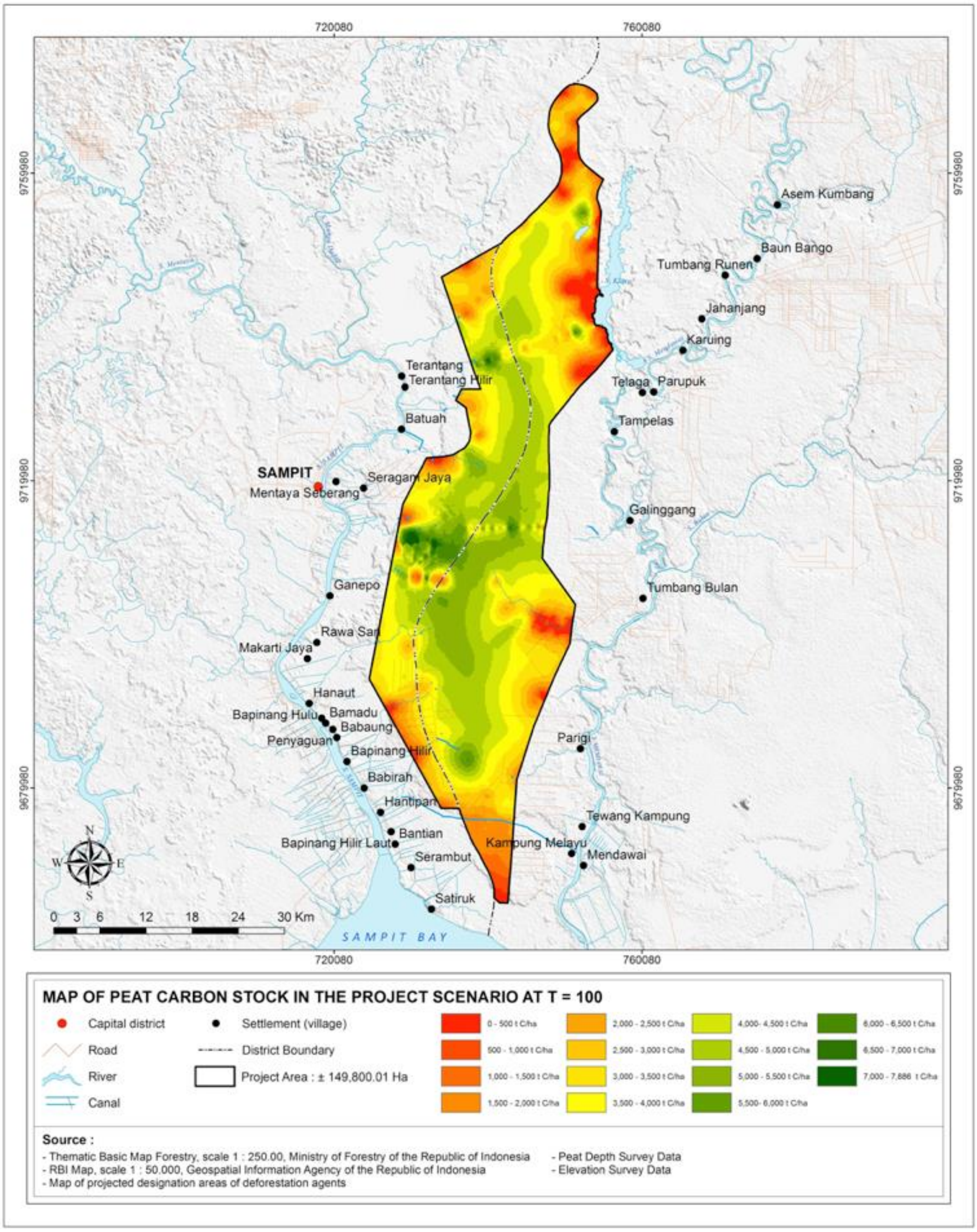
Step 1. Under the baseline scenario, successive changes of peat carbon stock within each stratum were calculated over 100 years. The remaining carbon stocks at t=100 were then mapped (see Map 19). The method for calculating dynamics of carbon stock over time under the baseline scenario is given in Section 5.3.

Map 19. Peat carbon stock in the baseline scenario at t = 100



Step 2. Under the project scenario, successive changes of peat carbon stock within each stratum were calculated over 100 years. The remaining carbon stocks at t=100 were then mapped (see Map 20). The method for calculating dynamics of carbon stock over time under the project scenario is given in Section 5.4.

Map 20. Peat carbon stock in the project scenario at t = 100



Step 3. All areas that show a positive peat carbon stock difference between the baseline and project scenarios at t=100 were delineated as the area eligible for crediting (see Map 21). Such differences were estimated using the following equations (7) – (11):

$$C_{WPS-BSL,t100} = \sum_{i=0}^{M_{WPS}} \left(C_{WPS,i,t100} \times A_{WPS,i}\right) - \sum_{i=0}^{M_{BSL}} \left(C_{BSL,i,t100} \times A_{BSL,i}\right) \quad (7)$$

$$C_{WPS,i,t100} = Depth_{peat\text{-}WPS,i,\,t100} \times C_{vol\_lower,WPS} \times 10 \quad (8)$$

$$C_{BSL,i,t100} = Depth_{peat\text{-}BSL,i,\,t100} \times C_{vol\_lower,BSL} \times 10 \quad (9)$$

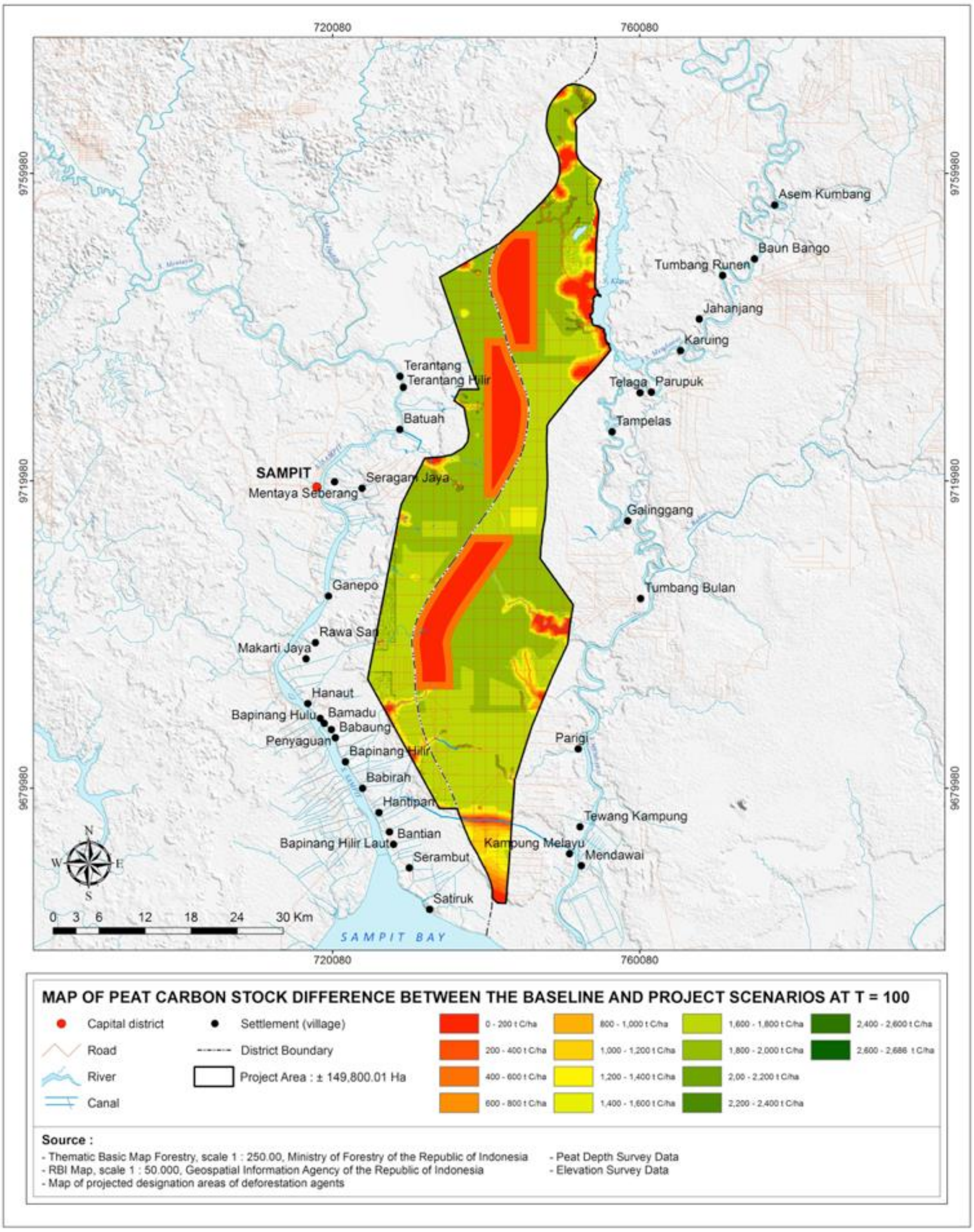
$$Depth_{peat-BSL,i,t100} = Depth_{peat-BSL,1,t0} - Sub_{initial-BSL,i} - \sum_{t=1}^{t=100} Rate_{peatloss-BSL,i,t} \quad (10)$$

$$Depth_{peat-WPS,i,t100} = Depth_{peat-WPS,1,t0} - \sum_{t=1}^{t=100} Rate_{peatloss-WPS,i,t} \quad (11)$$

Where:

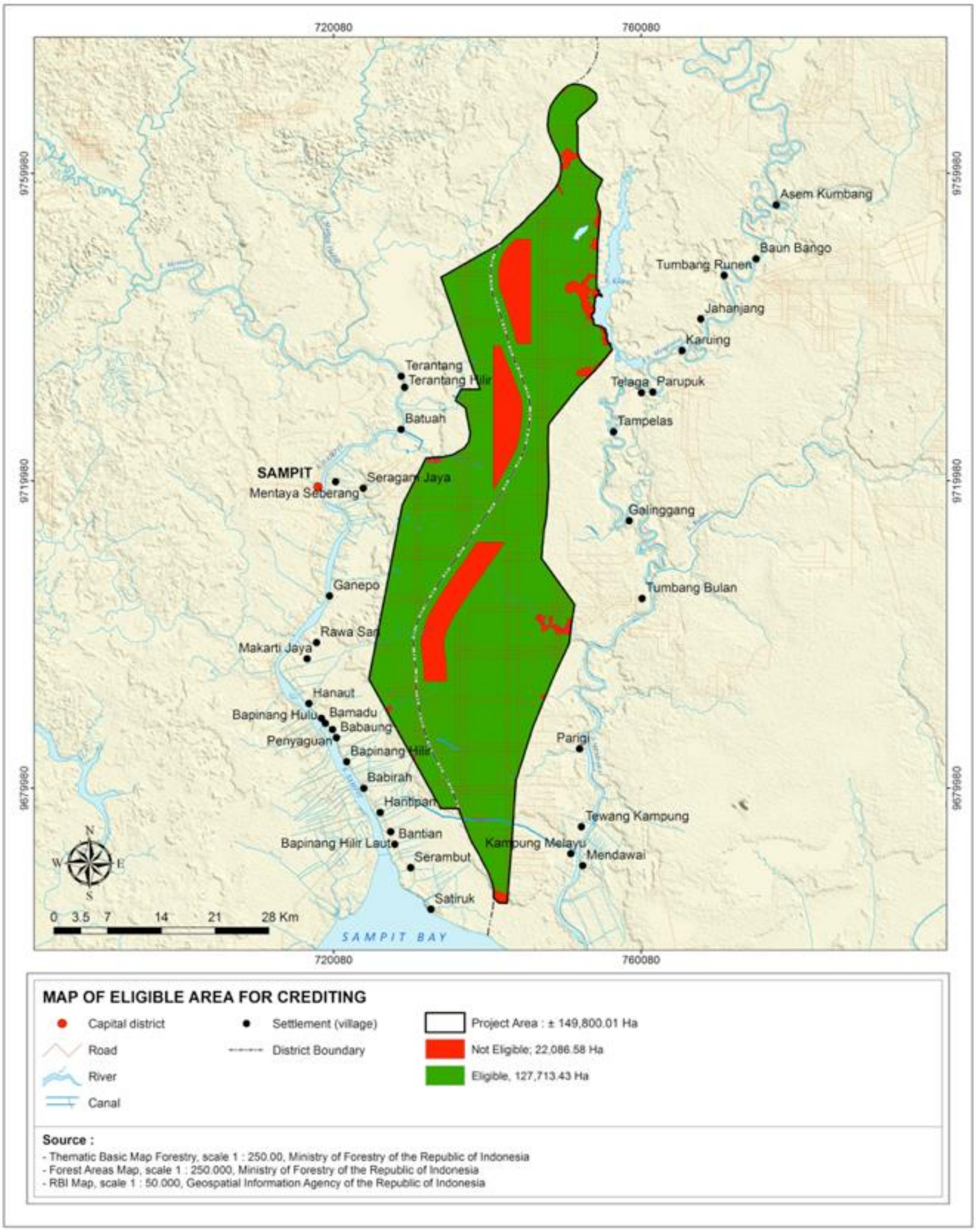
$C_{WPS\text{-}BSL,i,t100}$	Difference between peat carbon stock in the project scenario and baseline scenario in peat depth stratum *i* at *t*=100 (t C ha^{-1})
$C_{WPS,i,t100}$	Peat carbon stock in the project scenario in peat depth stratum *i* at *t*=100 (t C ha^{-1})
$C_{BSL,i,t100}$	Peat carbon stock in the baseline scenario in peat depth stratum *i* at *t*=100 (t C ha^{-1})
$A_{WPS,i}$	Area of project stratum *i* (ha)
$A_{BSL,i}$	Area of baseline stratum *i* (ha)
$Depth_{peat\text{-}BSL,i,t100}$	Average peat depth in the baseline scenario in stratum *i* at *t*=100 (m)
$Depth_{peat\text{-}WPS,i,t100}$	Average peat depth in the project scenario in stratum *i* at *t*=100 (m)
$Depth_{peat\text{-}BSL,i,t0}$	Average peat depth in the baseline scenario in stratum *i* at project start (m)
$Depth_{peat\text{-}WPS,i,t0}$	Average peat depth in the project scenario in stratum *i* at project start (m)
$Sub_{initial\text{-}BSL,i}$	Subsidence in the initial years after drainage in stratum *i*, deemed 0 for RDP projects (m)
$Rate_{peatloss\text{-}BSL,i,t}$	Rate of peat loss due to subsidence and fire in the baseline scenario in stratum *i* in year *t*; a conservative (high) value may be applied that remains constant over time; Subsidence in the initial years after drainage is not included in this rate (m yr^{-1})
$Rate_{peatloss\text{-}WPS,i,t}$	Rate of peat loss due to subsidence and fire in the project scenario in stratum *i* in year *t*; alternatively, a conservative (low) value may be applied that remains constant over time (m yr^{-1})
$C_{vol\_lower,WPS}$	Volumetric carbon content of the peat below the water table in the project scenario; in case of RDP projects, this is the same as $C_{vol\_lower,BSL}$ (kg C m^{-3})
$C_{vol\_lower,BSL}$	Volumetric carbon content of the peat below the water table in the baseline scenario (kg C m^{-3})
t_{100}	100 years since project start
10	Conversion from kg m^{-2} to t ha^{-1}

Map 21. Carbon stock difference between the baseline and project scenarios at t = 100



Based on the spatial analysis, **the area eligible for crediting from WRC activities is 127,713 ha or 85.3%**. Furthermore, as Sub-subsection 4.4.1.3 describes, the PDT over 125,951 ha (84%) of the project area is expected to exceed the maximum project crediting period of 60 years. For the rest of the project area, the approximate years in which the peat layers would be depleted (i.e., eligible period for crediting) were determined (see Table 19 and Map 15), and beyond these years, no accounting will be carried out. Map 22 indicates the WRC eligible area within the project area, and Table 23 is the summary of the area.

Map 22. Area eligible for crediting for WRC project activities



For the project scenario, few parts the project area will be affected by the drainage located outside the project area. Buffer zone agreements with the surrounding stakeholders have been established to ensure that drainage outside the project area would not cause significant hydrological impacts inside the project area or the area eligible for crediting. The effectiveness of these agreements will be monitored by the project.

Table 23. Summary of the area eligible for crediting from WRC activities

Description	Area (hectares)	Area (percent)
Project area	**149,800**	**100**
Peatland area within the project boundary	**146,638**	**97.9**
Area eligible for crediting	**127,713**	**85.3**
Area not eligible for crediting	**22,087**	**14.7**

4.4.2 Temporal boundary (G1.9, CL1)

The temporal boundaries of the Katingan Project are as follows.

- Historical reference period: August 22, 2000 to October 31, 2010
- Project crediting period: November 1, 2010 to October 31, 2070 (60 years)
- Baseline update period: Every 10 years

4.4.3 Carbon pools

4.4.3.1 Carbon pools included in the project

Table 24 describes carbon pools included in the Katingan Project.

Table 24. Summary of carbon pools

Carbon pool	In/excluded	Justifcation
Aboveground tree biomass	Included	Mandatory pool in ARR and REDD project activities
Aboveground non-tree biomass	Excluded	Non-tree biomass carbon pool is expected to increase in the project scenario compared to the baseline, and therefore can be conservatively omitted.
Belowground biomass	Excluded (as accounted for in the peat component below)	Belowground biomass is not distinguished from the soil pool in WRC procedures.
Litter on mineral soil	Excluded	It is conservatively excluded. However, litter carbon pools and their stock changes may be monitored in the future.
Litter on peatland	Excluded	This pool is not mandatory for peatland. As the litter carbon pool is expected to increase in the project scenario compared to the baseline, it is therefore conservatively omitted.
Dead wood	Excluded	This pool is not mandatory for either mineral soil or peatland. As the dead wood carbon pool is expected to increase in the project scenario compared to the baseline, it is therefore conservatively omitted.
Mineral soil carbon pool	Excluded	Carbon stock in this pool is expected to increase more or decrease less due to the implementation of project activities relative to the baseline, and thus conservatibevely omitted.
Peat carbon pool	Included	Carbon stock in this pool is expected to increase in the project scenario compared to the baseline.
Wood products	Excluded	This pool is mandatory only where the process of deforestation involves timber harvesting for commercial markets.

4.4.3.2 Carbon pool significance

No significance tests were necessary since, as described in the above Sub-subsection 4.4.3.1, all carbon pools not included in the baseline and project scenario have been shown either to increase more or decrease less in the project relative to the baseline scenario, or been conservatively excluded. All mandatory pools have been included and all sources of GHG emissions have either been included or conservatively excluded.

4.4.4 Sources of GHG emissions

Table 25, Table 26 and Table 27 describe sources of GHG emissions included in the Katingan Project.

Table 25. GHG sources included in the REDD project boundary

	Source	Gas	Included?	Justification/explanation
Baseline scenario	Deforestation	CO_2	Yes	Aboveground biomass losses as a result of deforestation are included
	Biomass burning	CO_2	No	Aboveground biomass losses as a result of fire are conservatively assumed zero
		CH_4	No	Aboveground biomass losses as a result of fire are conservatively assumed zero
		N_2O	No	Above ground biomass losses as a result of fire are conservatively assumed zero
	Combustion of fossil fuels	CO_2	No	Conservatively omitted.
		CH_4	No	Conservatively omitted.
		N_2O	No	Conservatively omitted.
	Use of fertilisers	CO_2	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore, it is conservatively omitted.
		CH_4	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore, conservatively omitted.
		N_2O	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore, it is conservatively omitted.
Project scenario	Biomass burning	CO_2	No	Per VM0007 REDD-MF, CO_2 emissions are excluded but carbon stock decreases due to biomass burning are accounted for as carbon stock changes.
		CH_4	Yes	If burning occurs in the project scenario it will be accounted for. IPCC combustion factors for CH4 will be used.
		N_2O	Yes	If burning occurs in the project scenario it will be accounted for. IPCC combustion factors for N2O will be used.
	Deforestation	CO_2	Yes	If deforestation occurs in the project scenario, it will be accounted for. Values will be calculated using deforestation emission factors.
	Forest degradation	CO_2	Yes	If forest degradation occurs in the project scenario, it will be accounted for. Values will be calculated using forest degradation emission factors.
	Combustion of fossil fuels	CO_2	No	Can be neglected if excluded from baseline accounting.
		CH4	No	Can be neglected if excluded from baseline accounting.
		N_2O	No	Can be neglected if excluded from baseline accounting.
	Use of fertilisers	CO_2	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore it is conservatively being omitted.
		CH_4	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore it is conservatively being omitted.
		N_2O	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore it is conservatively being omitted.

Table 26. GHG sources included in the ARR project boundary

Source		Gas	Included?	Justification/explanation
Baseline scenario	Burning of woody biomass	CO_2	No	Above ground biomass losses as a result of fire are assumed zero.
		CH_4	No	Above ground biomass losses as a result of fire are assumed zero.
		N_2O	No	Above ground biomass losses as a result of fire are assumed zero.
Project scenario	Burning of woody biomass	CO_2	No	Per REDD-MF, CO_2 emissions are excluded but carbon stock decreases due to burning are accounted as a carbon stock change.
		CH_4	Yes	If burning occurs in the project scenario it will be accounted for. IPCC combustion factors for CH4 will be used.
		N_2O	Yes	If burning occurs in the project scenario, it will be accounted for. IPCC combustion factors for N2O will be used.

Table 27. GHG sources included in the WRC project boundary

Source		Gas	Included?	Justification/explanation
Baseline / Project scenario	Microbial decomposition	CO_2	Yes	Initially TIER 1 methods (IPCC defaults) will be used for the baseline and project to estimate emissions, later in the project measurements will be performed to develop site-specific emission models, and if needed, in the reference regions for the baseline.
		CH_4	Yes	Required unless *de minimis* or conservatively omitted. In this project TIER 1 (IPCC defaults) will be used to estimate CH4 emissions in the baseline and project.
		N_2O	No	Excluded as per applicability condition in module BL-PEAT
	Water bodies	CO_2	Yes	Water bodies comprise about 5% of the drained peatland landscape. DOC values for 'drained' and 'undrained' peatlands (IPCC) are used to calculate the differences in carbon losses between baseline and project. These carbon losses will be expressed in CO2-equivalents, and conservatively assumed that all dissolved organic carbon (DOC) will be lost as CO2.
		CH_4	No	It will be conservatively assumed that all dissolved organic carbon (DOC) will be lost as CO2 and that no CH4 is being released. Over the long-term, the project will develop a site-specific model to quantify emissions from water bodies based on site specific measurements performed.
		N_2O	No	Conservatively omitted.
	Peat combustion	CO_2	Yes	Procedures provided in module E-BPB using IPCC combustion factors for both baseline and project scenario. If peat combustion occurs in the project scenario it will be accounted for.
		CH_4	Yes	Procedures provided in module E-BPB, using IPCC combustion factors for both baseline and project scenario. If peat combustion occurs in the project scenario it will be accounted for.

Source		Gas	Included?	Justification/explanation
		N_2O	Yes	Procedures provided in module E-BPB, using IPCC combustion factors for both baseline and project scenario. If peat combustion occurs in the project scenario it will be accounted for.
	Combustion of fossil fuels	CO_2	No	Can be neglected if excluded from baseline accounting.
		CH_4	No	Potential emissions are negligible.
		N_2O	No	Potential emissions are negligible.
	Fertiliser application	CO_2	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore, it is cconservatively omitted.
		CH_4	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore, it is cconservatively omitted.
		N_2O	No	Fertiliser application is higher in the baseline scenario compared to the project scenario. Therefore, it is cconservatively omitted.

4.5 Baseline Scenario and Additionality (G2.1, G2.2)

This section identifies the project's baseline and demonstrates the project's additionality using the "combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities: Version 1" [17]. Following this, the project passes preliminary screening ('Step 0').

4.5.1 Justification of baseline scenario and additionality

4.5.1.1 Alternative land use scenarios to the proposed project activity

Sub-step 1a. Identify credible alternative land use scenarios to the proposed project activity

The range of realistic and credible alternative land use scenarios that would have occurred on the land within the project boundary in the absence of the project are shown in Table 28. These seven scenarios were derived from the analysis of current land use across the lowlands peatlands of Central Kalimantan together with an analysis of land use trends within other similar regions of Indonesia; in particular the lowland peatlands of Sumatra which along with southern Borneo represents the two largest tracts of lowland peatland in Indonesia.

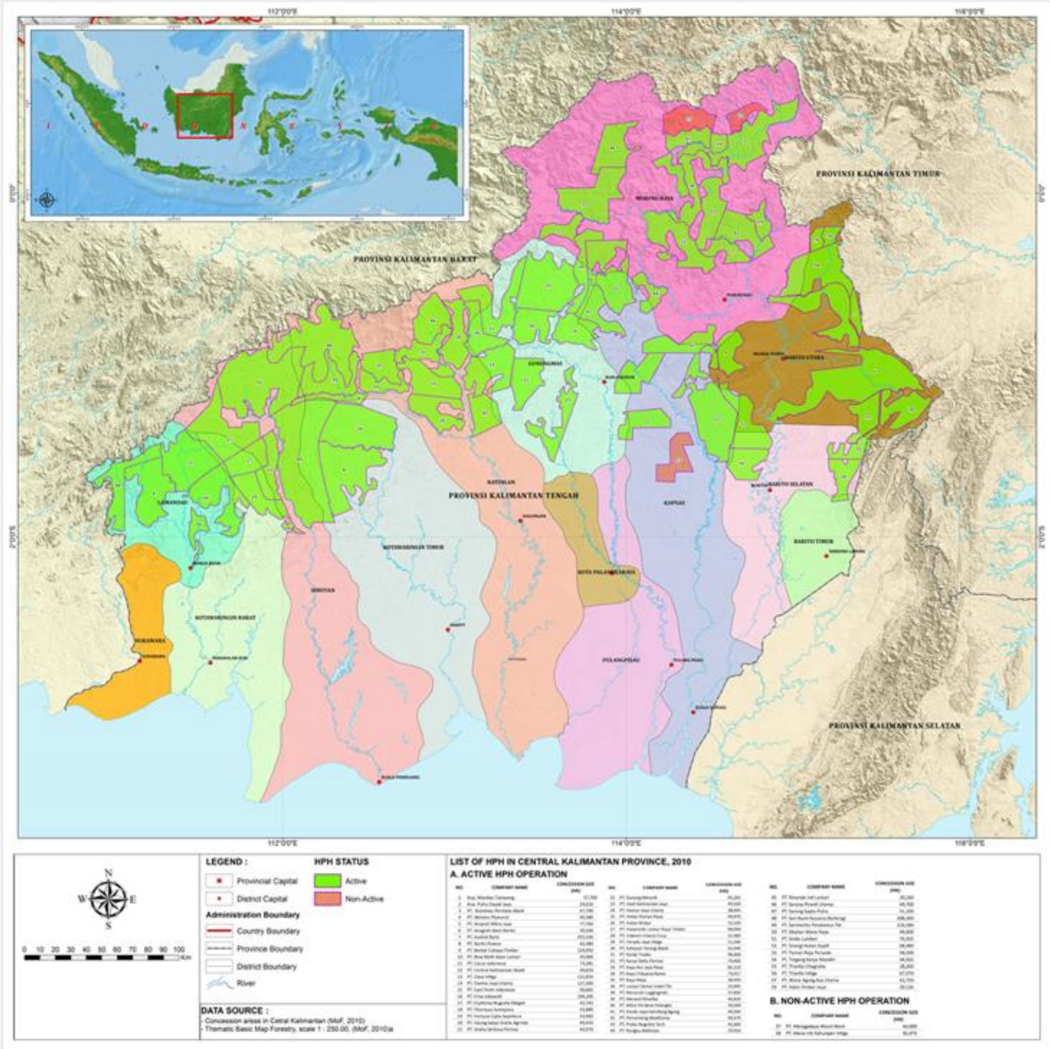
Table 28. Description of the major alternative land use scenarios for the project area

Land use scenario	Description
Industrial acacia plantation	Fast growing *Acacia crassicarpa* is among the most common industrial land uses of lowland peatlands in Indonesia [18]. Grown in 5-6 year fast rotations, the harvested wood is used for paper and pulp wood products. Commercial growing requires continuous drainage of the peat to below 70cm depth [19]. The area of industrial acacia plantation has grown rapidly in Indonesia over the past decade and further development is targeted in Ministry of Forestry development plans: from 10 million ha in 2010, to 13 million ha in 2014 [20]. Acacia plantations have already been established in peat forest areas of Central Kalimantan to the east of the project site in Pulang Pisau and Gunung Mas districts and to the West in Kubu Raya district of West Kalimantan, while applications for establishment have been lodged in many other nearby areas, including the project area itself (see below). The rapid expansion of industrial acacia plantations across Indonesia has already led to drainage and conversion of vast areas of peatland forest, providing a vision of the future for the project region.

Land use scenario	Description
Industrial oil palm plantation	Oil palm is also one of the most common non-forest commodity industrial land uses of lowland peatlands in Indonesia [21], despite the fact that peat soils are not ideal for its cultivation [13]. Grown in 25-35 year rotations, and commercially harvestable after 4-5 years, oil palm's fruit is processed to produce oil. Commercial growing requires continuous drainage of the peat to below 70cm depth [13]. The area of oil palm plantations in Indonesia has increased dramatically over the past decade [22], including in Central Kalimantan, although almost exclusively in areas legally outside of the forest estate (designated as *APL* or Other Land Utilization) or within the forest estate in areas ear-marked for conversion (designated *HPK* or Conversion Forest), these legal land use distinctions are expanded upon in the next section. Currently there are two pending oil palm plantation applications adjacent to the east of project area, including areas of forested peatland.
Forest *with* commercial logging	Much of the forested peatlands of Central Kalimantan were commercially logged in the 70's, 80's and 90's using selective cutting approach, including the majority of the project area (see below). However, none of the production forest on peatland in Central Kalimantan is subject to active commercial logging today. Historically activities were generally conducted on a large scale utilizing rail haulage systems to remove timber, rather than canals. At that time concession holding companies were not required to implement long-term management of the areas, and so following the initial harvest of the most commercially valuable trees, the operations were all closed. A resumption of commercial logging within production forest areas remains a legal possibility, albeit it an unlikely practice now, due to the low remaining timber potential within allowable diameter size. Most commercial logging operations in Central Kalimantan have now moved to the non-peat areas in the north of the province where primary forests still exist (see Map 23), while in the south the commercial focus has switched to conversion to plantations.
Unprotected Forest (status quo)	Unexploited and unprotected forests exist in Indonesia, but generally only as a transitional state; existing only between phases of commercial or local exploitation (see above and below). Neglected, unprotected forest areas tend to become rapidly degraded, which in turn reinforces the neglect. They rapidly lose all commercial value from standing timber and so become targeted for conversion. This progression can clearly be seen in the adjacent district of Pulang Pisau.
Protected Forest	Forest can be deliberately retained through the creation of a protected area. Over the past 10-20 years in Central Kalimantan, a number of former logging concession areas have been converted to protection forest, including Sebangau National Park and a number of areas of Watershed Protection forest (*Hutan Lindung*). The possibility of protection without exploitation is considered in more detail below.
Smallholder agriculture	Smallholder-managed agricultural land only occupies around 10% of the peatland area of Central Kalimantan, and only 3% of the districts in which the project lies [23] [24]. This figure is low relative to other parts of Indonesia due to the generally low population density and the unsuitability of peat soils for agriculture without drainage. Currently none of the project area is subject to smallholder agriculture, although it does exist within the wider project zone (see Sub-section 1.3.2). It typically exists closer to the rivers and villages where sand ridges allow more productive agriculture, including a variety of tree and non-tree crops, including rubber, cassava, pineapple, rice and oil palm (see Annex 2). Smallholder agriculture is not considered a likely land use for the project area, however it is considered here due to its prevalence in Indonesia generally.
Mining	To the north of the project area, open-cast and strip mining is a common land use. Such mining targets both gold and zircon. It is considered here due to its existence

Land use scenario	Description
	in the wider landscape, however it is not considered a likely land use for the project area as it exists almost entirely on non-peat areas and mostly operates illegally (see below).

Map 23. Active commercial logging concessions (HPH) in Central Kalimantan as of 2010



In addition to these seven major land use scenarios, a number or smaller or minority land use were also considered, including, infrastructure development and industrial aquaculture. However all were considered to either lack sufficient credibility or precedence to be included in this analysis.

Sub-step 1b. Consistency of credible alternative land use scenarios with enforced mandatory applicable laws and regulations

The seven major land use scenarios identified under Sub-step 1a were next considered in the context of mandatory laws and regulations in Indonesia. The key consideration in this analysis is the legal designation of the project area as 100% 'Production Forest' or '*Hutan Produksi*' (see Sub-section 1.3.2). The results of this analysis are shown in Table 29.

Table 29. Consistency of alternative land use scenarios with laws and regulations

Land use scenario	Legality
Industrial acacia plantation	This land use scenario is legally permissible, as regulated principally by the Forestry Laws No. 41/1999, 19/2004 and later by Ministry of Forestry decree No. 31/2014 and supporting regulations.
Industrial oil palm plantation	This land use is *not* legally permissible. Oil palm cannot legally be established on land designated as production forest. It can only be established legally by first excising the area from the forest estate as regulated under Government Decree PP No. 60/2012. However, this is only possible in forest areas designated as *Conversion Production Forest* (*Hutan Produksi Konversi* or HPK). As can be seen from the map of the project area (see Map 3), the area does not include any forest areas designated as HPK, as a result the scenario of commercial conversion to oil palm is not considered a legally viable scenario.
Forest *with* commercial logging	This form of land use is legally permissible, as regulated principally by the Forestry Laws No. 41/1999 and No. 19/2004, and later by Ministry of Forestry decree No. 31/2014 and supporting regulations.
Unprotected Forest	Legally, a number of routes exist by which the site could remain to be unexploited forest. The first is simply neglect: the area could remain designated as production forest but not be subject to any license application for logging or conversion. Secondly, the site could be subject to an application for management as an ecosystem restoration concession, a form of logging concession permissible on production forest land as regulated and later by Ministry of Forestry decree No. 31/2014.
Protected Forest	Forest land could be legally converted to some form of protection or conservation forest. This is a complex process, governed and regulated by a range of laws (see below).
Smallholder agriculture	As production forest, the project area is not legally permissible for conversion to smallholder agriculture (based on the same legal regulations referenced above). Despite this, however, neglected forest land (which is not subject to an active concession licence or commercial exploitation) is often targeted by smallholders. If no commercial licence is issued, such smallholders can attempt to claim a title to the occupied land via a number of legal routes. These are considered in more detail below.
Mining	Mining is not legally permissible within the project area without an appropriate licence. Such licences are governed by a complex set of laws that restrict the area that can be mined and which outline the compensation arrangements which must be paid to the concession holder (if there is one) and the state. Such licences are only granted to legally registered mining companies. The bulk of the mining activity to the north of the project area is small-scale, unregistered and probably illegal. As with smallholder agriculture, this may be tacitly permitted within neglected forest areas, and so is retained here for further consideration.

In conclusion, we reject industrial oil palm plantation as a credible alternative land use scenario as it is not legally permissible. Of those scenarios retained, smallholder agriculture and mining are retained despite their illegality, as both remain commonplace across much of Indonesia and so merit further consideration.

4.5.1.2 Barrier analysis

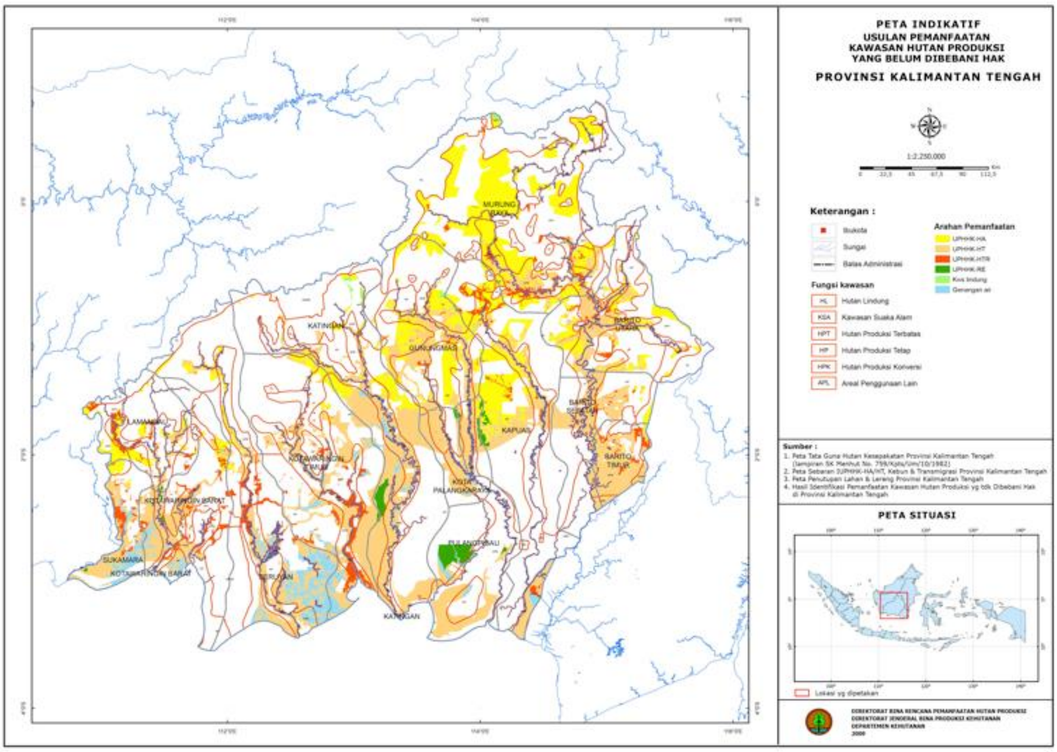
Sub-step 2a. Identification of barriers that would prevent the implementation of at least one alternative land use scenarios

In this section, we consider each of the six remaining scenarios in turn with respect to barriers that would prevent realization of that scenario (following the listed barriers in A/R CDM project activities: Version 1" [17]. The results of this analysis are shown in Table 30.

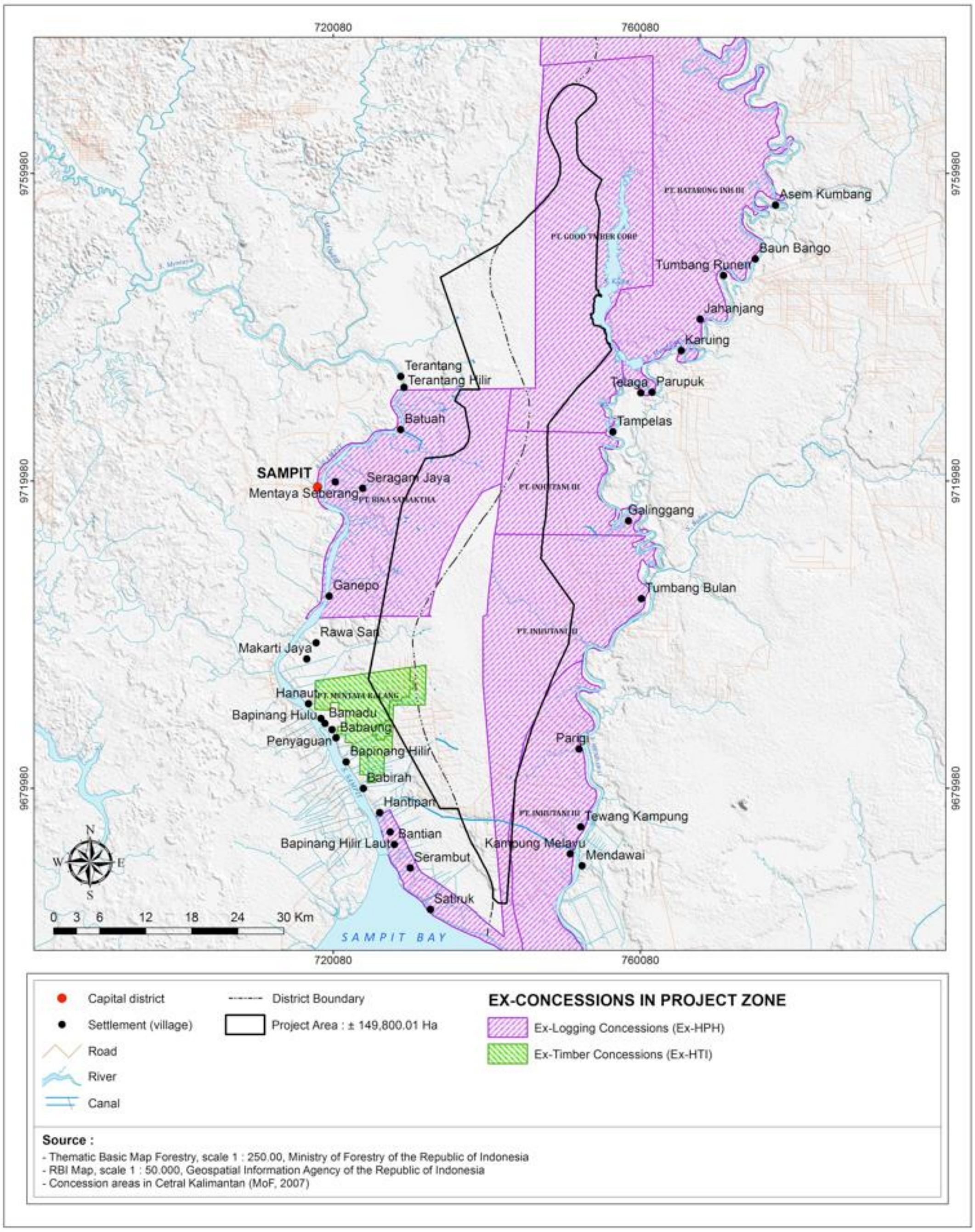
Table 30. Identification of barriers that would prevent the implementation of each scenario

Land use scenario	Barriers
Industrial acacia plantation	There are no barriers for this land use. At the time of the project's initiation, the area was both legally eligible for plantation establishment, and designated as such in the Ministry of Forestry's indicative maps (which indicate areas targeted for different uses, akin to development plans; see Map 24). Furthermore, in 2008, an application for the establishment of a 50,000-ha acacia plantation within the project area was filed by PT. Natural Wood Kencana with the Ministry of Forestry (i.e., Letter No. 04/TOR/CEO/X/2008 dated October 23, 2008).
Forest *with* commercial logging	The principal barriers are both ecological and economic, and result from the paucity of commercial-sized timber due to the majority of the site having been logged between 1970-2002 based on licences issued in the 70's. At this time, most of the peatlands in southern Central Kalimantan were also logged, and subsequent to that period there has been no resumption of commercial logging in any of these peatland areas. In addition to the lack of high value commercial timber, the economics of commercial logging have changed. When first logged, tax collecting regimes were far more lax, allowing companies to operate more marginal sites profitably, labour was cheaper (and labour laws were more lax). Timber prices were high and markets very open. High value export markets are now difficult to access without accreditation, and this would be very difficult to obtain on a site-based on peat soils.
Unprotected Forest	Without the prospect of revenue from carbon offset sales, there exist numerous barriers to the forest remaining intact, principally economic and institutional, but also related to prevailing practice and local traditions of exploitation. The land is *politically* as well as *legally* designated for production. *De facto* protection through neglect (or through deliberately refusing to issue any licences) is not tenable as the area would generate no revenues, either to state coffers or to local communities. The experience across Kalimantan, and indeed across Indonesia, is that unprotected forest does not often remain intact for long.
Protected Forest	As described above, legal conversion of the land status to become fully protected would not generate political support locally, as this would place an additional financial management burden and obligation on the local government while adding no additional state revenue.
Smallholder Agriculture	Barriers exist to prevent the expansion of smallholder agriculture in the project area. These include physical barriers such as the general unsuitability of peat soils for growing crops (which accounts for the very low levels of smallholder agriculture within peat areas of Central Kalimantan generally), but principally the fact that the expansion of smallholder agriculture with areas designated as production forest relies almost entirely on legal neglect of such areas. As no barriers exist to prevent the establishment of commercial plantations on the project area the possibility of an expansion of smallholder agriculture is negated.
Mining	The main barrier to the expansion of mining within the project area is the lack of suitable mineral deposits and the peat overburden. These combine to render the vast majority of the site, with the small exception of some marginal areas in the north, unsuitable for mining. This is confirmed by absence of any commercial mining exploitation permits for the area. In addition, as above, any expansion of small-scale mining relies on legal neglect of the project area, which is not considered a likely scenario.

Map 24. Ministry of Forestry indicative map 2009



Map 25. Logging concessions previously existing in the project zone



In conclusion, significant barriers prevent the realization of all but a single credible land use scenario: industrial acacia plantation.

4.5.1.3 Investment analysis

Because a single credible land use scenario was identified through the analytical steps above, a detailed investment analysis is not required by the A/R CDM additionality tool [17]. However, as part of the analytical preparation for the project, such an analysis was independently commissioned and is available to download [25]. This study supported the identification of Industrial acacia plantation as being the most profitable and likely land use on areas legally classified as production forest, while conversion to oil palm would be the most profitable land use within areas designated as conversion forest within the wider project zone.

4.5.1.4 Common practice analysis

Maintenance of intact forest on land designated for production is not common practice in Indonesia. Outside of legally designated protected areas, and without the prospect of revenues from carbon finance, few examples exist. Those that do tend to be small projects backed by stable philanthropic donors, and even in these cases, the projects often lead to conflict with local government or communities as the areas are perceived as making no financial contribution to local coffers, despite being designated for production. Other examples include offset projects whereby large corporates are paying management costs of the site as reparations for areas damaged as part of their operations elsewhere. These are rare and typically very small in extent.

4.5.1.5 Conclusion

The project is considered additional, with the most likely and plausible business-as-usual scenario being conversion to **industrial acacia plantation**.

4.5.2 Description of acacia plantations as the baseline scenario

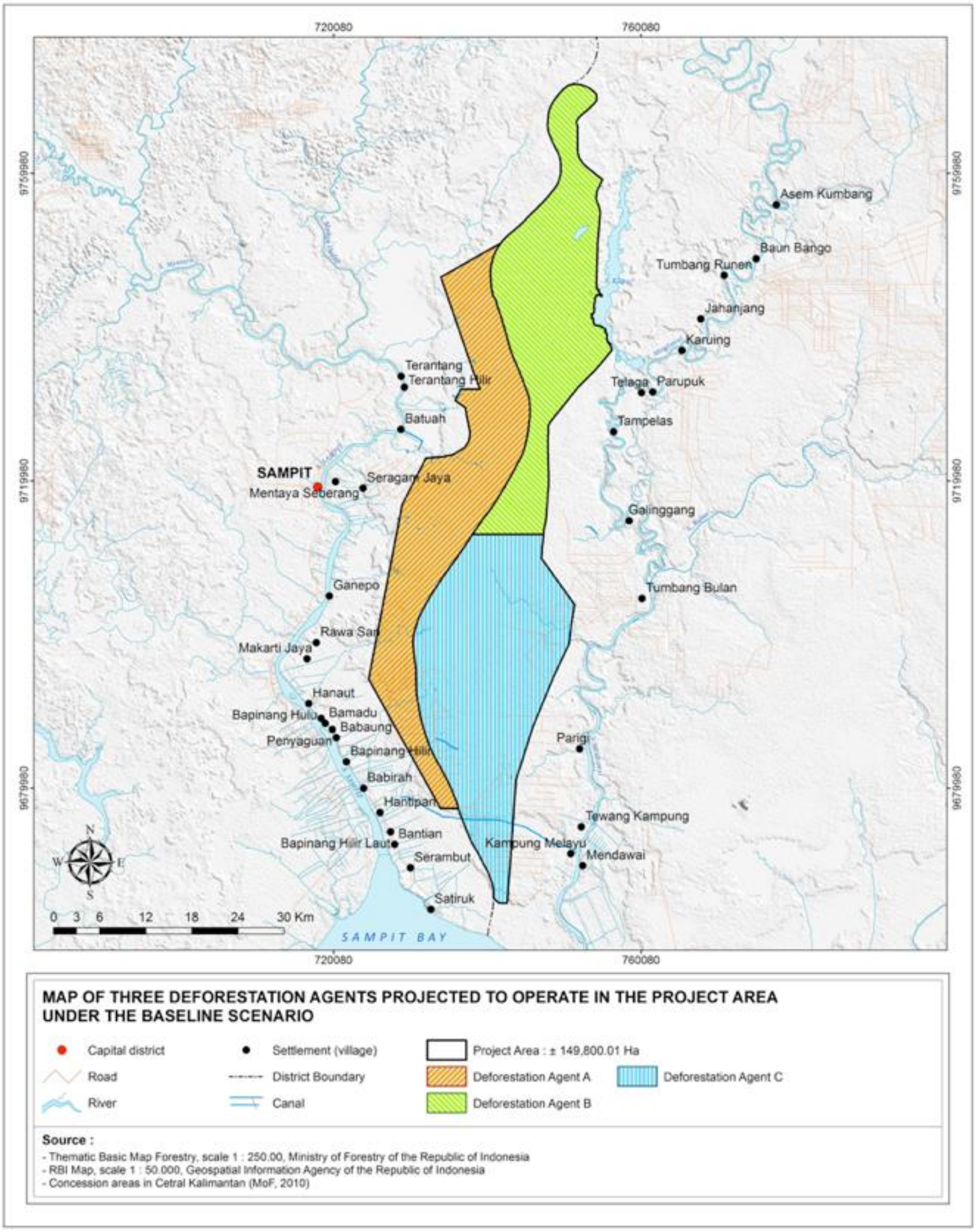
Historical data on industrial acacia plantation concessions [26] exhibit a pattern in the period of 2000 to 2010 of vast areas of peatlands (peatdomes) being split up and licensed to a range of companies producing similar commodities and each managing an area on average <70,000 ha. This pattern can be clearly observed in Kampar Peninsula in Riau Province and Merang in South Sumatra where three or more plantation companies have been operating on the same peat dome. Given this pattern, and the size of the project area, it is reasonable to suggest that in the absence of the project the project area woud have been granted to and managed as industrial acacia plantations by a total of three companies (designated here as deforestation agents A, B and C).

In 2008, PT. Natural Wood Kencana (deforestation agent A) applied for an industrial acacia plantation concession in the project area covering 50,000ha. Without the Katingan Project, this company would have successfully obtained the concession in 2010. Given the fact that the area was zoned for plantation establishment and that pulp and paper industry was on the rise, additional operators would have applied for concessions in the adjacent areas within the project area. Two additional agents (B and C) were therefore projected to apply for concessions in 2010, receive reservation letters in 2011 and eventually obtain the concessions in 2012. A spatial analysis based on the administrative territory and the location of previous logging concessions in the project area, these three companies were assumed to have received licenses for 47,309 ha, 44,837 ha and 57,654 ha within the project area, respectively (see Map 26 and Table 31).

Table 31. Summary of the concessions granted to the projected deforestation agents

Deforestation agent	Area (Ha)	District	License year
Agent A	47,308.62	Kotawaringin Timur	2010
Agent B	44,837.19	Katingan	2012
Agent C	57,654.20	Katingan	2012
TOTAL	149,800.01		

Map 26. Three deforestation agents projected to operate in the project area under the baseline scenario



According to the national regulation, Minister's decree No. 70/1999, deforestation agents are mandated to set aside certain areas of concession sites into the following five different land use purposes: 1) Plantation area, 2) Protected area, 3) Native tree area, 4) Community buffer area, and 5) Infrastructural development area. In line with the regulations, these designations should be based on the existance of communities, previous concession boundary in the same area, and natural and administrative borders, and are projected in Map 27 and Table 32 below. Regulations state that land designated as protected areas must prioritize intact forest situated far away from the community land. In the Sections 5.3 and 5.4, 'community buffer area' is further referred to as 'community crop area', 'protected forest' is referred to as 'conservation forest', 'native tree species area' is included in the 'forest' and 'river buffer' categories, and infrastructure is referred to as 'canals and ground facilities such as yards, stations, nursery, roads and other 'bare' land' or 'non-vegetated land' used for infrastructure.

Map 27. The projected land use within the concession areas of the deforestation agents

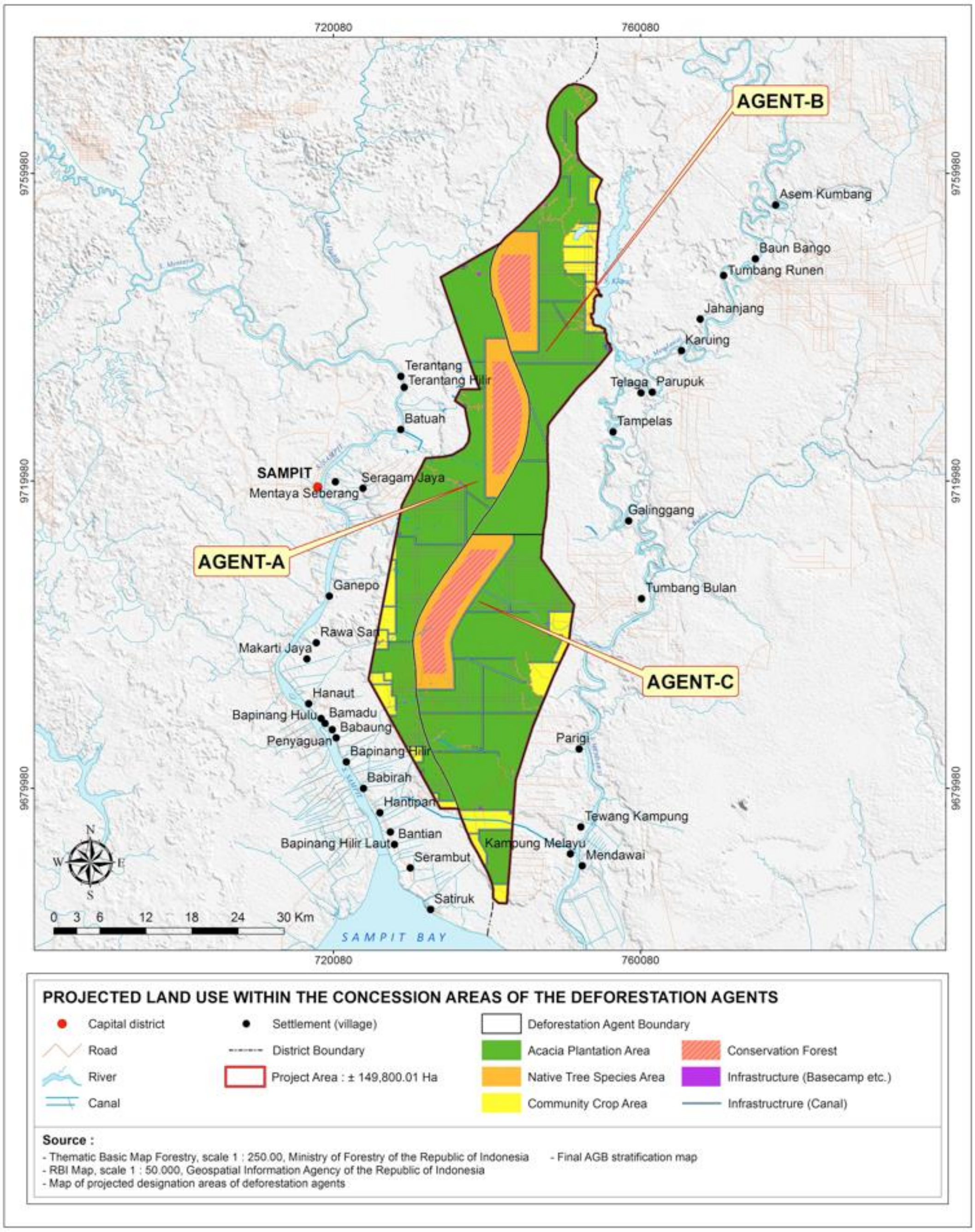


Table 32. Projected land use within the concession areas of the deforestation agents

Land use	Agent A (ha)	Agent B (ha)	Agent C (ha)	Total (ha)	%
Acacia plantation area	32,950.58	30,965.14	39,799.82	103,715.55	69.24%
Native tree species area	4,789.20	4,505.47	5,803.52	15,098.19	10.08%
Community crop area'	3,566.79	3,799.06	4,842.25	12,208.10	8.15%
Conservation forest	4,787.91	4,529.49	5,928.45	15,245.85	10.18%
Infrastructure	1,214.13	1,038.03	1,280.16	3,532.32	2.36%
TOTAL	47,308.62	44,837.19	57,654.20	149,800.01	100%

4.5.3 Estimated impacts of the baseline scenario on communities and biodiversity

Predicted impacts of the selected baseline on community and biodiversity objectives are described below in Chapters 6 and 7 respectively.

5 QUANTIFICATON OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Project Scale and Estimated GHG Emission Reductions or Removals (CL2.2)

Estimated GHG emission reductions and removals are shown below. The project is categorized as a large project.

Project	No
Large project	Yes

Years	Estimated GHG emission reductions or removals (tCO2e)
2011	1,404,330
2012	1,398,752
2013	3,950,285
2014	4,037,205
2015	4,424,832
2016	4,640,182
2017	5,239,509
2018	5,515,287
2019	5,892,227
2020	6,219,617
2021	6,666,469
2022	6,823,628
2023	7,275,262
2024	7,462,232
2025	7,896,374
2026	8,094,746
2027	8,509,039
2028	8,727,679
2029	9,285,238
2030	9,423,876
2031	9,096,606
2032	9,425,608
2033	8,351,267
2034	8,300,658
2035	8,258,380
2036	8,259,888
2037	8,254,357
2038	8,208,700
2039	8,233,633
2040	8,196,342
2041	8,226,215
2042	8,149,872
2043	8,132,722
2044	8,155,212
2045	8,100,459
2046	8,097,548
2047	8,114,120

Years	Estimated GHG emission reductions or removals (tCO2e)
2048	8,112,153
2049	8,079,863
2050	8,080,873
2051	8,037,521
2052	8,046,742
2053	8,029,369
2054	8,017,338
2055	7,978,032
2056	7,973,987
2057	7,974,344
2058	7,943,670
2059	7,923,838
2060	7,911,214
2061	7,909,534
2062	7,895,543
2063	7,903,288
2064	7,882,187
2065	7,846,179
2066	7,878,557
2067	7,842,378
2068	7,806,442
2069	7,823,664
2070	7,765,710
Total estimated ERs	**447,110,780**
Total number of crediting years	60
Average annual ERs	**7,451,846**

5.2 Leakage Management (CL3.2)

The project will take steps to proactively reduce and/or remove the threat of leakage, in particular the threat of leakage from the displacement of planned deforestation activities (see Section 5.5). Since 2007, the Katingan Project and its partners (in particular Wetlands International, working in collaboration with other NGOs such as Greenpeace, WWF, Rainforest Action Network, WALHI and Sawit Watch) have been proactively engaging the government of Indonesia, as well as key industry players, to drive systemic change in industrial land-use for oil palm and acacia plantations across the country and to stop to expansion of plantations in peatlands. For further details of leakage and leakage management see Section 5.5 below.

5.3 Baseline Emissions (CL1)

This section describes baseline emissions based on the VCS methodology VM0007 REDD+ MF and its modules BL-PL, BL-ARR, AR ACM 003, and BL-PEAT.

5.3.1 General procedures and assumptions

Baseline emissions and changes in baseline emissions and carbon stocks were determined based on analyses of the most likely baseline scenario as described in Sub-section 5.3.2.

Emissions that are accounted result from:

- Above ground biomass stock changes due to conversion to plantations
- Peat microbial decompositions
- Peat burning
- Dissolved Organic Carbon from Water bodies

It is assumed that no non-human induced rewetting (e.g. collapse of dikes or canals that would have naturally closed over time, progressive subsidence leading to raising relative water table depths, increasingly thinner aerobic layers and reduced CO_2 emission rates) will occur in the baseline scenario. For peatland areas that were abandoned before the project started, this assumption was based on expert judgment taking account of verifiable local experience and/or studies and/or scientific literature in a conservative way.

It is assumed that the baseline agents perform regular maintenance of canals for drainage and transportation purposes. Due to limitations of available information on volume and frequency of dredging of the baseline agents, emissions from dredging (emissions from peat exposed to aerobic decomposition by spreading or piling following the establishment or maintenance of canals) is conservatively omitted in the baseline calculations. Note that the omission of this source of GHG emissions is very conservative, resulting in lower emission estimates in the baseline water body stratum compared to strata at the same location in the project scenario, since emissions from water bodies are lower than emissions resulting from peat microbial decomposition.

CO_2 and CH_4 are accounted for in the baseline, while N_2O emissions were conservatively omitted. It was assumed that uncontrolled burning of peat occurs only in part of the deforested project area, these emissions are accounted for since the loss is significant. GHG emissions from biomass burning in the baseline were conservatively omitted.

Baseline changes in land cover classes and drainage status during the project life-time determines (changes in) emissions of CO_2 and CH_4. Baseline emissions therefore have been calculated on an annual basis. (see Map 31, Table 35 and Appendix 4).

5.3.2 Proxy area analysis

5.3.2.1 Proxy area selection

Since the project area does not have a verifiable plan for the rate of deforestation, per module BL-PL, a minimum of 6 proxy areas are required to determine the baseline rate of deforestation, as well as 5 proxy areas to demonstrate the risk of abandonment. According to the methodology, all proxy areas must meet the following criteria:

- Land conversion practices shall be the same as those used by the baseline agent or class of agent;
- The post-deforestation land use shall be the same in the reference regions as expected in the project area under business as usual;
- The reference regions shall have the same management and land use rights type as the proposed project area under business as usual;
- If suitable sites exist they shall be in the immediate area of the project; if an insufficient number of sites exists in the immediate area of the project, sites shall be identified elsewhere in the same country as the project; if an insufficient number of sites exists in the country, sites shall be identified in neighbouring countries;
- Agents of deforestation in reference regions must have deforested their land under the same criteria that the project lands must follow (legally permissible and suitable for conversion);
- Deforestation in the reference region shall have occurred within the 10 years prior to the baseline period; and

- The three following conditions shall be met:
    - The forest types surrounding the reference region or in the reference region prior to deforestation shall be in the same proportion as in the project area (±20%).
    - Soil types that are suitable for the land-use practice used by the agent of deforestation in the project area must be present in the reference region in the same proportion as the project area (±20%). The ratio of slope classes "gentle" (slope<15%) to "steep" (slope≥15%) in the reference regions shall be (±20%) the same of the ratio in the project area.
    - Elevation classes (500m classes) in the reference region shall be in the same proportion as in the project area (±20%).

Suitable reference regions were identified using a database, provided by the Indonesian Ministry of Forestry[11], of pulp and paper concessions in Indonesia whose licenses were granted between 2000 and 2010. Using peat distribution geospatial data for Indonesia, obtained from Wetlands International Indonesia [27], the pulp and paper concessions with similar peat proportions as the project area were identified. Next, NASA Shuttle Radar Topography Mission's (SRTM) 90m Digital Elevation Model (DEM) data, downloaded via the Consultative Group on International Agricultural Research's online database[12], was analysed to identify the concessions that met the slope and elevation requirements. To determine which of the remaining concessions met the forest type and forest cover percentage criteria, medium-resolution satellite imagery was used. Table 33 shows proxy area requirements based on the project area's land cover.

Table 33. Reference region selection criteria

Project area	Reference region Requirement
96.65% forest cover	At least 77.32% forest cover
97.44% peat	At least 77.95% peat
100% of area in the 0-500m class	At least 80% of the area must fall in the 0-500m class
100% of area has "gentle" (slope<15%) slopes	At least 80% of the area must have "gentle" slopes

5.3.2.2 Satellite imagery analysis

A) Data acquisition

For each concession, Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+) or Landsat 8 Operational Land Imager (OLI) data was downloaded from the United States Geological Survey's online database[13]. All Landsat Level 1 data provided by USGS is geometrically corrected, using precision ground control points and SRTM DEM data, orthorectified and meets all standards laid out by the GOFC-GOLD 2013 handbook. For the first time-step, imagery from the concession grant date was downloaded. Due to Landsat's long revisit time and the high level of cloud cover in Indonesia, a compromise had to be made between cloud cover and the imagery acquisition date's proximity to the concession grant date.

B) Landsat pre-processing

All Landsat data was atmospherically corrected using the ATCOR2 for IMAGINE software. For optimal results, the radiometric rescaling values from each Landsat scene's metadata were used to create the scene's calibration file. Landsat 7 imagery acquired after 31/05/2003, when the sensor's Scan Line Corrector (SLC) failed, were also masked using the Landsat 7 gap-mask layer to remove all pixels affected by the scan line error.

[11] Ministry of Forestry (2010), downloaded from Global Forest Watch Commodities (http://commodities.globalforestwatch.org/#v=home)
[12] Available at http://srtm.csi.cgiar.org/SELECTION/inputCoord.asp
[13] Available at http://earthexplorer.usgs.gov

C) Landsat classification

To increase the classification's accuracy, the concession shapefile data was used to subset the Landsat scene in order to remove all spectral data outside of the area of interest. The Unsupervised Classification ISODATA algorithm, with the standard clustering parameters, was then used to classify all concessions into forest and non-forest classes. The clouds, cloud shadows and scan line error gaps were masked out for all images and cross-applied to both time-steps to ensure only data available in both time-steps was used to calculate deforestation rates. When necessary, additional imagery from the same calendar year was processed and used to fill in cloud gaps to reduce overall cloud cover below 10%. All images were further processed with a 3*3 majority filter to remove noise and improve the classification accuracy. Lastly, an accuracy assessment was run on each map to ensure the overall classification accuracy was at least 90%. 100 points, with a 50-meter buffer between points, were randomly created for both forest and non-forest classes and compared with the unprocessed Landsat data and high-resolution imagery from Google Earth (when available). The accuracy was then calculated using the equation (12).

$$Overall\ Classification\ Accuracy = \frac{Number\ of\ Pixels\ Classified\ Correctly}{Total\ Number\ of\ Classified\ Pixels} \quad \textbf{(12)}$$

All maps had a satisfactory overall accuracy with the lowest accuracy being 91%.

5.3.2.3 Area of deforestation

Using the module BL-PL, a total of 7 suitable proxy areas were identified (see Table 34 and Map 28).

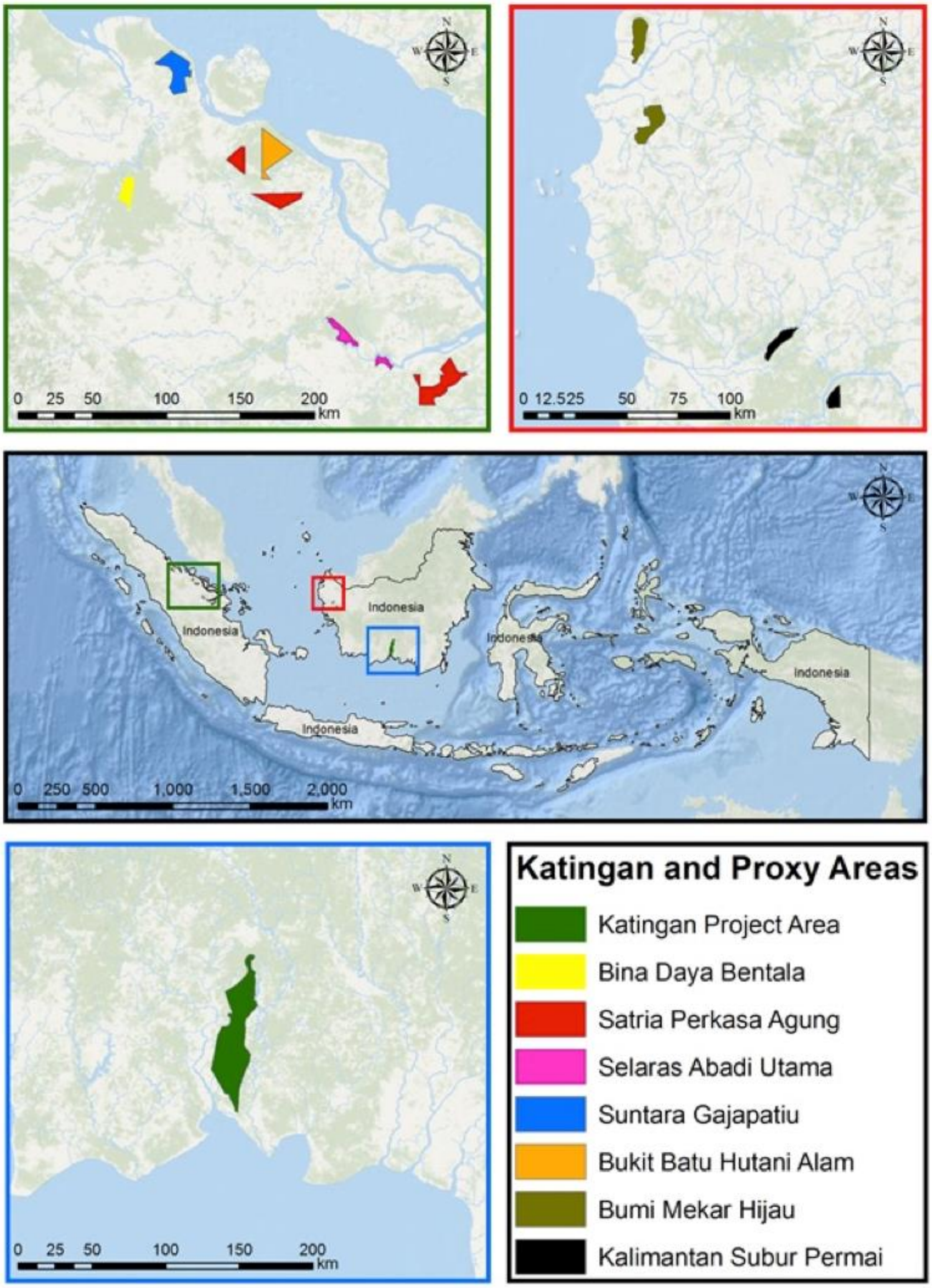
Table 34. Summary of suitable reference regions

Reference region	Deforestation Rate	Area in Ha	Province	Concession Grant Date	Peat %	Timestep 1 date	Forest % at Timestep 1	Timestep 2 date	Forest % at Timestep 2	Cloud Gap
Satria Perkasa Agung full concession	7.31%	97533.25	Riau	22/08/2000	88.31 %	26/04/2000[a] 21/05/2000[b] 23/02/2000[c] 06/12/2000[d] 01/09/2000[d]	84.50%	09/10/2005[a] 15/02/2009[b] 01/05/2007[c] 19/06/2005[d]	42.55%	3.04%
Suntara Gajapatiu	6.42%	34258.30	Riau	15/03/2001	100%	20/09/2001	92.26%	28/08/2010	34.48%	8.30%
Bukit Batu Hutani Alam	14.31%	33030.50	Riau	30/10/2003	100%	21/05/2000	88.07%	09/10/2005	16.55%	7.85%
Selaras Abadi Utama	8.13%	17434.80	Riau	30/12/2002	100%	02/10/2002	92.40%	15/02/2009	35.52%	1.47%
Kalimantan Subur Permai	**3.91%**	13246.02	West Kalimantan	04/04/2006	92.11 %	12/08/2005	93.42%	11/05/2009 30/07/2009 18/10/2009	77.79%	1.42%
Bumi Mekar Hijau	4.40%	25118.70	West Kalimantan	01/05/2007	85.93 %	05/07/2006 13/07/2006	83.88%	12/10/2010 15/12/2010	66.27%	7.38%
Bina Daya Bentala	10.63%	14124.76	Riau	22/12/2006	100%	03/08/2004	77.55%	15/10/2010 13/09/2010	13.76%	1.86%

a. Plot 1 of the Satria Perkasa Agung concession; b. Plot 2 of the Satria Perkasa Agung concession; c. Plot 3 of the Satria Perkasa Agung concession

d. Plot 4 of the Satria Perkasa Agung concession

Map 28. Geographic location of the Katingan Project and reference regions for the baseline deforestation rate calculation



The baseline deforestation rate was calculated using the equation (13).

$$D\%_{planned,i,t} = \left(\sum_{pn=1}^{n^*} \left(D\%_{pn} / Yrs_{pn} \right) \right) / n \qquad \textbf{(13)}$$

Where:

$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in stratum I during year t. If actual annual proportion is known and documented (e.g. 25% per year for 4 years), set to proportion; %
$D\%_{pn}$	Percent of deforestation in land parcel pn etc of a reference region as a result of planned deforestation as defined in this module; %
Yrs_{pn}	Number of years over which deforestation occurred in land parcel pn in reference region; years
n	Total number of land parcels examined
pn	1, 2, 3, …n land parcels examined in reference region
i	1, 2, 3, …M strata

The average projected annual deforestation rate for these proxy areas was estimated to be 7.82%. However, in order to guarantee that a conservative approach was used, the deforestation rate applied in the baseline emission calculation (subsection 5.3.6) was the lowest rate of the 7 proxy areas, **3.91%** (see Table 34). Since this approach is unquestionable conservative, the baseline rate of deforestation uncertainty was set to zero.

5.3.2.4 Likelihood of Deforestation

Since all pulpwood plantation concessions are zoned for deforestation, and are not under government control for the duration of the concession license, the likelihood of deforestation ($L\text{-}D_i$) is assumed to be equal to 100%.

5.3.2.5 Risk of Abandonment

To assess the risk of abandonment, 5 proxy areas with concession grant dates of at least ten years before the project start date were selected using the criteria outlined in Sub-subsection 5.3.2.1. After confirming the elevation, slope and soil criteria were met, Landsat 5 TM, Landsat 7 ETM+ and Landsat 8 OLI imagery was downloaded for three time-steps and visually analysed to determine if any areas were abandoned for forest regrowth. All 5 proxy areas showed clear signs of continued deforestation and plantation activities for all three time-steps, therefore the BL-PL module is applicable to this project.

5.3.2.6 Area of Deforestation

The annual area of deforestation in the baseline is calculated using using equation (14).

$$AA_{planned,i,t} = \left(A_{planned,i} * D\%_{planned,i,t}\right) * L - D_{\mathrm{i}} \qquad \textbf{(14)}$$

Where:

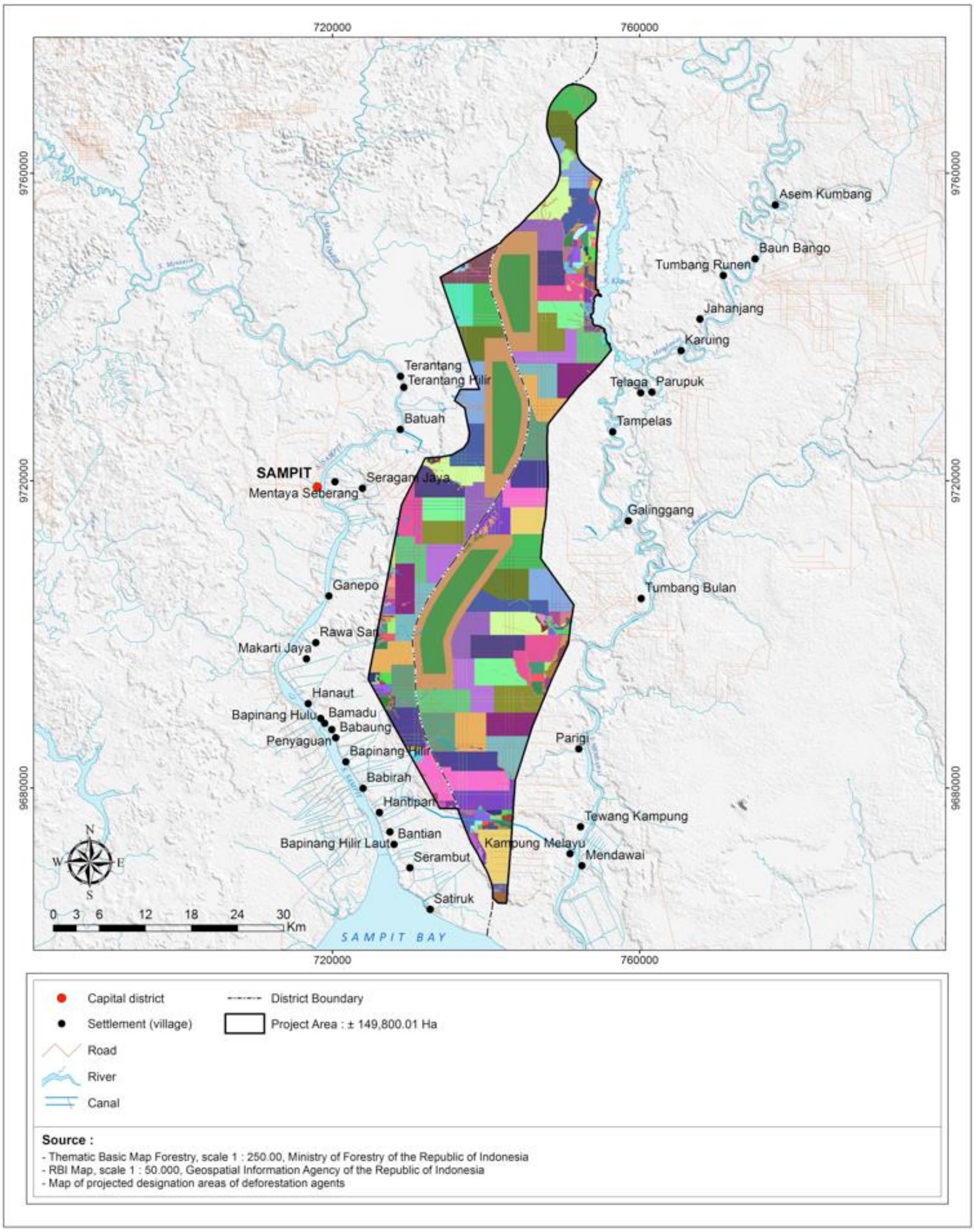
$AA_{planned,I,t}$	Annual area of baseline planned deforestation for stratum *I* at time *t*; ha
$D\%_{planned,I,t}$	Projected annual proportion of land that will be deforested in stratum *I* during year *t*. If actual annual proportion is known and documented, set to proportion; %
$A_{planned,I}$	Total area of planned deforestation over the baseline period for stratum *I*; ha
$L\text{-}D_i$	Likelihood of deforestation for stratum *I*; %

5.3.3 Projection of deforestation under the baseline scenario

Following the determination of the total annual area deforested in the baseline ($AA_{planned,i,t}$), the area was allocated spatially to produce a spatial map of the baseline scenario. The project area was stratified into six strata (Table 35) based on five land use classes, two drainage statuses and one water body class through a Combination-Elimination process as described in Annex 14. A baseline scenario map is provided in Map 29. The mapping process involved the following steps:

- Delineation of forest and non-forest area at the project start date. This process is described in Sub-subsection 4.4.1.1.
- Delineation of water bodies present at the project start date (rivers and canals)
- Division of the project area into three assumed concession areas, corresponding to different baseline agents. The division is in compliance with historical records that timber plantation license being given is decreasing with size range from 30,000 to 70,000 ha. Strenghtened in 2014 by Ministry of Forestry Decree no P.8/Menhut-II/2014 that limits concession sizes in Indonesia to a maximum of 50,000 hectares.
- Division of each concession area into five zones (acacia plantations, conservation areas, indigenous species area, infrastructure, and areas for community crops) in line with specific regulation (see Table 32).
- Delineation of 50 meters width river buffers (25 meters from both sides of natural rivers). Forest cover inside the buffers are prohibited to log or convert under regulation.
- Drainage canals were laid out in a step wise approach complying with applicable regulations, common practice and hydrotopography of the project area. Primary canals that enclose the concession areas (mandatory by regulation) were delineated first; then secondary canals that act as main outlets for tertiary canals and discharging channels into main canals or natural streams. Considering the hydrotopograhy of the area, baseline agents were assumed to construct secondary canals perpendicular to elevation contour-lines. Tertiary canals are not necessarily perpendicular to elevation contour-line and act as planting block borders, therefore the delineation was carried out in step 8. All the canals were placed in *Acacia* plantations and community crop zones only.
- Division of the *Acacia* plantation area of each assumed agent's concession into 4 Major Blocks (termed Blok RKT, Rencana Kerja Tahunan), resulting in 12 Major blocks in the project area.
- Division of each Major Blocks into smaller planting blocks (termed Blok Tanam) of 500 by 500 meter square parcels
- Division of all Major Blocks into deforestation/planting zones based on deforestation rate (D%) resulting in analysis of Reference Region. Each planting zone consists of several planting blocks.
- Division of all community crop zones into agriculture planting zones based on deforestation rate (D%) resulting in form the analysis of the proxy area analysis
- Assigning canals' construction years, starting from the closest area to access points, in this case rivers
- Assigning deforestation/planting years to deforestation/planting zones, starting from the closest area to access points, in this case rivers
- Assigning planting years to community crop zones
- Choosing and delineating locations for camps and log yards
- Assigning camps and log yards construction years, starting from the closest area to access points, in this case rivers

Map 29. Baseline scenario map[14]



[14] Legend of this map is continued to the box below the map. Numbers preceding alphabet symobols denote year of drainge/deforestation in reference to project start date. Abbreviations: AC=Acacia, CA= Community crops, IF=Ground fascility, IS=Indigineous species area, CF=Conservation area.

5.3.4 Emission characteristics in the baseline scenario

5.3.4.1 Stratification of emission characteristics for CUPP activities under the baseline scenario

Baseline strata of relative homogeneous emission characteristics were mapped on the basis of the Master Baseline Scenario Map (see Map 29) by taking into account (1) Coverage of land use / cover / drainage status; (2) Timing of land use change / drainage status under the assumed baseline; and (3) the delineation of peat. The stratification map of emission characteristics presents the following information:

- Land use (vegetation cover, water bodies, etc.) and the related emission factors: different land uses translate into different emission factors.
- Timing of deforestation or conversion / *Acacia* plantings / other agriculture plantings and canal constructions. Temporal variability of these activities and the different drainage status translate into different emissions. For example, if a peatland parcel belongs to the acacia

stratum (forest planned to be drained in year 3 and to be deforested and converted to acacia in year 6) and was initially undrained and forested, then the Emission Factor (EF) of undrained peatland forest will be used for year 1 – 2, the EF for drained peatland forest for year 3 – 5, and finally the EF for acacia for year 6 onwards.

- Area of peatland, outside which peat-related emissions are absent

In the baseline scenario, the six strata that significantly differ in peat GHG emission characteristics are summarized in Table 35 and Map 30. A summary of dynamics of these strata is presented in Map 31 and Appendix 4.

Map 30. Baseline stratification of the project area for CUPP activities

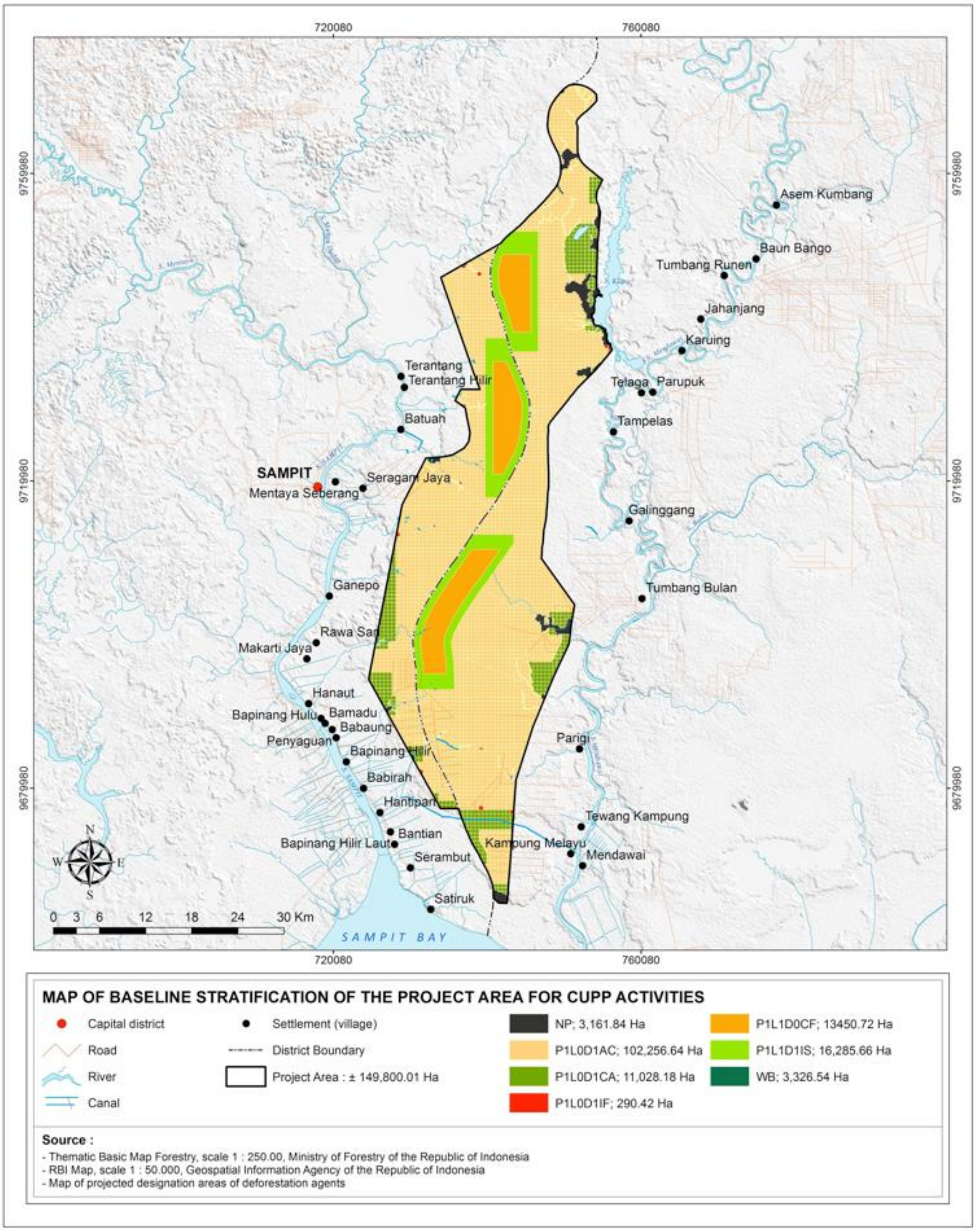
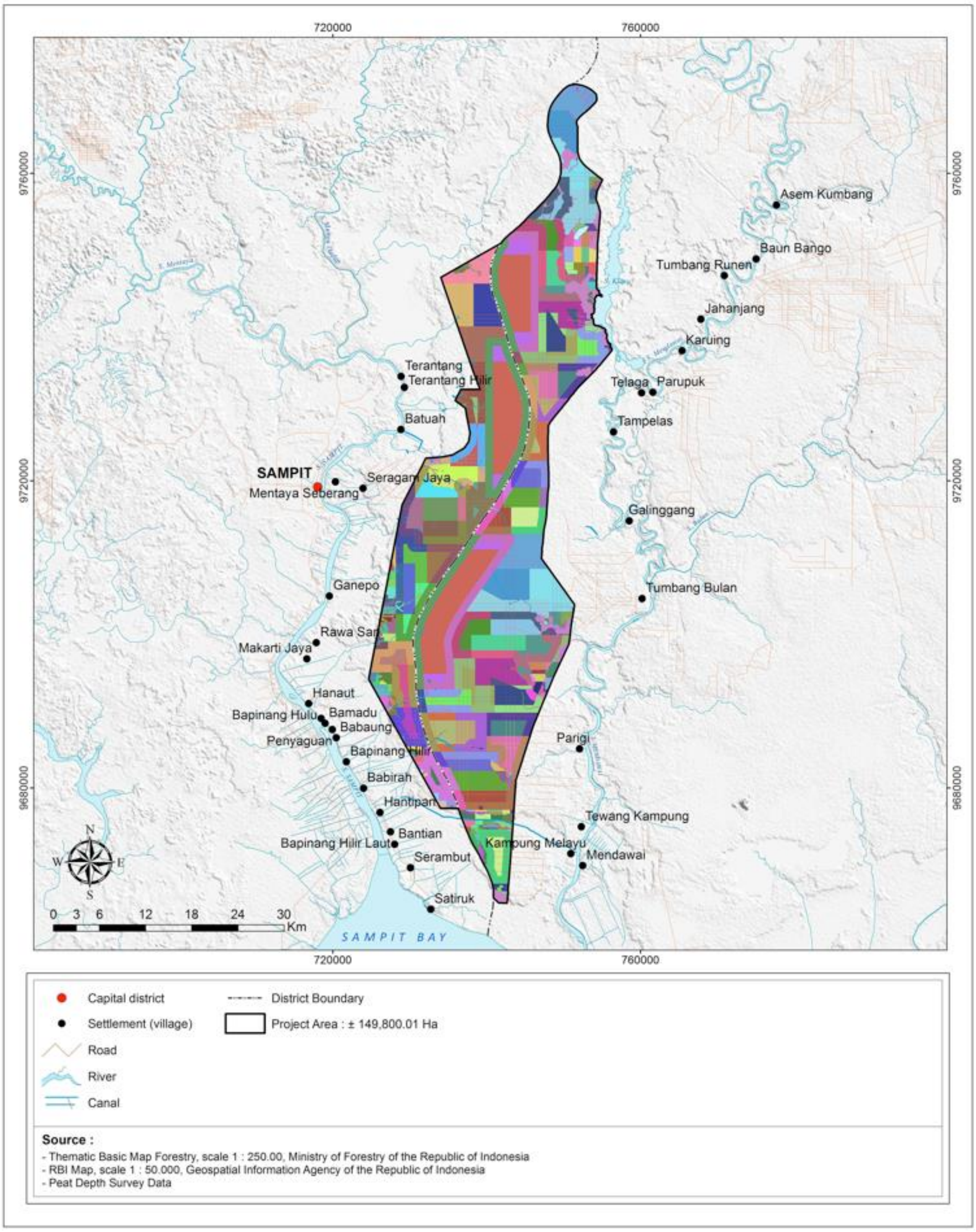


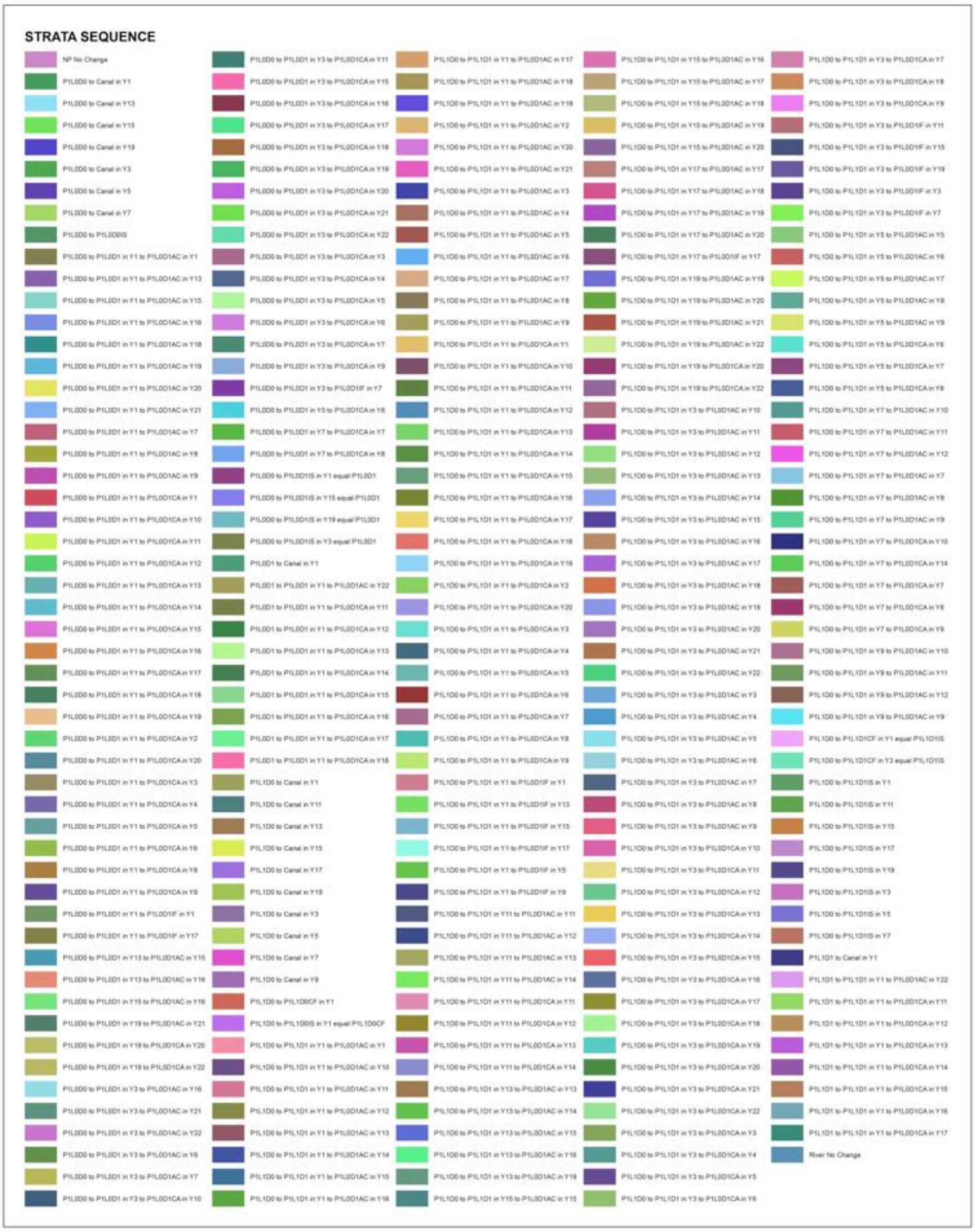
Table 35. Baseline stratification of peatlands and water bodies based on relative homogeneous emission characteristics

Strata	Description	Area (ha)	Percentage of Project Area	Assumed water table depth (cm-ss)
P1L0D1AC	Acacia Plantation on drained peatland. This stratum represents typical acacia plantations on peatland in Indonesia. For this stratum, drainage is required and forest covers are removed if present. Acacia planting starts in the same year as deforestation. The development of drainage constructions is assumed to happen just before- or at the same year as the deforestation/planting (details are provided in Map 31 and Appendix 4).	102,257	68.3	80
P1L1D0CF	Conservation Forest (undrained peatland forest). This stratum represents peatlands where forest covers are not removed and drainage is absent. This stratum remains unchanged since the project start date. The locations of these strata have been selected and positioned in areas where forest cover and peat were present at the project start date	13,451	9.0	20
P1L0D1CA	Community crops on drained peatland. This stratum represents areas nearby community villages that are or will be utilized for agriculture crops. The locations of these strata have been selected in or near deforested areas and with sufficient transportation access, in this project, rivers.	11,028	7.4	80
P1L0D1IF	Infrastructures on drained peatland. This stratum represents lands within acacia plantations planting that would be used for company operation supports, such as base camps, station camps and log yards. Infrastructure areas are usually drained (when on peatland) and barren. The locations have been selected as close as possible to transportation access (rivers).	290	0.2	80
P1L1D1IS	Native Tree species area and river buffer (drained peatland forest). This stratum consists of 2 types of drained forested peatlands in the project area. The indigenous species areas were positioned as *c.a.* 1 km buffer zone around each conservation area (stratum P1L1D0CF). Peatlands in this stratum are assumed to experience drainage impacts from the surrounding drained areas, but the forest cover remains unchanged during the project duration. Boundary canals are also constructed along the periphery of the indigenous species area. River buffers were positioned as a 50 m belt extending from both sides of rivers in the project area	16,286	10.9	50
WB	Water bodies. This stratum represents rivers and drainage canals on peatlands. Rivers remain unchanged during the project period, while drainage canals coverage gradually expands following the assumed yearly operation of the baseline agents.	3,327	2.2	NA
Total		146,638	97.9	

Map 31. Stratification changes in the baseline scenario for CUPP activities[15]



[15] Legend of this map is extended to the box below.



5.3.4.2 Stratification based on the emission characteristics for REDD under the baseline scenario

Carbon stock changes and emissions regarding aboveground biomass under the baseline scenario are driven by land cover changes before, during and after the occurances of deforestation. In the project area, GHG emissions as a result of deforestation occurred over 114,694 ha of forest land designated as acacia plantations, community crops, and infrastructure. Ministry of Forestry regulation [28] mandates that 30,348 ha of forest land must be set aside, of which 15,123 ha designated as conservation forest and 14,966 ha designated as native tree species area. These areas were therefore excluded from emission calculations. Given that no land cover change would occur in these areas, they are referred as non relevant strata and therefore excluded from emission calculations.

A total 114,778 ha of the forest in the project area is planned to be deforested in the baseline scenario, of which 103,364 ha will be transformed into areas designated as acacia plantation areas. In areas designated as ‘community crops’, 7,980 ha of forested area will be deforested and replaced by rubber tree plantations. While in areas designated as ‘infrastructure area’, 3,346 ha of forest area will be deforested and converted into canals, drainage ditches and other infrastructures. Given relatively small impacts (compared to peat/belowground), the carbon loss of AGB due to uncontrolled burning under the baseline scenario is excluded in the calculation.

In the baseline scenario, the stratification of AGB and land cover changes which significantly differ in GHG emission characteristics were estimated and summarized as summarized in Map 32 and Table 36. The dynamics of strata changes are provided in more detail in Appendix 5.

Map 32. Stratification of aboveground biomass in the baseline scenario for REDD

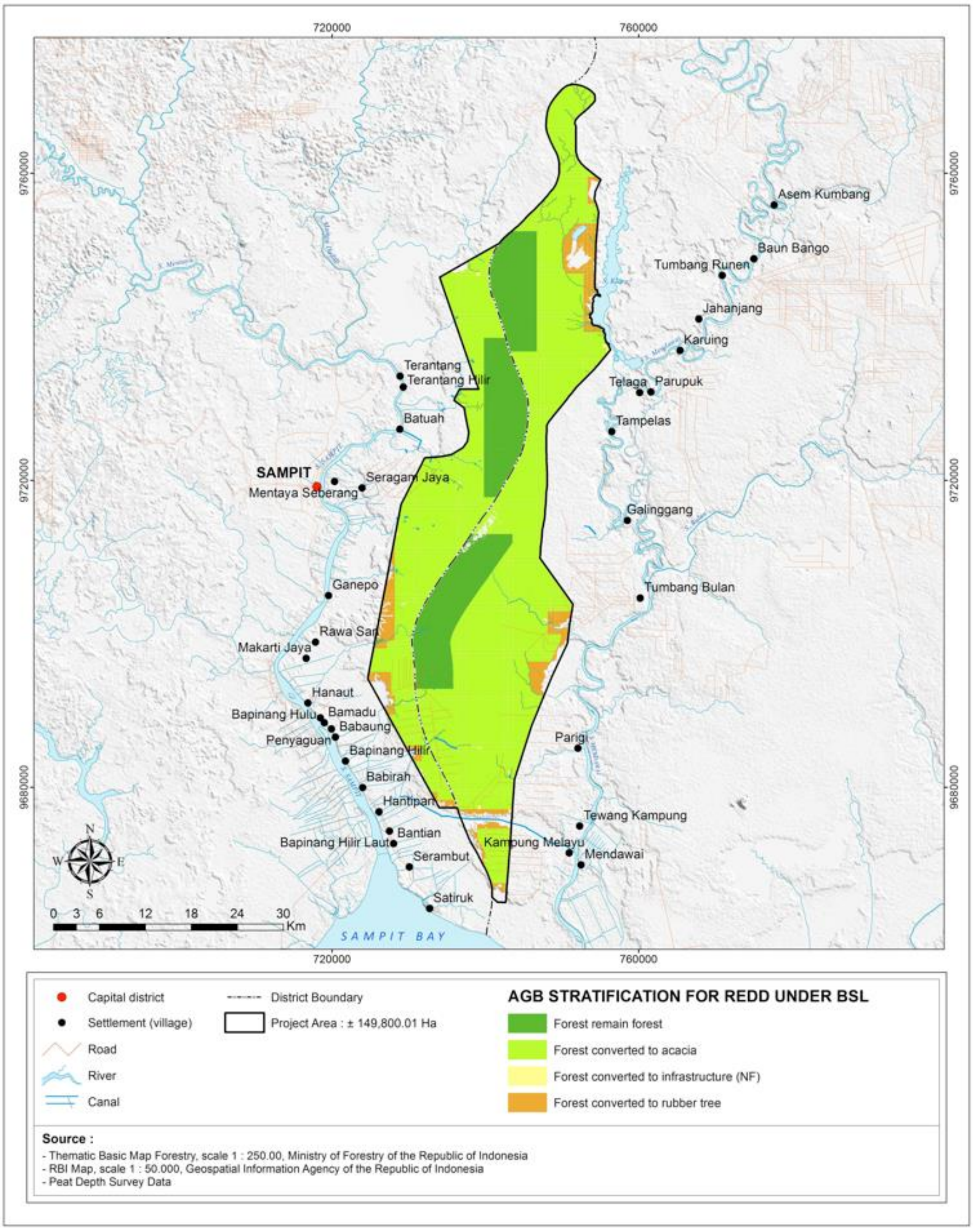


Table 36. Land cover changes strata in the baseline scenario for REDD

Strata	Description	Land use	Area (ha)	Proportion
F0F1*	Forest to forest	Protected area	15,122.82	10.45%
F0F1*	Forest to forest	Native tree area	14,965.81	10.34%
F0Ac1	Forest to *Acacia* plantation	Acacia plantation area	103,363.53	71.39%
F0Rbr1	Forest to rubber tree plantation	Community crops	7,980.38	5.51%
F0NF1	orest to Non-forest	Infrastructure	3,345.73	2.31%
Total			144,778.26	100.00%

*Non relevant strata as there is no land cover change in baseline secanario

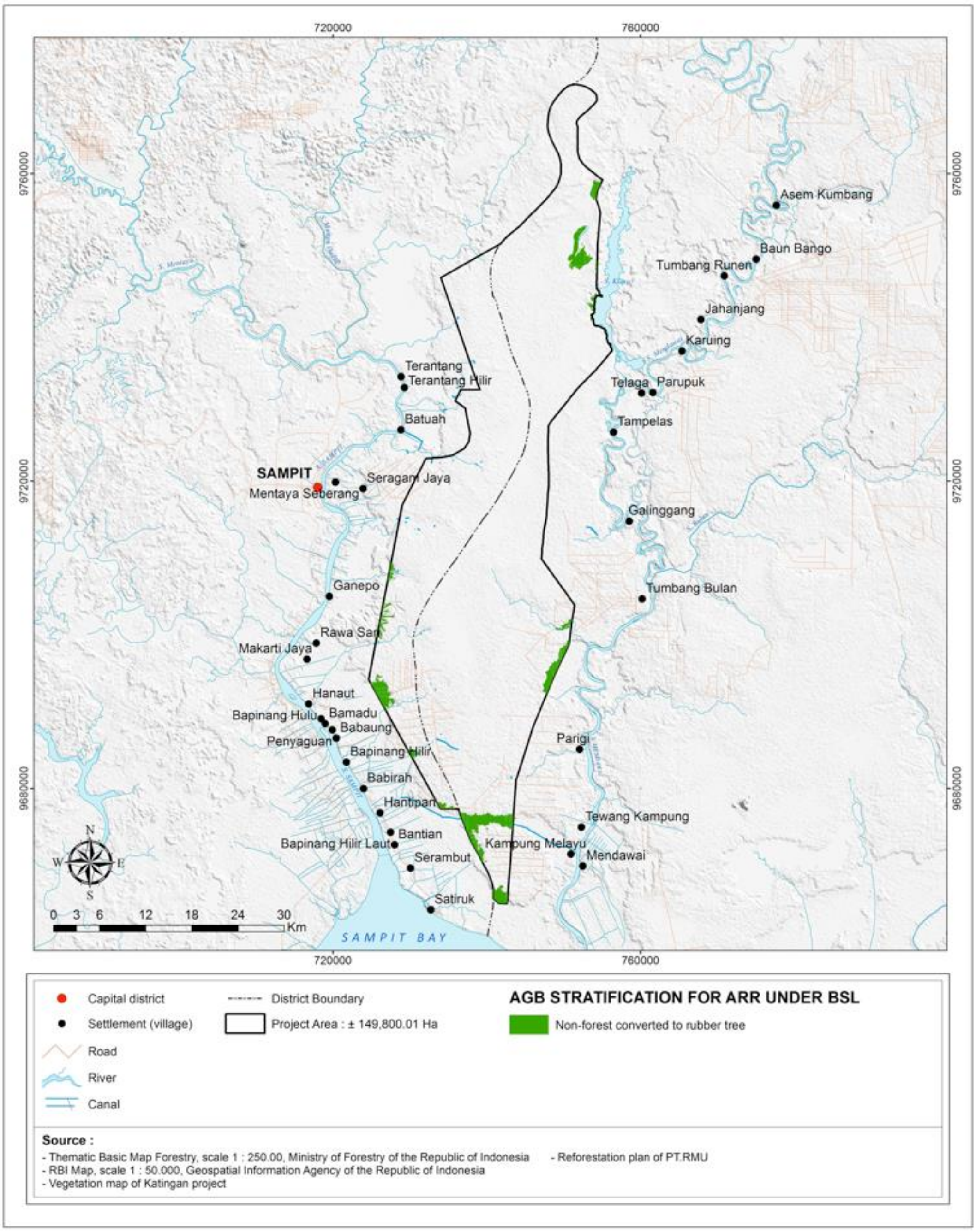
5.3.4.3 Stratification of emission characteristics for ARR activities under the baseline scenario

Replanting under the ARR activities in the areas designated for 'community crops' in the baseline will increase carbon stocks and will therefore be subtracted from the emissions resulting from other baseline activities such as deforestation and forest degradation. Spatial analysis showed that 4,227.72 ha of non-forest area would be transformed to rubber tree plantation (as an ARR activity). A rubber plantation is harvested and renewed every 25 year. Map 33 shows the stratitication map of ARR activities under the baseline scenario. The dynamics of changes in the rubber plantation strata are presented in Table 37.

Table 37. Land cover changes strata in the baseline scenario for ARR

Strata	Planting Agent	Land use	Area (Ha)	Planting Start year
NF0Rbr1	Agent A	Community crops	1,004.37	2010
	Agent B	Community crops	1,018.52	2012
	Agent C	Community crops	2,204.82	2012
Total			4,227.72	

Map 33. Stratification of aboveground biomass in the baseline scenario for ARR



5.3.5 Baseline emissions from microbial decompositions of peat, peat burnings and water bodies in peatlands

5.3.5.1 Spatial and temporal variability

Quantification of GHG emissions from microbial decompositions of peat, peat burnings and water bodies in peatlands has been carried out by using a spatially and temporally explicit approach. Each baseline stratum as set out in Table 35 and Sub-subsection 5.3.4.1 was discretized into parcels of the smallest land or water body unit with relatively uniform combinations of spatial variables as given in Table 38. Temporal discretization has been used by sequencing the calculation into 1 year time-step, while temporal variables determine the sequence of strata changes, temporal variability of GHG emission parameters and temporal restrictions to GHG emissions as given in Table 38. The schematization provides an assurance of the proper use of GHG emission parameters at the correct spatial location and the correct time.

Table 38. Variables used in the schematization of quantification of GHG emissions from microbial decompositions of peat, peat burnings and dissolved organic carbon from water bodies in peatlands in the baseline scenario.

Variables	Description
(A) Spatial Variables	
(A1) Soil Type	Distinction between peat or non-peat. This is used to exclude all non peat parcels from GHG calculation
(A2) Initial peat thickness available for microbial decompositions and burnings	Derived from DEM, DEL and Peat Thickness maps as described in Section 4.4.1.3. These maps are used to determine the initial condition for subsequent calculations of the remaining peat layer available for microbial decompositions and burnings.
(A3) Initial stratum	Stratum of the corresponding parcel at the project start date (as derived in Annex 14 and Section 5.4.2.1) before conversion into baseline stratum takes effect. This is used to determine the correct Emission Factor for the corresponding parcel for the duration before B1 and B2 (in this table, below) take effect.
(A4) Peat burning tag	This is used to identify whether the corresponding parcel has been marked as possible area for peat burning (PBA_{BSL}). All parcels without tag are excluded from peat burning calculation.
(B) Temporal Variables	
(B1) Year of drainage	Determines the onset of conversion from initial stratum to drained stratum and sets all the drainage related parameters/variables accordingly, such as initial consolidations, bulk density changes, etc. This does not take effect if the initial stratum of the parcel is already a drained stratum. Together with B2 this is used to determine the correct Emission Factor for the corresponding parcel
(B2) Year of deforestation/ planting of the baseline land cover	Determines the onset of conversion of initial stratum to deforested/planted stratum. Together with B1 this is used to determine the correct Emission Factor for the corresponding parcel
(B3) PDT	The PDT is the period of time that it takes to deplete the remaining peat layer by microbial decomposition and burning (conservatively will be assumed that PDT is reached once the remaining peat layer has reached 20 cm). Once the PDT is reached in a given stratum all GHG emissions in that stratum are set to zero.
(B4) Year tag for burning	Determines whether the corresponding parcel has been marked to catch peat burning for the corresponding year, and counting the number of burn scars (and any repetitions) of the parcel since year 1. This is used to set the correct burn scar depth and other related burning parameters for the corresponding parcel accordingly.
(B5) Burning restriction	If the corresponding parcel has been marked for burning in the corresponding year (as being checked in B4), this restriction further checks whether GHG emissions from burning would still be possible based on variables: B1 (Year of drainage), B2 (Year of deforestation/planting) and B3 (Remaining peat thickness available for microbial decomposition and burning). Only drained-deforested parcels with >20 cm peat is categorized as available and would emit GHGs from burning.

5.3.5.2 Emissions calculations

Taking into account the spatial and temporal variability described in Section 5.3.4.1 and Appendix 4, the net CO_2-equivalent emissions from the peat (microbial decomposition and burning) and water bodies were estimated following equation (15) from module BL-PEAT:

$$GHG_{BSL-WRC} = \sum_{t=1}^{t*}\sum_{i=1}^{M}(E_{peatsoil-BSL,i,t} + E_{peatditch-BSL,i,t} + E_{peatburn-BSL,i,t}) \quad (15)$$

Where:

$GHG_{BSL-WRC}$	Net GHG emissions in the CUPP baseline scenario up to year $t*$ (t CO_2e)
$E_{peatsoil-BSL,i,t}$	GHG emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO_2e yr^{-1})
$E_{peatditch-BSL,i,t}$	GHG emissions from water bodies in the baseline scenario in stratum i at year t (t CO_2e yr^{-1})
$E_{peatburn-BSL,i,t}$	GHG emissions from burning of peat in the base line scenario in stratum i at year t (t CO_2-e yr^{-1})
i	1, 2, 3 …M strata in the baseline scenario (unitless)
t	1, 2, 3, … $t*$ times elapsed since the project start (yr)

For all strata i where the project duration exceeds the peat depletion time (PDT or t_{PDT}), for $t > t_{PDT-BSL,I}$ the following equations (16), (17), (18) apply:

$$E_{peatsoil-BSL,i,t} = 0 \quad (16)$$
$$E_{peatditch-BSL,i,t} = 0 \quad (17)$$
$$E_{peatburn-BSL,i,t} = 0 \quad (18)$$

Where:

$t_{PDT-BSL,i}$	Peat Depletion Time in the baseline scenario in stratum i in years elapsed since the project start (yr)
$E_{peatsoil-BSL,i,t}$	GHG emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO_2e yr^{-1})
$E_{peatditch-BSL,i,t}$	GHG emissions from water bodies at year t (t CO_2e yr^{-1})
$E_{peatburn-BSL,i,t}$	GHG emissions from burning of peat in the base line scenario in stratum i at year t (t CO_2e yr^{-1})
i	1, 2, 3 …M_{BSL} strata in the baseline scenario (unitless)
t	1, 2, 3, … $t*$ time elapsed since the project start (yr)

GHG emissions from peat soils comprise GHG emission as CO_2 and CH_4. Were calculated using the following equation (19) :

$$E_{peatsoil-BSL,i,t} = E_{CO2-BSL,i,t} + E_{CH4-BSL,i,t} \quad (19)$$

Where:

$E_{CO2-BSL,i,t}$	CO_2 emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO_2e yr^{-1})
$E_{CH4-BSL,i,t}$	CH_4 emissions from the peat soil within the project boundary in the baseline scenario in stratum i at year t (t CO_2e yr^{-1})

5.3.5.3 Subsidence related to initial compression, microbial decomposition and burning of peat

The initial peat thickness in the baseline scenario is assumed equal to the initial peat thickness as mapped at the project start date (Section 4.4.1.3) minus the initial thickness loss due to compression resulting from initial drainage (see Annex 13). GHG emissions from peat soils comprise GHG emission as CO_2 and CH_4. Were calculated using the following equation (20):

$$E_{peatsoil-BSL,i,t} = E_{CO2-BSL,i,t} + E_{CH4-BSL,i,t} \quad (20)$$

Where:

$E_{CO2-BSL,i,t}$	CO_2 emissions from the peat soil within the project boundary in the baseline scenario in stratum *i* at year *t* (t CO_2e yr^{-1})
$E_{CH4-BSL,i,t}$	CH_4 emissions from the peat soil within the project boundary in the baseline scenario in stratum *i* at year *t* (t CO_2e yr^{-1})

On peatlands that were undrained and which would remain undrained during the project period (stratum P1L1D0CF) and peatlands that are already drained at the project start date (strata P1L1D1, P1L0D1) the compression is assumed to be absent, therefore $Depth_{peatloss-BSL-comp} = 0$.

As a result of the initial compression, the bulk density of peat increases proportionally with associated thickness loss. This is taken into account when quantifying peat carbon stock dynamics.

To maintain consistency between annual net CO_2-equivalent emissions and remaining peat carbon stock, annual rates of peat and carbon stock loss in the baseline scenario were quantified annually based on the rate of emissions from microbial decompositions of peat (CO_2 and CH_4 decomposition), burn scar depths (for areas where peat burning was projected to occur), bulk density of peat above water table, and a conservative carbon content value (48 $kg.kg^{-1}$ dry mass) as calculated using equation (21) as follows:

$$Rate_{peatloss-BSL,i,t} = D_{peatburn-BSL,i,t} + \left(\frac{12}{44} \times \frac{EF_{CO2,i,t}}{BD_{BSL,i,t} \times C_c \times 10}\right) + \left(\frac{1}{GWP_{CH4}} \times \frac{12}{16} \times \frac{EF_{CH4,i,t}}{BD_{BSL,i,t} \times C_c \times 10}\right) \quad (21)$$

Where:

$Rate_{peatloss-BSL,I,t}$	Rate of peatloss due to microbial decompositions and burning in baseline scenario of stratum i at year t ($m.y^{-1}$)
$D_{peatburn-BSL,i,t}$	Burn scar depth under baseline scenario in stratum *i* at year *t* (m)
$BD_{BSL,i,t}$	Bulk density of peat soil above water table in baseline scenario in stratum *i* at year *t** ($kg.m^{-3}$)
$EF_{CO2,i,t}$	CO_2 emissions from microbial decomposition of peat in baseline scenario in stratum *i* at year *t* ($tCO_2.ha^{-1}.y^{-1}$). Equals CO_2 emission factor when peat available for decomposition > 20 cm, otherwise zero
$EF_{CH4,i,t}$	CH_4 emissions from microbial microbial decomposition of peat in baseline scenario in stratum *i* at year *t* ($tCO_2.ha^{-1}.y^{-1}$). Equals CH_4 emission factor when peat available for decomposition > 20 cm, otherwise zero
GWP_{CH4}	Global Warming Potential of CH_4
Cc	Carbon content of peat soil ($kg.kg^{-1}$)

Remaining peat thickness was assessed annually for the project crediting period based on the rate of peat loss due to microbial decompositions of and burning incidents using equation (22) as follow:

$$Depth_{peat-BSL,i,t} = Depth_{peat-BSL,i,t0} - \sum_{t=1}^{t=t*} Rate_{peatloss-BSL,i,t} \quad (22)$$

Where:

$Depth_{peat\text{-}BSL,i,t}$	Remaining peat thickness in the baseline scenario in stratum *i* at year *t** (m)
$Depth_{peat\text{-}BSL,i,t0}$	Peat thickness at the baseline scenario in stratum *i* at year *t0* = project start date (initial peat thickness) (m)
$Rate_{peatloss\text{-}BSL,i,t}$	Rate of peat loss due (subsidence) due to microbial decomposition of peat and peat burning in the baseline scenario in stratum *i* in year *t* (m yr^{-1})
i	Strata

Peat carbon stock and its annual changes were calculated using equation (23) following annual peat carbon loss due to microbial decompositions and burning.

$$C_{stock-BSL,i,t} = C_{stock-BSL,i,t-1} - C_{loss-BSL,i,t-1} \quad \textbf{(23)}$$

Where:

$C_{stock\text{-}BSL,i,t}$	Remaining peat carbon stock in baseline scenario in stratum *i* at year *t* (t $C.ha^{-1}$)
$C_{stock\text{-}BSL,i,t\text{-}1}$	Remaining peat carbon stock in baseline scenario in stratum *i* at previous year (t $C.ha^{-1}$)
$C_{loss\text{-}BSL,i,t\text{-}1}$	Equivalent carbon stock loss from microbial decomposition of peat and peat burning in baseline scenario in stratum *i* at previous year (t $C.ha^{-1}$)

By tracking annual peat carbon stock and peat thickness in the baseline scenario it has been assured that there is no GHG emissions has been accounted for within any parcel of each stratum once available carbon stock/peat has been depleted. Conservatively, peat is assumed depleted once peat thickness available for decompositions and burning has been reduced to 20 cm.

A summary of the quantified GHG emissions from peat microbial decomposition, uncontrolled peat burning and water bodies under the baseline scenario are presented in Table 39, and the next Sub-subsections 5.3.6.3, 5.3.6.4 and 5.3.6.5 describe how Table 39 has been calculated.

Table 39. A summary of the annual GHG emissions from peat microbial decomposition, uncontrolled peat burning and water bodies in the Project area under the baseline scenario ($tCO_2e.y^{-1}$) since the start of the project in 2010

Year	CO_2 from peat microbial decomposition	CH_4 from peat microbial decomposition	CO_2 from peat burning	CH_4 from peat burning	CO_2 from DOC	Total
2011	872,262	80,618	113,627	13,693	2,779	1,082,979
2012	966,973	80,528	127,390	15,351	2,779	1,193,020
2013	2,292,138	49,284	205,515	24,766	6,052	2,577,755
2014	2,588,966	48,998	251,623	30,322	6,052	2,925,961
2015	2,910,708	47,418	244,700	29,488	6,314	3,238,629
2016	3,204,660	47,144	269,703	32,501	6,314	3,560,321
2017	3,628,150	42,686	313,518	37,781	7,012	4,029,146
2018	3,932,268	42,398	338,149	40,749	7,012	4,360,576
2019	4,307,185	39,805	349,520	42,119	7,370	4,746,000
2020	4,584,724	39,541	404,301	48,721	7,370	5,084,656
2021	4,973,666	36,356	382,934	46,146	7,965	5,447,067
2022	5,268,302	36,073	386,441	46,569	7,965	5,745,349
2023	5,631,354	34,002	403,044	48,569	8,275	6,125,244
2024	5,923,395	33,720	379,011	45,673	8,275	6,390,075

Year	CO_2 from peat microbial decomposition	CH_4 from peat microbial decomposition	CO_2 from peat burning	CH_4 from peat burning	CO_2 from DOC	Total
2025	6,308,103	29,970	388,991	46,876	8,890	6,782,830
2026	6,585,466	29,681	373,954	45,064	8,890	7,043,055
2027	6,906,267	28,391	411,579	49,598	9,127	7,404,961
2028	7,189,341	28,092	417,025	50,254	9,127	7,693,839
2029	7,614,737	23,607	423,444	51,028	9,821	8,122,636
2030	7,894,864	23,301	400,032	48,206	9,821	8,376,224
2031	8,081,433	23,087	379,649	45,750	9,821	8,539,740
2032	8,286,789	22,849	390,765	47,090	9,821	8,757,313
2033	8,278,593	22,832	387,157	46,655	9,821	8,745,058
2034	8,268,410	22,812	346,079	41,705	9,821	8,688,826
2035	8,262,373	22,797	309,556	37,303	9,821	8,641,850
2036	8,255,644	22,783	310,482	37,415	9,821	8,636,144
2037	8,248,377	22,766	310,670	37,438	9,821	8,629,072
2038	8,241,859	22,752	255,033	30,733	9,821	8,560,198
2039	8,234,741	22,737	288,620	34,781	9,821	8,590,699
2040	8,225,122	22,720	274,839	33,120	9,821	8,565,622
2041	8,217,806	22,704	276,610	33,333	9,821	8,560,273
2042	8,209,559	22,682	216,776	26,123	9,821	8,484,961
2043	8,202,803	22,667	228,318	27,514	9,821	8,491,122
2044	8,193,613	22,650	232,271	27,990	9,821	8,486,345
2045	8,185,905	22,633	214,734	25,877	9,821	8,458,970
2046	8,178,125	22,617	196,918	23,730	9,821	8,431,210
2047	8,170,001	22,598	202,848	24,444	9,821	8,429,712
2048	8,161,601	22,583	190,877	23,002	9,821	8,407,884
2049	8,154,522	22,567	176,446	21,263	9,821	8,384,618
2050	8,145,756	22,550	190,277	22,930	9,821	8,391,334
2051	8,138,962	22,537	183,798	22,149	9,821	8,377,267
2052	8,131,369	22,520	171,602	20,679	9,821	8,355,991
2053	8,123,480	22,506	170,305	20,523	9,821	8,346,635
2054	8,113,478	22,490	167,613	20,198	9,821	8,333,601
2055	8,105,756	22,477	149,992	18,075	9,821	8,306,120
2056	8,096,914	22,461	159,279	19,194	9,821	8,307,668
2057	8,086,643	22,444	150,819	18,175	9,821	8,287,901
2058	8,079,669	22,431	160,835	19,382	9,821	8,292,137
2059	8,069,217	22,414	150,511	18,137	9,821	8,270,101
2060	8,053,640	22,384	151,922	18,308	9,821	8,256,074
2061	8,041,789	22,367	154,261	18,589	9,821	8,246,826
2062	8,030,326	22,348	149,805	18,052	9,821	8,230,353
2063	8,017,565	22,326	152,702	18,402	9,821	8,220,815
2064	8,005,012	22,307	145,495	17,533	9,821	8,200,168
2065	7,993,522	22,289	134,659	16,227	9,821	8,176,517
2066	7,980,530	22,269	143,981	17,351	9,821	8,173,951
2067	7,965,650	22,246	130,055	15,672	9,821	8,143,443

Year	CO_2 from peat microbial decomposition	CH_4 from peat microbial decomposition	CO_2 from peat burning	CH_4 from peat burning	CO_2 from DOC	Total
2068	7,949,145	22,218	131,385	15,833	9,821	8,128,402
2069	7,936,436	22,197	133,213	16,053	9,821	8,117,720
2070	7,922,493	22,175	128,773	15,518	9,821	8,098,779

5.3.5.4 Emissions from peat microbial decomposition

It is assumed that the rate of conversion of undrained peatland to drained peatland in the baseline scenario is based on the rate of conversion of the forest by the deforestation agents as outlined in Sub-subsection 5.3.4.2 and Appendix 4. The temporal variability of the emissions from peat microbial decompositions are therefore directly related to the land use and land use changes in the baseline. Table 40 below and Table 35 in Sub-subsection 5.3.4.1 provide details on the WRC related baseline stratification that is used and the area (ha) per stratum. Based on this data, the baseline GHG emissions for the different 'emission strata' were calculated using conservative and scientifically robust (TIER 1) IPCC default emission factors for each stratum *i* and procedured using equations (24), (25) and (26) defined by the VCS methodology VM0007 module BL-PEAT:

$$E_{peatsoil\text{-}BSL,i,t} = E_{peatsoil\text{-}BSL,CO2,i,t} + E_{peatsoil\text{-}BSL,CH4,i,t} \quad \textbf{(24)}$$

Where:

$E_{peatsoil\text{-}BSL,i,t}$ GHG emissions from the peat soil within the project boundary in the baseline scenario in stratum *i* at year *t* (t CO_2e yr^{-1})

$E_{peatsoil\text{-}BSL,CO2,i,t}$ CO_2 emissions from the peat soil within the project boundary in the baseline scenario in stratum *i* at year *t* (t CO_2e yr^{-1})

$E_{peatsoil\text{-}BSL,CH4,i,t}$ CH_4 emissions from the peat soil within the project boundary in the baseline scenario in stratum *i* at year *t* (t CO_2e yr^{-1})

i 1, 2, 3 …M_{BSL} strata in the baseline scenario (unitless)

t 1, 2, 3, … *t** time elapsed since the project start (yr)

For each stratum, the CO_2 emissions from microbial decomposition of the peat within the project boundary were estimated as follows:

$$E_{peatsoil\text{-}BSL,CO2,i,t} = A_{i,t} \times EF_{CO2,i,t} \quad \textbf{(25)}$$

Where:

$E_{peatsoil\text{-}BSL,CO2,i,t}$ CO_2 emissions from the peat soil within the project boundary in the baseline scenario in stratum *i* at year *t* (t CO_2e yr^{-1})

$EF_{CO2,i,t}$ *Emission factor for* CO2 emissions corresponds to each stratum *i*, as provided by IPCC (t CO_2e ha^{-1} yr^{-1})

$A_{,i,t}$ *Area of stratum i at time t* (ha)

i 1, 2, 3 …M_{BSL} strata in the baseline scenario (unitless)

t 1, 2, 3, … *t** time elapsed since the project start (yr)

For each stratum, the CH_4 emission from the peat soil within the project boundary were estimated as follows:

$$E_{peatsoil\text{-}BSL,CH4,i,t} = A_{i,t} \times GWP_{CH4} \times EF_{CH4,i,t} \quad \textbf{(26)}$$

Where:

$E_{peatsoil\text{-}BSL,CH4,i,t}$ CH_4 emissions from the peat soil within the project boundary in the baseline

	scenario in stratum *i* at year *t* (t CO_2e yr^{-1})
$EF_{CH4,t,t}$	*Emission factor for* CH_4 emissions corresponds to each stratum *i*, as provided by IPCC (t CO_2e ha^{-1} yr^{-1})
$A_{,i,t}$	*Area of stratum i at time t* (ha)
GWP_{CH4}	*Global Warming Potential for* CH_4
i	1, 2, 3 …M_{BSL} strata in the baseline scenario (unitless)
t	1, 2, 3, … *t** time elapsed since the project start (yr)

Table 40. The stratification used for the calculation of GHG emissions per stratum, the area (ha) per each stratum and the CO_2 and CH_4 default factors used for the specific land use

Strata	Description	Area (ha)	IPCC default emission factor for CO_2 (t CO_2-eq ha-1 yr-1)	IPCC default emission factor for CH_4 (t CO_2-eq ha-1 yr-1)	IPCC default emission factor for ∆ DOC (t CO_2-eq ha-1 yr-1)
Initial					
P1L0D0	Undrained deforested peatland	3,172	1.5	0.20	
P1L0D1	Drained deforested peatland	987	19.43	0.14	
P1L1D0	Undrained forested peatland	141,910	0	0.72	
P1L1D1	Drained deforested peatland	354	19.43	0.14	
WB	Water bodies (rivers and canals) present at the project start date	216			2.09
After conversion					
P1L0D1AC	*Acacia* on drained peatland	102,257	73.33	0.08	
P1L1D0CF	Conservation area (undrained peatland forest)	13,451	0	0.72	
P1L0D1CA	Community crops on drained peatland	11,028	51.33	0.20	
P1L0D1IF	Ground facilities on drained peatland	290	19.43	0.14	
P1L1D1IS	Indigenous species area and river buffer (drained peatland forest)	16,286	19.43	0.14	
WB	Water bodies (rivers and canals)	3,327			3.01

Note: Appendix 6 provides more details on the emission factors used and the references.

Calculated annual GHG emissions from microbial decompositions of peat in the baseline scenario is presented in Table 41.

Table 41. GHG emissions from microbial decompositions of peat in the baseline scenario in tCO_2-e.y^{-1}.

Year	CO_2 from peat microbial decomposition	CH_4 from peat microbial decomposition	Total
2011	872,262	80,618	952,880
2012	966,973	80,528	1,047,500
2013	2,292,138	49,284	2,341,422
2014	2,588,966	48,998	2,637,964
2015	2,910,708	47,418	2,958,127
2016	3,204,660	47,144	3,251,804
2017	3,628,150	42,686	3,670,836
2018	3,932,268	42,398	3,974,666
2019	4,307,185	39,805	4,346,990
2020	4,584,724	39,541	4,624,265

Year	CO_2 from peat microbial decomposition	CH_4 from peat microbial decomposition	Total
2021	4,973,666	36,356	5,010,022
2022	5,268,302	36,073	5,304,374
2023	5,631,354	34,002	5,665,356
2024	5,923,395	33,720	5,957,115
2025	6,308,103	29,970	6,338,073
2026	6,585,466	29,681	6,615,147
2027	6,906,267	28,391	6,934,658
2028	7,189,341	28,092	7,217,433
2029	7,614,737	23,607	7,638,344
2030	7,894,864	23,301	7,918,165
2031	8,081,433	23,087	8,104,520
2032	8,286,789	22,849	8,309,637
2033	8,278,593	22,832	8,301,426
2034	8,268,410	22,812	8,291,222
2035	8,262,373	22,797	8,285,170
2036	8,255,644	22,783	8,278,427
2037	8,248,377	22,766	8,271,143
2038	8,241,859	22,752	8,264,611
2039	8,234,741	22,737	8,257,478
2040	8,225,122	22,720	8,247,843
2041	8,217,806	22,704	8,240,510
2042	8,209,559	22,682	8,232,242
2043	8,202,803	22,667	8,225,470
2044	8,193,613	22,650	8,216,263
2045	8,185,905	22,633	8,208,538
2046	8,178,125	22,617	8,200,742
2047	8,170,001	22,598	8,192,599
2048	8,161,601	22,583	8,184,185
2049	8,154,522	22,567	8,177,089
2050	8,145,756	22,550	8,168,306
2051	8,138,962	22,537	8,161,499
2052	8,131,369	22,520	8,153,889
2053	8,123,480	22,506	8,145,987
2054	8,113,478	22,490	8,135,968
2055	8,105,756	22,477	8,128,233
2056	8,096,914	22,461	8,119,375
2057	8,086,643	22,444	8,109,087
2058	8,079,669	22,431	8,102,100
2059	8,069,217	22,414	8,091,632
2060	8,053,640	22,384	8,076,024
2061	8,041,789	22,367	8,064,155
2062	8,030,326	22,348	8,052,674
2063	8,017,565	22,326	8,039,891
2064	8,005,012	22,307	8,027,319

Year	CO_2 from peat microbial decomposition	CH_4 from peat microbial decomposition	Total
2065	7,993,522	22,289	8,015,810
2066	7,980,530	22,269	8,002,798
2067	7,965,650	22,246	7,987,896
2068	7,949,145	22,218	7,971,363
2069	7,936,436	22,197	7,958,633
2070	7,922,493	22,175	7,944,667

5.3.5.5 Emissions from peat burning

This section explains in more detail how the numbers for peat burning in the Project area in Table 39 have been calculated.

Peatland fires in Indonesia are widely known as human induced events. Based on this fact it can be inferred that the probability of peat burning events increases according to the decrease in distance to human activity (roads, rivers, agriculture area, etc). It is common in Kalimantan that local comunities use rivers and canals extensively as transportation means. Observations in the project area showed that most burnings occur along the Hantipan canal where human activity is high. Burnt area in this location extended to about 1 km from the canal sides.

Per module E-BPB, GHG emissions from biomass burning can result from:

- Conversion of forest land to non-forest land using fire
- Periodical burning of grassland or agricultural land after deforestation
- Controlled burning in forest land remaining forest land
- Uncontrolled fire in drained peat swamp forest
- Uncontrolled peat burning in (abandoned) drained peat sites

Since it is illegal to clear forests on Acacia plantation it is assumed that the deforestation agents do not perform controlled peat burning during site preparation or (rotational) clearance for plantation/crop establishment. Therefore, only emissions from unintentional/uncontrolled burnings are accounted for in the baseline scenario. Furthermore, above ground biomass lost by combustion is conservatively omitted.

Procedures for quantification of GHG emissions from uncontrolled peat burnings follow the VCS methodology VM0007 module E-BPB using the following equation (27):

$$E_{peatburn-BSL,i,t} = \sum_{g=1}^{G}\left(\left(\left(A_{peatburn-BSL,i,t} \times P_{BSL,i,t} \times G_{g,i}\right) \times 10^{-3}\right) \times GWP_g\right) \quad (27)$$

Where:

$E_{peatburn\text{-}BSL,i,t}$	Greenhouse emissions due to peat burning under baseline scenario in stratum *i* in year *t* of each GHG (CO_2, CH_4, N_2O) (t CO_2e)
$A_{peatburn\text{-}BSL,i,t}$	Area peat burnt under baseline scenario in stratum *i* in year *t* (ha)
$P_{BSL,i,t}$	Average mass of peat burnt under baseline scenario in stratum *i*, year *t* (t d.m. ha^{-1})
$G_{g,i}$	Emission factor in stratum *i* for gas *g* (kg t^{-1} d.m. burnt)
GWP_g	Global warming potential for gas *g (*t CO_2/t *g)*
g	1, 2, 3 ... *G* greenhouse gases including carbon dioxide, methane and nitrous oxide (unitless)
i	1, 2, 3 …*M* strata (unitless)

t 1, 2, 3, … *t* time elapsed since the start of the project activity (year)

The average mass of peat burnt for a particular stratum is estimated using the equation (28):

$$P_{BSL,i,t} = D_{peatburn\text{-}BSL,i,t} \times BD_{upper} \times 10^{-4} \quad \textbf{(28)}$$

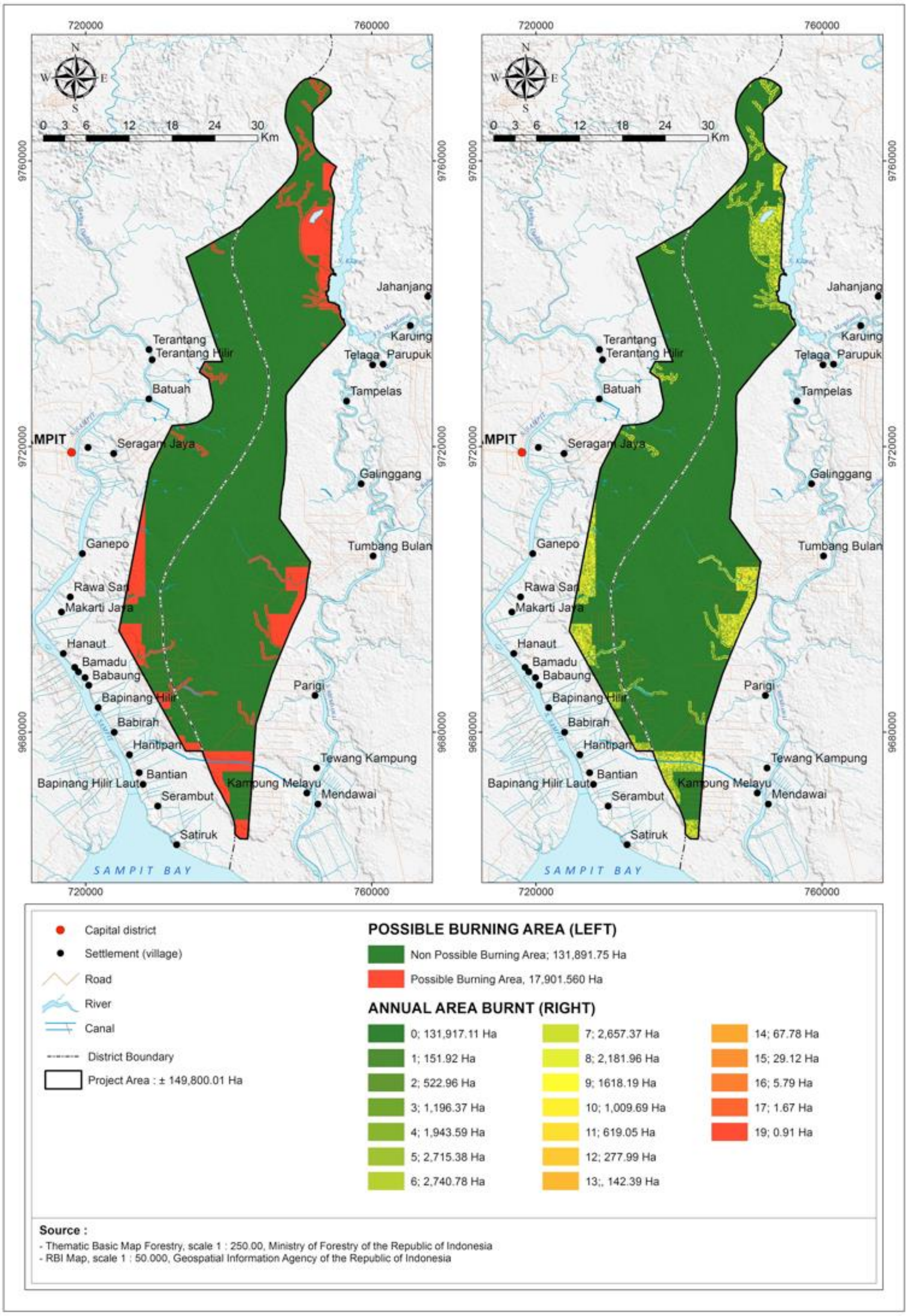
Where:

$P_{BSL,i,t}$	Average mass of peat burnt under baseline scenario in stratum *i*, year *t* (t d.m. ha^{-1})
$D_{peatburn\text{-}BSL,i,t}$	Average burn scar depth under baseline scenario in stratum *i* in year *t* (m)
$BD_{upper,i}$	Bulk density of the upper peat in stratum *i* (g cm^{-3})
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t* time elapsed since the start of the project activity (years)

Emissions from peat burning in the baseline are thus calculated from the mass of peat lost by combustion and emission factors from scientific literature (see Appendix 6 for the default values that were used for the calculations of baseline carbon losses and emissions from burning).

Uncontrolled burnings in peatlands were assumed to repeat randomly on places that are 'high risk' areas. To determine where the 'high risk areas' are in the baseline of the project area, a hotspot intensity analysis was performed, and the spatial position of burning within the project boundary in the baseline scenario was simulated (details provided in Annex 12). A water body network map from BIG 2008 (rivers and canals) was used to represent human activity variable. NOAA and NASA MODIS Fire hotspot data from 1997-2010 for Kalimantan were plotted on ArcGIS 10.1 and the distances to the nearest human activities (using rivers and canals as proxy) were calculated. Histogram analysis showed that the closer an area to human activity the higher the probability is for a peat fire. Plotting percentages of hotspot numbers against distances to human activity resulted in a Burning Probability Density (BPD) model with an $R^2 > 0.9$ (Annex 12). The resulted BPD model was used in creating a proportionally scaled down "Possible Burning Area" (PBA_{BSL}) map (Map 34) that shows the area with the highest burning probability (95 percent probability threshold) in the project baseline. This map does not show the "actual area burnt" in the baseline scenario, rather showing possible locations where peat burning can be expected to occur randomly.

Map 34. Map of possible burning area (left) and annual area burnt (right) in the baseline scenario.



To assess the frequency and extent of uncontrolled peat fires in the baseline scenario, remote sensing data of the proxy areas was used, per VCS methodology VM0007 module BL-PEAT (see Annex 12). MODIS fire pixels, which are recorded daily, were downloaded for the seven proxy areas and filtered as to only include the pixels with 100% confidence of the presence of a fire. To identify fires that occurred on bare soil all available Landsat data was subsequently downloaded for the 2000-2010 period, only selected data collected after the individual concession grant dates. When no cloud-free data was available within 2 months prior to the fire pixel acquisition date it was conservatively excluded. Each fire occurring on bare soil was conservatively assumed to have burnt 0.49 km^2 (Giglio, L., et al, 2006). Based on this data the average percentage of burnt area per proxy area was determined to be 1.44% per year. This value was used as a parameter in estimating "Annual Area Burnt Threshold" in the baseline scenario ($AABT_{BSL}$), according to the following equation (29):

$$AABT_{BSL} = 1.44\%.y^{-1} \times A_{Project} = 2{,}157\ ha.y^{-1} \quad \textbf{(29)}$$

Where:

$A_{project}$ Project area size (149,800 hectares)

The coverage of the Annual Area Burnt for each baseline stratum ($AAB_{BSL,i,t}$) was simulated as a subset of PBA_{BSL} by randomly selecting parcels in PBA_{BSL} annually over 100 years in such a way that the annual average area of the selected parcels approximately equals (but does not exceed) the area of $AABT_{BSL}$. Once a parcel was selected randomly in the first year the parcel is marked as "catching the 1st burning". If it was randomly selected again for the second year it is marked as "catching the 2nd burning", and so forth.

Given the random nature of the $AAB_{BSL,i,t}$ selection, and due to gradual land use change in the baseline scenario, $AAB_{BSL,i,t}$ varies by strata and year with increasing trend following land use change (Figure 16, Table 42). The project has assured that not every burning event would result in peat GHG emissions. At every burning event during the calculation, for the GHG emissions from peat burning to take effect, the corresponding "burnt parcel" must have been drained and deforested first, and that available peat for decomposition and burning exceed 20 cm. By applying these restrictions, net annual area burnt with positive net GHG emissions from peat burning havs been calculated as given in Figure 17.

Figure 16. Annual area burnt in baseline scenario

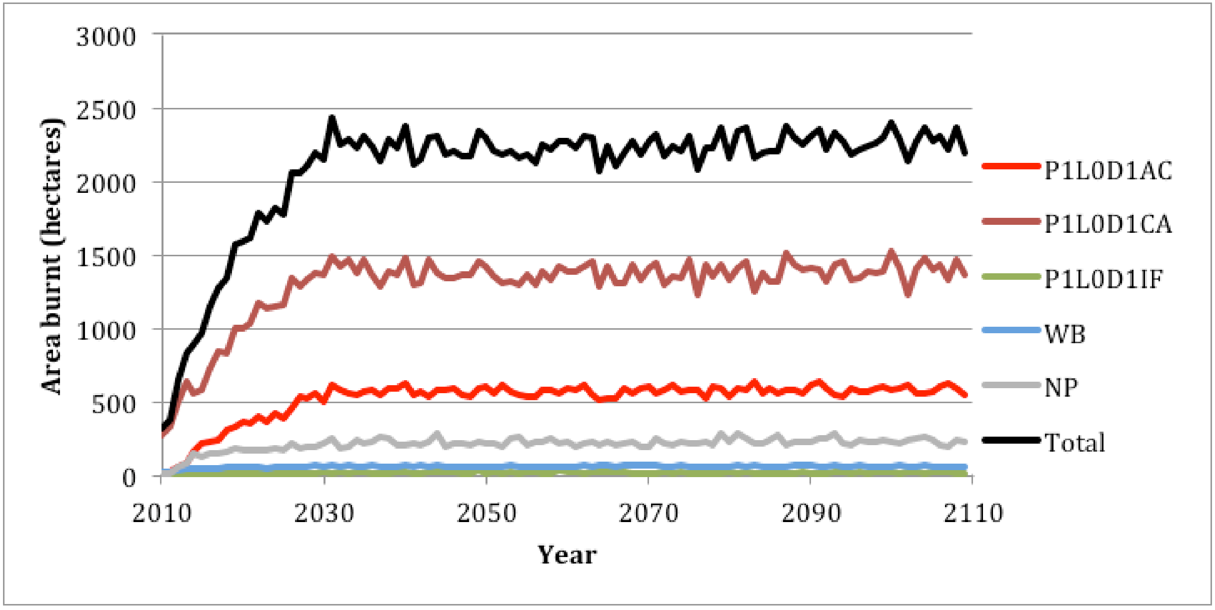


Figure 17. Annual area burnt with positive net GHG emissions from peat burning in baseline scenario

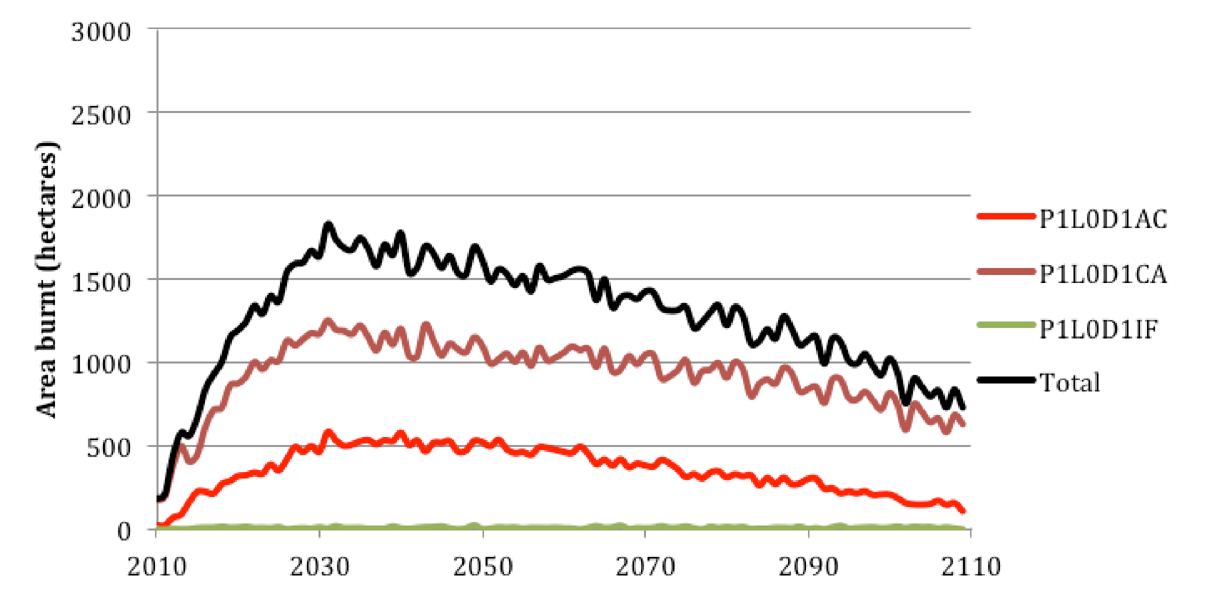


Table 42. GHG emissions from peat burning per stratum and per (repeated) burning

Strata	Strata Area	Total Area Burnt in 60 years	Average Burnt area in 60 years	GHG Emissions from peat burning in 60 years (tCO_2e)			
	(ha)	(ha)	($ha.y^{-1}$)	1st burning	2nd burning	≥3rd burning	Total
P1L0D1AC	102,257	28,631	477.2	1,865,786	1,101,649	1,600,247	4,567,683
P1L0D1CA	11,028	73,039	1,217.3	4,242,612	2,484,608	3,946,775	10,673,995
P1L0D1IF	290	626	10.4	40,996	24,101	36,479	101,575.4
P1L1D0CF	13,451	-	-	-	-	-	-
P1L1D1IS	16,286	-	-	-	-	-	-
WB	3,327	3,205	53.4	-	-	-	-
NP	3,162	11,321	188.7	-	-	-	-
Total	149,800	116,821	1,947	6,149,395	3,610,358	5,583,501	15,343,253

*See Appendix 6 for the defaults used.

Given the fact that there is a difference in burn scar depths between 1st, 2nd and 3rd burnings, calculations took into account the repetition of burnings. Burn scar depths of 18, 11 and 4 cm were assumed for the first, 2nd and 3rd burning respectively [29] (see Appendix 6 for more details).

The peat burning baseline will be re-assessed every 10 years based on observations of burning frequency and extent in reference region and/or based on the latest scientific findings of 'repeated burnings' pattern.

Calculated annual GHG emissions from uncontrolled peat burning are presented in Table 43.

Table 43. GHG emissions from peat burning in the baseline scenario in tCO_2-$e.y^{-1}$.

Year	CO_2 from peat burning	CH_4 from peat burning	Total
2011	113,627	13,693	127,320
2012	127,390	15,351	142,741
2013	205,515	24,766	230,281

Year	CO_2 from peat burning	CH_4 from peat burning	Total
2014	251,623	30,322	281,945
2015	244,700	29,488	274,188
2016	269,703	32,501	302,204
2017	313,518	37,781	351,299
2018	338,149	40,749	378,898
2019	349,520	42,119	391,640
2020	404,301	48,721	453,021
2021	382,934	46,146	429,080
2022	386,441	46,569	433,009
2023	403,044	48,569	451,613
2024	379,011	45,673	424,685
2025	388,991	46,876	435,867
2026	373,954	45,064	419,018
2027	411,579	49,598	461,177
2028	417,025	50,254	467,279
2029	423,444	51,028	474,472
2030	400,032	48,206	448,239
2031	379,649	45,750	425,399
2032	390,765	47,090	437,855
2033	387,157	46,655	433,812
2034	346,079	41,705	387,784
2035	309,556	37,303	346,859
2036	310,482	37,415	347,897
2037	310,670	37,438	348,108
2038	255,033	30,733	285,767
2039	288,620	34,781	323,400
2040	274,839	33,120	307,959
2041	276,610	33,333	309,943
2042	216,776	26,123	242,898
2043	228,318	27,514	255,831
2044	232,271	27,990	260,261
2045	214,734	25,877	240,611
2046	196,918	23,730	220,648
2047	202,848	24,444	227,292
2048	190,877	23,002	213,879
2049	176,446	21,263	197,709
2050	190,277	22,930	213,207
2051	183,798	22,149	205,947
2052	171,602	20,679	192,281
2053	170,305	20,523	190,828
2054	167,613	20,198	187,812
2055	149,992	18,075	168,067
2056	159,279	19,194	178,473
2057	150,819	18,175	168,994

Year	CO_2 from peat burning	CH_4 from peat burning	Total
2058	160,835	19,382	180,216
2059	150,511	18,137	168,648
2060	151,922	18,308	170,229
2061	154,261	18,589	172,850
2062	149,805	18,052	167,858
2063	152,702	18,402	171,103
2064	145,495	17,533	163,028
2065	134,659	16,227	150,886
2066	143,981	17,351	161,332
2067	130,055	15,672	145,727
2068	131,385	15,833	147,218
2069	133,213	16,053	149,266
2070	128,773	15,518	144,291

5.3.5.6 Emissions from water bodies in peatlands

This section explains in more detail how the numbers for emissions from water bodies in the project area in Table 39 have been calculated.

Except for drainage canals, it is assumed that the baseline agents do not create open water such as ponds and lakes. Hence the only type of open water body present in the baseline scenario are rivers and drainage canals. The area of canals in the baseline scenario is determined based on the rate of conversion, topography characteristics and common practice, as set out in Sub-sections 5.3.3 and 5.3.4. In the baseline stratification, all area that is-, or would be, water body during the project-life falls into the WB stratum.

Temporal stratification is being applied to this stratum by separating water bodies present at the project start date and drainage canals that would be constructed in later phases by the baseline agents during the project period. Therefore, part of the WB stratum would remain land before the conversion is completed. This situation has been taken into account by using a spatially and temporally explicit quantification approach, as set out in Sub-section 5.3.5. In total 3,327 ha of the peatland area falls into the stratum WB in the baseline scenario. Details on area and sequence of changes from land strata to WB is given in Table 68 and Appendix 4.

No default emission factors are yet provided by IPCC for CO_2 and CH_4 from water bodies. Therefore, IPCC default values for Dissolved Organic Carbon (Δ DOC) were used to calculate the difference in carbon losses between the project scenario and the baseline scenario.

From DOC values it cannot be explained ‘how’ this carbon will be lost: either transported to the sea, lost as CO_2 within or outside the project area, or lost as CH_4 in- or outside the area (which will be a considerable part). The ‘carbon loss’ can be calculated, but not the exact proportion of the GHG species CH_4 and CO_2, and therefore all carbon will be assumed to be lost as CO_2 which makes the approach conservative and any double counting will be avoided. Canals and rivers are treated similarly in the use of DOC values. The TIER 1 (IPCC) default annual values for DOC are 0.57 and 0.82 ton C per hectare, for natural and drained peatland respectively. Conservatively, the Hantipan canal (that presents at the project start date) is treated as of producing the same DOC value as that of a natural river despite being man-made water body. Default values used for calculations are given in Appendix 6.

For the quantification procedure, the project used the approach as set out in the VCS methodology VM0007 module BL-PEAT by using the equation (30). ($E_{peatditch-CO2,i,t}$ + $E_{peatditch-CH4,i,t}$) found in the equation 7 in the module BL-PEAT was replace with DOC emission, translated into CO_2-equivalents.

$$E_{peatditch-BSL,i,t} = A_{ditch-BSL,i,t} \times EF_{DOC-BSL} \quad \textbf{(30)}$$

Where:

$E_{peatditch-BSL,i,t}$	GHG emissions from canals and other open water stratum *i* at year *t* in the baseline scenario (t CO_2e yr^{-1})
$A_{ditch-BSL,i,t}$	Total area of canals and other open water stratum *i* at year *t* in the baseline scenario (ha)
$EF_{DOC-BSL}$	IPCC emission factor of Dissolved Organic Carbon from canal and open in the baseline scenario (t CO_2e $ha^{-1}yr^{-1}$)
i	1, 2, 3 …M_{BSL} strata in the baseline scenario (unitless)
t	1, 2, 3, … *t* time elapsed since the project start (yr)

Projected annual GHG emissions from Dissolved Organic Carbon in water bodies in baseline scenario is presented in Table 44.

Table 44. GHG emissions from Dissolved Organic Carbon in water bodies in the baseline scenario in tCO_2-e.y^{-1}.

Year	CO_2 from DOC
2011	2,779
2012	2,779
2013	6,052
2014	6,052
2015	6,314
2016	6,314
2017	7,012
2018	7,012
2019	7,370
2020	7,370
2021	7,965
2022	7,965
2023	8,275
2024	8,275
2025	8,890
2026	8,890
2027	9,127
2028	9,127
2029	9,821
2030	9,821
2031	9,821
2032	9,821
2033	9,821
2034	9,821
2035	9,821
2036	9,821

Year	CO_2 from DOC
2037	9,821
2038	9,821
2039	9,821
2040	9,821
2041	9,821
2042	9,821
2043	9,821
2044	9,821
2045	9,821
2046	9,821
2047	9,821
2048	9,821
2049	9,821
2050	9,821
2051	9,821
2052	9,821
2053	9,821
2054	9,821
2055	9,821
2056	9,821
2057	9,821
2058	9,821
2059	9,821
2060	9,821
2061	9,821
2062	9,821
2063	9,821
2064	9,821
2065	9,821
2066	9,821
2067	9,821
2068	9,821
2069	9,821
2070	9,821

5.3.6 Baseline emissions from deforestation

Annual emissions from deforestation are estimated based on the carbon stock losses as a result of conversion of the original forest to acacia plantation area (103,715.55 ha), infrastructure (3,528.26 ha), and rubber tree plantation area (12,208.10 ha) by the three deforestation agents as described in Sub-section 4.5.2. The rate of conversion applied for acacia and rubber plantations is conservatively estimated as the lowest rate of deforestation found in proxy area (3.91%) to determine $AA_{planned,I,t}$. GHG dynamics in the acacia baseline are determined based on the changes in land cover, the soil emissions related to these land cover changes, the emissions from drainage canals and emissions resulting from uncontrolled burnings. The changes in carbon stock in AGB are a result of the conversion of forest to acacia or other land uses, the plantings schemes (rotational and year-by-year) that are applied for the establishment of the acacia plantations and forest degradation as a result of various illegal threads such as illegal logging in undeveloped or conservation areas.

The predicted drainage layout and drainage density of each proportion of the converted land is estimated based on the predicted annual deforestation rate, local hydrotopographic conditions, common practice among acacia plantations and existing regulations. Existing regulations require acacia plantation operators to construct main canals along the concession borders. These canals must be constructed at an early stage of the plantation development, collect water from all other canals in the concession area, and discharge it to nearby rivers. Local topographic conditions play a role in the baseline agents' decisions in designing secondary canals which would act as the main outlets for tertiary canals. The canals need to be constructed with minimal flow resistance, hence positioning them perpendicular to general contour line is optimal. Common practice shows that acacia plantation operators do not necessarily layout tertiary canals perpendicular to the contour line, as long as all of them connect to secondary canals.

As a result of the spatial layout of the baseline deforestation activity, the remaining forest in the project area would have been converted as shown in Table 45 below.

Table 45. Projection of annual forest convertion in project area under the baseline skenario

Year	Forest (ha) deforested and converted to									TOTAL
	Acacia plantation			Infrastructure			Rubber tree plantation			
	Agent A	*Agent B*	*Agent C*	*Agent A*	*Agent B*	*Agent C*	*Agent A*	*Agent B*	*Agent C*	
2010	-	-	-	-	-	-	-	-	-	-
2011	1,589	-	-	423	-	-	133	-	-	2,146
2012	1,640	-	-	-	-	-	155	-	-	1,795
2013	1,646	1,527	2,052	-	374	406	181	130	213	6,529
2014	1,636	1,527	2,041	-	-	-	155	88	259	5,705
2015	1,655	1,517	2,022	189	-	-	150	173	255	5,961
2016	1,646	1,619	1,930	-	-	-	125	77	196	5,593
2017	1,656	1,575	2,017	-	158	207	175	207	82	6,076
2018	1,683	1,630	1,945	-	-	-	127	191	282	5,857
2019	1,719	1,518	1,949	189	-	-	179	75	181	5,811
2020	1,695	1,550	1,986	-	-	-	174	180	235	5,819
2021	1,650	1,519	1,996	-	145	190	195	170	66	5,930
2022	1,649	1,550	1,942	-	-	-	141	58	117	5,456
2023	1,629	1,666	2,097	161	-	-	57	34	83	5,727
2024	1,624	1,517	2,043	-	-	-	10	173	92	5,459
2025	1,608	1,540	1,819	-	168	192	24	155	81	5,585
2026	1,595	1,515	1,844	-	-	-	156	178	127	5,415
2027	1,658	1,544	1,955	182	-	-	92	106	60	5,598

Year	Forest (ha) deforested and converted to									TOTAL
	Acacia plantation			Infrastructure			Rubber tree plantation			
	Agent A	*Agent B*	*Agent C*	*Agent A*	*Agent B*	*Agent C*	*Agent A*	*Agent B*	*Agent C*	
2028	1,616	1,566	1,916	-	-	-	133	135	-	5,367
2029	1,655	1,578	1,935	-	157	204	85	158	64	5,837
2030	1,550	1,484	2,041	-	-	-	117	161	104	5,455
2031	-	1,323	1,962	-	-	-	-	146	136	3,567
2032	-	1,527	2,282	-	-	-	-	186	5	4,000
2033	-	-	-	-	-	-	-	-	-	-
2070	-	-	-	-	-	-	-	-	-	-
TOTAL	32,798	30,792	39,773	1,145	1,002	1,199	2,562	2,781	2,637	**114,690**
	103,364			***3,346***			**7,980**			

Per BL-PL, net carbon stock changes in the baseline are equal to pre-deforestation stocks minus the long-term average carbon stock in the post-deforestation land-use (acacia and rubber plantation),), as defined in the following equation (31).

$$\Delta C_{AB_{tree},i} = C_{AB_{tree_{bsl}},i} - C_{AB_{tree_{post}},i} \quad \textbf{(31)}$$

Where :
$\Delta C_{AB\ tree,i}$ = Baseline carbon stock change in aboveground tree biomass in stratum *i*; t CO2-e ha-1
$C_{AB\ treeBSL,i}$ = Forest carbon stock in aboveground tree biomass in stratum *i*; t CO2-e ha-1
$\Delta C_{AB\ treepost,i}$ = Post-deforestation carbon stock in aboveground tree biomass in stratum *i*; t CO2-e ha-1

Pre-deforestation stock is equal to the average carbon density estimated from biomass plots in the project area (98.38 tC/ha). Referring to the baseline stratification (sub section 5.4.3), long-term average carbon stock is dependent on the post deforestation land-use of acacia plantations and rubber tree plantations. For *Acacia crassicapa*, the long-term average carbon stock is calculated from the biomass dynamics of *Acacia crassicarpa* in plantations with the rotation of 5 year. For rubber tree (*Hevea brasiliensis*) plantations the long-term average carbon stockis estimated from the biomass dynamic of rubber tree plantation with a 25 year rotation cycle based on RSPO default value. Applying the VCS AFOLU guidance[16], calculation of the long-term average carbon stockof *Acacia crassicarpa* and *Hevea brasiliensis* was calculated as 17.66 tC/ha and 21.09 tC/ha, respectively. Carbon stock change ($\Delta AB_{tree,i}$ *or* *EF*) of forest convertion to *Acacia* plantation, rubber tree plantation, and infrastructure is 296.00 tCO_2-e ha^{-1}, 283.41 tCO_2-e ha^{-1}, and 352.81 tCO_2-e ha^{-}1, respectively. Table 46 provides an overview of the carbon stock changes and emissions within the project life time.

It is assumed that 100% of the deforested areas will be converted to plantations in the year of conversion. GHG emissions from fertilizer application and aboveground biomass loss due to fires are conservativelly excluded in the baseline.

[16] AFOLU Guidance: example for calculationg Long Term Average Carbon Stock for ARR project with harvesting

Stock changes in aboveground biomass is accounted for at the time of deforestation, and is estimated using the following equation **(**32**)**:

$$\Delta C_{BSL,i,t} = AA_{planned,i,t} * \Delta C_{ABtree,i} \quad \textbf{(32)}$$

Where :
$\Delta C_{BSL,i,t}$ = Sum of the baseline carbon stock change in all pools in stratum *i* at time *t,* t CO2-e
$AA_{planned,i,t}$= Annual area of baseline planned deforestation for stratum *i* at time *t*; ha
$\Delta AB_{tree,i}$ = Baseline carbon stock change in aboveground tree biomass in stratum *i*; t CO2-e ha-1

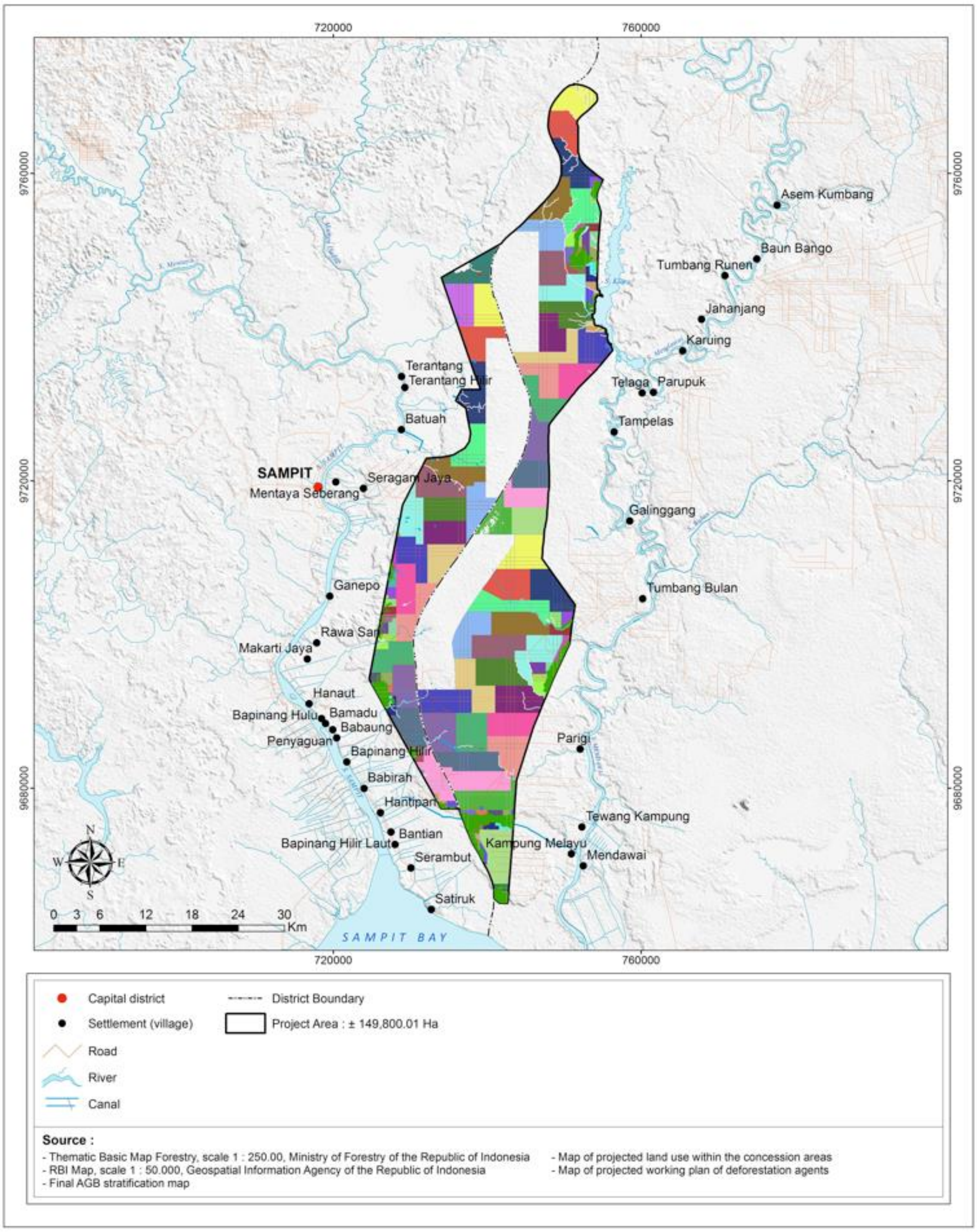
Total emissions from deforestation in the project crediting period are estimated as **34,037,000 tCO2** which is released from forest conversion from 2011 to 2031 (see Table 46 and Map 35 below).

Table 46.Carbon stock changes and emissions from deforestation in project area within project life time.

Year	Emission (x1000 tCO2-e) resulted from the conversion from forest to									TOTAL
	Acacia plantation			Infrastructure			Rubber tree plantation			
	Agent A	*Agent B*	*Agent C*	*Agent A*	*Agent B*	*Agent C*	*Agent A*	*Agent B*	*Agent C*	
2011	470	-	-	149	-	-	38	-	-	657
2012	485	-	-	-	-	-	44	-	-	529
2013	487	452	607	-	132	143	51	37	60	1,970
2014	484	452	604	-	-	-	44	25	73	1,682
2015	490	449	598	67	-	-	43	49	72	1,768
2016	487	479	571	-	-	-	35	22	56	1,651
2017	490	466	597	-	56	73	50	59	23	1,813
2018	498	482	576	-	-	-	36	54	80	1,726
2019	509	449	577	67	-	-	51	21	51	1,725
2020	502	459	588	-	-	-	49	51	67	1,715
2021	488	450	591	-	51	67	55	48	19	1,769
2022	488	459	575	-	-	-	40	16	33	1,611
2023	482	493	621	57	-	-	16	10	24	1,702
2024	481	449	605	-	-	-	3	49	26	1,612
2025	476	456	538	-	59	68	7	44	23	1,670
2026	472	448	546	-	-	-	44	51	36	1,597
2027	491	457	579	64	-	-	26	30	17	1,664
2028	478	464	567	-	-	-	38	38	-	1,585
2029	490	467	573	-	55	72	24	45	18	1,744
2030	459	439	604	-	-	-	33	46	29	1,610

Year	Emission (x1000 tCO2-e) resulted from the conversion from forest to									TOTAL
	Acacia plantation			Infrastructure			Rubber tree plantation			
	Agent A	*Agent B*	*Agent C*	*Agent A*	*Agent B*	*Agent C*	*Agent A*	*Agent B*	*Agent C*	
2031	-	392	581	-	-	-	-	41	39	1,052
2032	-	452	676	-	-	-	-	53	1	1,181
2033	-	-	-	-	-	-	-	-	-	-
2070	-	-	-	-	-	-	-	-	-	-
TOTAL	9,708	9,114	11,773	404	353	423	726	788	747	34,037
			30,595			1,180			2,262	

Map 35. Projected emissions from deforestation in the project area



5.3.7 Baseline emissions from ARR activities

Under the baseline scenario, ARR activities are carried out in the non-forest community buffer areas of the three deforestation agents (timber plantation companies). Based on spatial analysis, in total 4,227.72 ha will be planted with rubber tree (*Hevea brasiliensis*); 1,004.37 ha by agent A, 1,018.52 ha by agent B, and 2,204.82 ha by agent C.

The annual planting rate is set equal to the deforestation rate that resulted from analyses in the reference region. For rubber, the plantation was assumed to operate on a 25 year rotation (i.e. harvested and replanted every 25 years). We assumed 3 planting times and 2 harvesting times within the project period. Activities and sequences associated with the establishment of rubber tree plantation under baseline scenario are summarized in Table 47 below.

Table 47. The assumed annual planting and harvesting under ARR activities within the project periode

	Planting									Harvesting					
Agent	Agent A			Agent B			Agent C			Agent A		Agent B		Agent C	
Year/Rotation	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*1*	*2*	*1*	*2*
2010	-														
2011	44														
2012	49			-			-								
2013	-			91			66								
2014	27			98			14								
2015	29			3			12								
2016	47			53			171								
2017	-			1			214								
2018	58			9			0								
2019	15			125			103								
2020	3			0			42								
2021	30			25			135								
2022	66			142			100								
2023	119			166			139								
2024	158			61			130								
2025	152			29			134								
2026	30			-			83								
2027															

	Planting									Harvesting					
Agent	Agent A			Agent B			Agent C			Agent A		Agent B		Agent C	
Year/Rotation	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*1*	*2*	*1*	*2*
	65			93			141								
2028	18			36			187								
2029	75			12			152								
2030	22			33			88								
2031	-			37			70								
2032	-			3			223								
2033	-			-			-								
2034	-			-			-								
2035	-	-		-			-			-					
2036	-	44		-			-			44					
2037	-	49		-	-		-	-		49		-		-	
2038	-	-		-	91		-	66		-		91		66	
2039	-	27		-	98		-	14		27		98		14	
2040	-	29		-	3		-	12		29		3		12	
2041	-	47		-	53		-	171		47		53		171	
2042	-	-		-	1		-	214		-		1		214	
2043	-	58		-	9		-	0		58		9		0	
2044	-	15		-	125		-	103		15		125		103	

	Planting									Harvesting					
Agent	Agent A			Agent B			Agent C			Agent A		Agent B		Agent C	
Year/Rotation	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*1*	*2*	*1*	*2*
2045	-	3		-	0		-	42		3		0		42	
2046	-	30		-	25		-	135		30		25		135	
2047	-	66		-	142		-	100		66		142		100	
2048	-	119		-	166		-	139		119		166		139	
2049	-	158		-	61		-	130		158		61		130	
2050	-	152		-	29		-	134		152		29		134	
2051	-	30		-	-		-	83		30		-		83	
2052	-	65		-	93		-	141		65		93		141	
2053	-	18		-	36		-	187		18		36		187	
2054	-	75		-	12		-	152		75		12		152	
2055	-	22		-	33		-	88		22		33		88	
2056	-	-		-	37		-	70		-		37		70	
2057	-	-		-	3		-	223		-		3		223	
2058	-	-		-	-		-	-		-		-		-	
2059	-	-		-	-		-	-		-		-		-	
2060	-	-	-	-	-		-	-		-	-	-		-	
2061	-	-	44	-	-		-	-		-	44	-		-	
2062	-	-	49	-	-	-	-	-	-	-	49	-	-	-	-

	Planting									Harvesting					
Agent	Agent A			Agent B			Agent C			Agent A		Agent B		Agent C	
Year/Rotation	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*3*	*1*	*2*	*1*	*2*	*1*	*2*
2063	-	-	-	-	-	91	-	-	66	-	-	-	91	-	66
2064	-	-	27	-	-	98	-	-	14	-	27	-	98	-	14
2065	-	-	29	-	-	3	-	-	12	-	29	-	3	-	12
2066	-	-	47	-	-	53	-	-	171	-	47	-	53	-	171
2067	-	-	-	-	-	1	-	-	214	-	-	-	1	-	214
2068	-	-	58	-	-	9	-	-	0	-	58	-	9	-	0
2069	-	-	15	-	-	125	-	-	103	-	15	-	125	-	103
2070	-	-	3	-	-	0	-	-	42	-	3	-	0	-	42
	1,004	1,004	268	1,019	1,019	380	2,205	2,205	580	1,004	268	1,019	380	2,205	580

According to module BL-ARR, GHG emissions and removal are estimated using the procedure provided in AR-ACM0003 *Afforestation and reforestation lands except wetlands and associated pool*. Net GHG removals under the ARR baseline scenario up to time *t**; t CO2-e ($\Delta C_{BSL\text{-}ARR}$) is equal to the summation from *t*=1 to *t** of the baseline net GHG removals by sinks in year *t*;(ΔC) in AR-ACM0003, as describe in equation (33):

$$\Delta C_{BSL-ARR} = \sum_{t=1}^{t^*} (\Delta C_{BSL,t\ ACM0003}) \qquad (33)$$

Where:

$\Delta C_{BSL\text{-}ARR}$	Net GHG removals under the ARR baseline scenario up to time t; t CO2-e
$\Delta C_{BSL,t\ ACM0003}$	Baseline net GHG removal by sinks in year t (from AR-ACM0003) (t CO2-e)
t = 1,2,3,...	t time since project start
$C_{TREE,BSL,t}$	Change in carbon stock in tree biomass under baseline scenario, in year t: tCO2-e
t = 1,2,3,...	t time since planting start

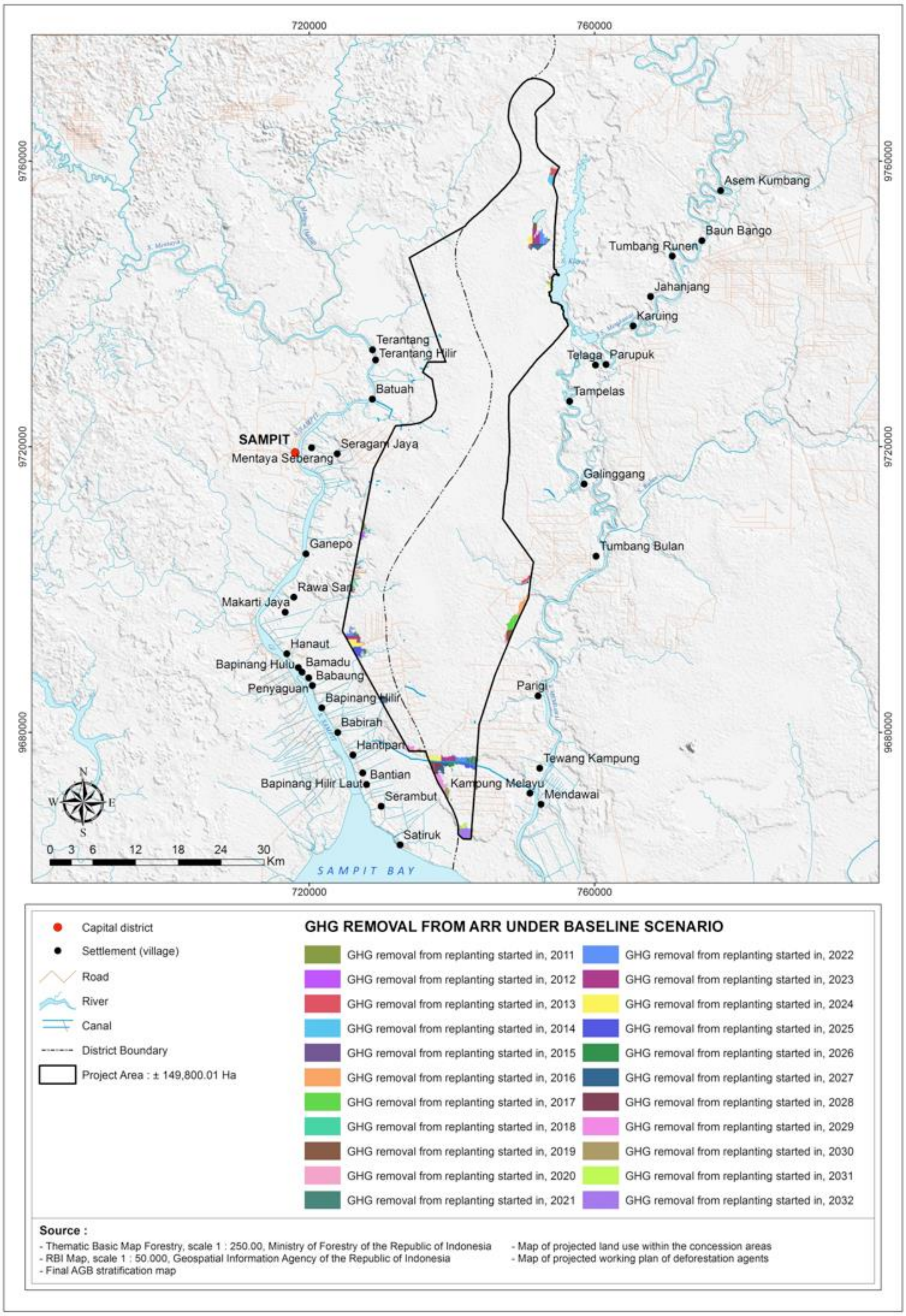
Net GHG removals under the ARR baseline scenario within the project period are estimated at 445,017.19 tCO2-e. Annual GHG removals and emissions (carbon losses because of harvesting are subtracted) under ARR are presented in Table 48 below.

Table 48. Baseline net GHG removal from ARR activities in project area within project periode

Year	NET GHG removal from ARR (tCO2-e)			
	Agent A	Agent B	Agent C	Total
2010	-	-	-	-
2011	295.26	-	-	295.26
2012	627.61	-	-	627.61
2013	627.61	614.85	443.25	1,685.71
2014	812.35	1,279.02	540.50	2,631.87
2015	1,005.45	1,297.58	620.71	2,923.75
2016	1,323.53	1,653.95	1,779.78	4,757.26
2017	1,323.53	1,663.70	3,226.08	6,213.31
2018	1,713.96	1,724.03	3,226.09	6,664.08
2019	1,813.52	2,567.54	3,924.44	8,305.51
2020	1,833.52	2,569.33	4,205.61	8,608.45
2021	2,033.10	2,739.54	5,119.77	9,892.42
2022	2,477.39	3,701.74	5,793.70	11,972.83
2023	3,278.98	4,823.03	6,736.93	14,838.95
2024	4,347.82	5,235.67	7,617.13	17,200.62
2025	5,375.53	5,432.88	8,522.22	19,330.64
2026	5,577.71	5,432.88	9,085.99	20,096.59
2027	6,017.45	6,064.77	10,041.17	22,123.40
2028	6,139.46	6,306.49	11,306.38	23,752.33
2029	6,646.71	6,389.04	12,332.16	25,367.91
2030	6,793.19	6,613.50	12,929.09	26,335.77
2031	6,793.19	6,865.32	13,403.43	27,061.94
2032	6,793.19	6,888.91	14,912.58	28,594.68
2033	6,793.19	6,888.91	14,912.58	28,594.68
2034	6,793.19	6,888.91	14,912.58	28,594.68

Year	NET GHG removal from ARR (tCO2-e)			
	Agent A	Agent B	Agent C	Total
2035	6,793.19	6,888.91	14,912.58	28,594.68
2036	(588.25)	6,888.91	14,912.58	21,213.24
2037	(1,515.60)	6,888.91	14,912.58	20,285.89
2038	6,793.19	(8,482.22)	3,831.28	2,142.25
2039	2,174.59	(9,715.45)	12,481.34	4,940.47
2040	1,965.67	6,424.92	12,907.27	21,297.86
2041	(1,158.68)	(2,020.40)	(14,064.16)	(17,243.23)
2042	6,793.19	6,635.45	(21,244.78)	(7,816.14)
2043	(2,967.52)	5,371.00	14,912.17	17,315.64
2044	4,304.02	(14,208.74)	(2,546.12)	(12,450.83)
2045	6,293.36	6,834.57	7,883.41	21,011.34
2046	1,803.53	2,623.70	(7,941.44)	(3,514.20)
2047	(4,313.97)	(17,175.85)	(1,935.69)	(23,425.52)
2048	(13,246.71)	(21,152.96)	(8,668.17)	(43,067.84)
2049	(19,927.74)	(3,436.77)	(7,092.32)	(30,456.83)
2050	(18,899.52)	1,751.51	(7,714.86)	(24,862.86)
2051	1,738.68	6,681.94	818.32	9,238.94
2052	(4,200.38)	(9,115.17)	(8,966.91)	(22,282.46)
2053	3,742.92	638.92	(16,717.48)	(12,335.64)
2054	(5,887.89)	4,618.14	(10,731.98)	(12,001.74)
2055	3,131.16	1,070.53	(10.63)	4,191.07
2056	6,793.19	386.43	3,053.91	10,233.52
2057	6,793.19	6,092.22	(22,816.09)	(9,930.68)
2058	6,793.19	6,681.94	14,912.58	28,387.71
2059	6,793.19	6,681.94	14,912.58	28,387.71
2060	6,793.19	6,681.94	14,912.58	28,387.71
2061	(588.25)	6,681.94	14,912.58	21,006.28
2062	(1,515.60)	6,681.94	14,912.58	20,078.92
2063	6,793.19	(8,689.19)	3,831.28	1,935.28
2064	2,174.59	(9,922.42)	12,481.34	4,733.51
2065	1,965.67	6,217.95	12,907.27	21,090.89
2066	(1,158.68)	(2,227.36)	(14,064.16)	(17,450.20)
2067	6,793.19	6,691.69	(21,244.78)	(7,759.90)
2068	(2,967.52)	5,183.53	14,912.17	17,128.17
2069	4,304.02	(14,446.78)	(2,546.12)	(12,688.88)
2070	6,293.36	6,594.74	7,602.24	20,490.34
TOTAL	116,123.60	100,941.92	224,209.19	441,274.71

Map 36. Pojected spatial GHG removal from ARR under baseline scenario



5.3.8 Significant sources of baseline emissions

No significance tests were necessary since, as described in section 4.4.3, all carbon pools not included in the baseline and project have either been shown to increase more or decrease less in the project relative to the baseline scenario, or been conservatively excluded. All mandatory pools have been included and all sources of GHG emissions have either been included or conservatively excluded.

5.4 Project Emissions (CL2)

5.4.1 General procedures and assumptions

Project emissions and changes in project emissions and carbon stocks will in the future partly be determined from site specific data. Until no site specific data is available, calculations will be based on proxy analyses and (IPCC) default emissions factors.

Emissions in the project scenario that are accounted result from:

1. Above ground biomass stock changes due to REDD and ARR activities
2. Peat microbial decompositions
3. Water bodies

The planned project activities related to climate are described in Section 2.2.1 and mainly include 1) rewetting of drained peatland, 2) conservation of existing undrained peat, 3) replanting of vegetation, 4) avoidance of any deforestation and forest degradation, 5) zero burning, fire control and fire prevention.

Since the project is planned to conduct rewetting and fire-prevention activities, uncontrolled burning is assumed to be absent in the project area during the project period hence no GHG emissions are expected to occur. However, the project had a dedicated fire monitoring plan as part of the larger fire management effort and where fires occur, associated emissions will be accounted for during each monitoring event. It is assumed that no non-human induced rewetting will appear in the project scenario.

GHG sources included In or excluded from project emission is listed in Sub-section 4.4.4. The emissions of N_2O from rewetted organic soils are controlled by the quantity of N available for nitrification and denitrification, and the availability of the oxygen required for these chemical reactions. Oxygen availability is in turn controlled by the depth of the water table. Raising the depth of the water table will cause N_2O emissions to decrease rapidly, and fall practically to zero if the depth of the water table is less than 20 cm below the surface [[30]].

During a transient period directly after rewetting, soil CH_4 emissions may be higher before they stabilize to levels in undrained or never-drained sites. In the first-instance, this variability is omitted, and CH_4 emissions from the rewetted strata were quantified by using TIER 1 IPCC defaults for 'rewetted' or 'undrained' organic soils (see Appendix 6). Upon rewetting, post 2017, CH_4 emission from rewetted strata will be directly-monitored and once sufficient data from the site has been collected CH_4 emission will be re-assessed and this variability will be taken into account in GHG emissions quantification by using site-specific data.

5.4.2 Emission characteristics in project scenario

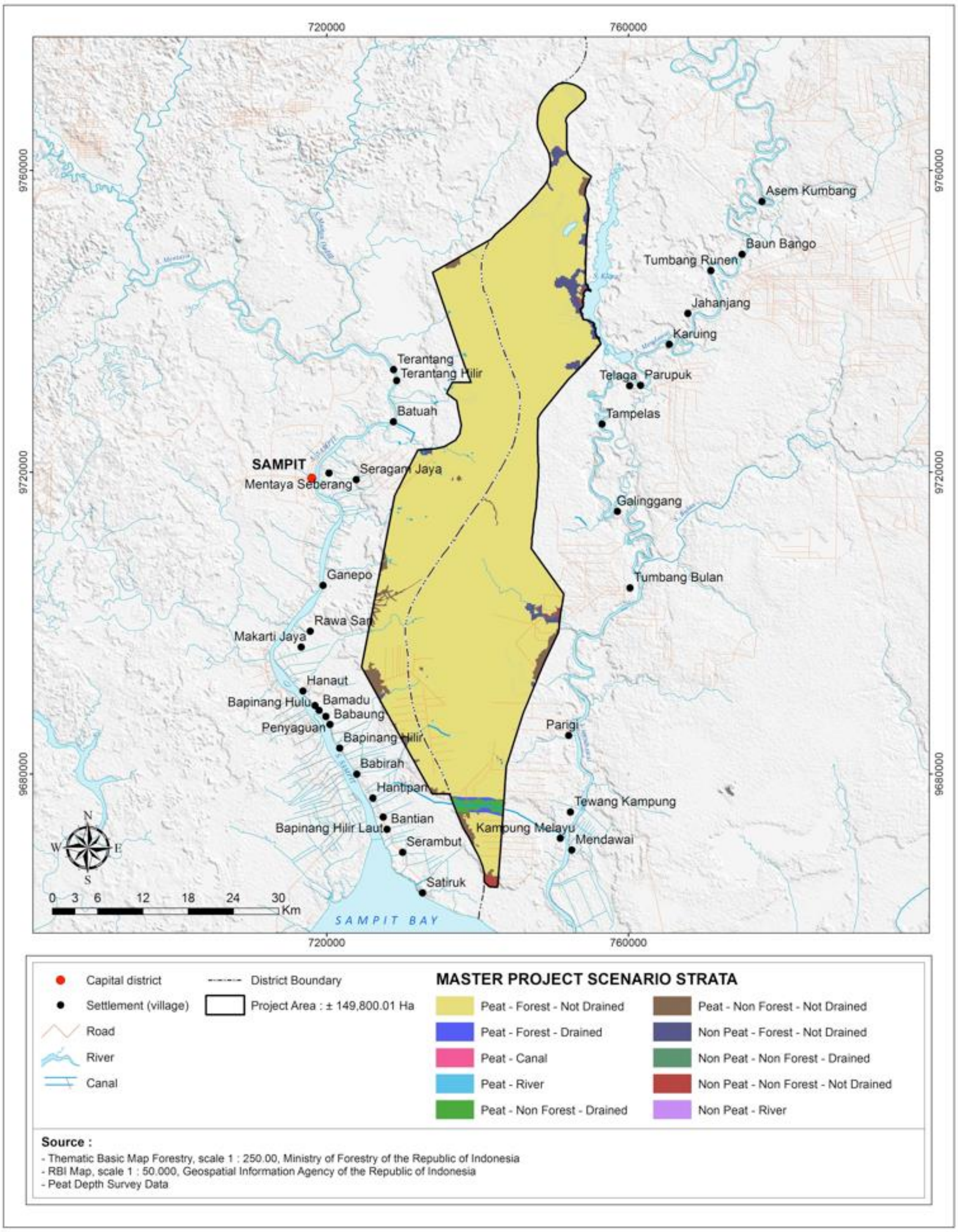
For the project scenario, the project area has been stratified into five strata based on two land cover classes (forest and non-forest), two drainage statuses (drained and undrained) and one water body class through a Combination-Elimination process as described in Annex 14. From this stratification, a project scenario map has been developed (see Map 37). The mapping process of the Project Scenario Map involved the following steps:

- Delineation of forest and non-forest area at the project start date. This process is described in section 4.4.1.1.
- Delineation of water bodies present at the project start date (rivers and canals)

- Delineation of drained and undrained area at the project start date. Drainage canals in the project area were mapped based on the BIG river map 2008 (that also include canals). Drainage impacts were assumed to extend 1 km from canal sides. This assumption was made following direct observations on fire impacts along the Hantipan canal where peat burnings have been contained within a belt c.a. 1 km from canal sides. The presence of drainage canals always results in differential lowering of water tables perpendicular to canals (fundamental law of water movement in unconfined aquifer, Remson, Hornberger and Molz, 1971) with diminishing drawdown as the location gets far from the canal. At 1 km from canal water table drops are apparently small enough to keep peat soil moist and resists burning (see Annex 5).
- The overlay of the delineations from above three steps provided the project scenario map as presented in Map 37.

The project scenario map has been translated into project scenario maps relevant to each activity as described in later paragraphs.

Map 37. Master project scenario map



5.4.2.1 Emission characteristic stratification for WRC under project scenario

The locations of WRC activities under the project scenario are chosen based on the project activities described in Map 6 in Sub-section 2.2.1, and were defined and mapped on the basis of the project scenario map (see Map 37) by taking into account (1) Coverage of initial land use / cover / drainage status and (2) Timing of land use change / drainage status under the project scenario based on planned rewetting (3) peatland coverage. The stratification map of emission characteristics for WRC activities presents the following information:

1. Location and coverage area of land use (vegetation cover, water bodies, etc). Spatial distributions of different land use translates into variability of emission factors.

2. Timings of drainage canal blocking (rewetting). Temporal distributions of different drainage status translates into different onsets or sequence of emission factors.
3. Location of peatland (outside which WRC activities are not relevant)

In the project scenario, five strata that significantly differ in characteristics of emissions from peat and water body were assumed as summarized in Table 49 and Map 38. The summary of dynamics of strata changes is presented in Table 50 and Map 39.

Table 49. Stratification of project area based on relative homogeneous emission characteristics from peat and water body at project start date

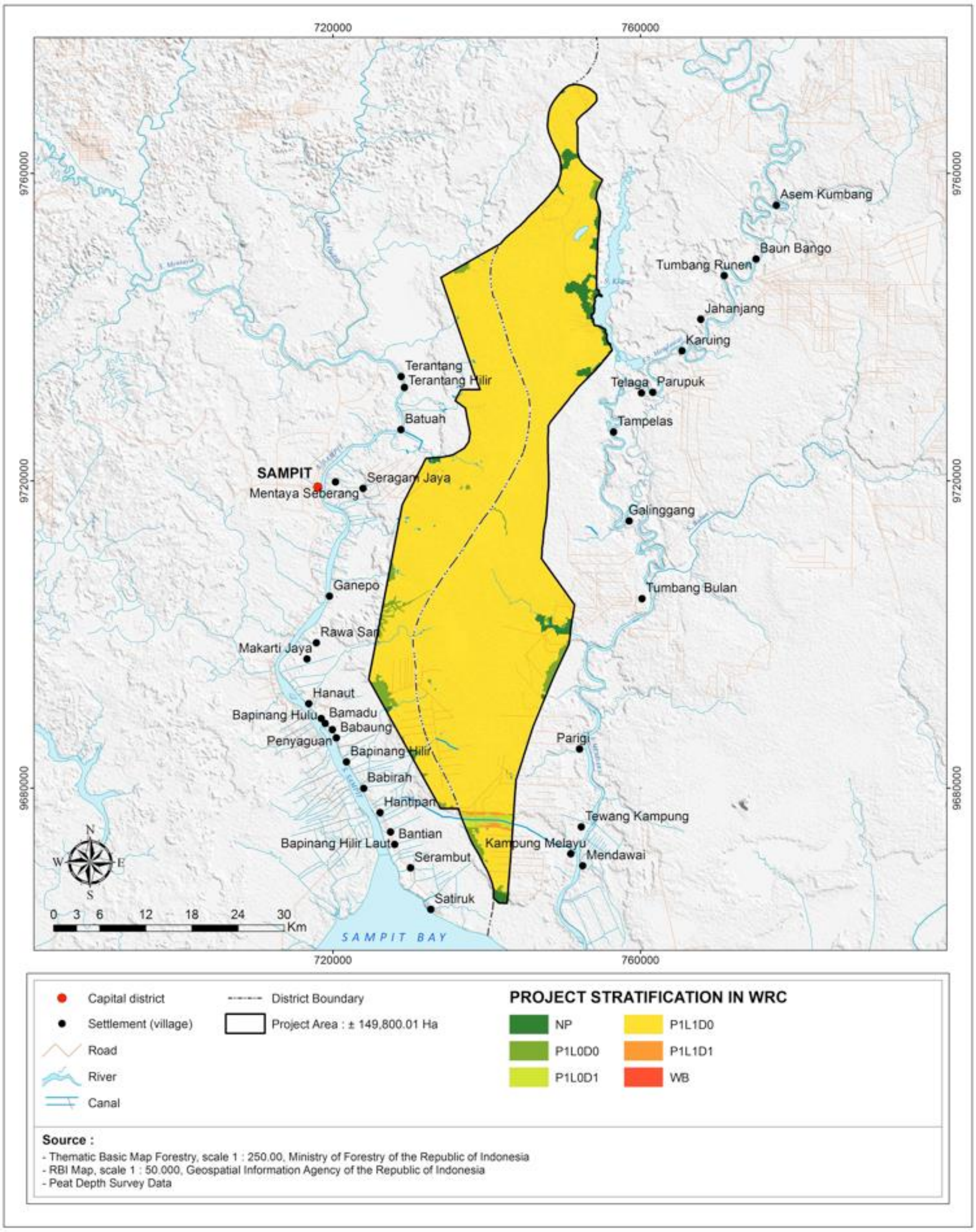
Strata	Description	Area (hectares)	Percentage of Project Area
P1L0D0	Undrained non-forested peatland. This stratum represents peatland where forest cover is absent at project start date, due to burnings and/or logging before project start date; while drainage impact from man-made canals is absent or minimal. Illegal loggers sometimes construct and utilize shallow canals (up to 1 meter depth) to transport timbers from logging locations to nearby rivers in wet season. Once utilized these canals have been abandoned and naturally collapsed and filled with debris. With this consideration wherever this type of canals present in the stratum impact on water table depth is assumed negligible since: (1) canals depth is shallow and discharge in dry season is negligible, (2) natural blocking occurs and further limits water outflow from the peatland.	3,172	2.1
P1L0D1	Drained non-forested peatland. This stratum represents peatland where forest cover is absent at project start date, due to burnings and/or logging before project start date; while drainage impact from man-made canals is present. This stratum is located in part of a *c.a.* 1 km belt along both sides of Hantipan canal, to the south of the project area.	987	0.7
P1L1D0	Undrained forested peatland. This stratum represents peatland where forest cover is present at project start date while drainage impact from man-made canals is absent. This stratum covers the most part of the project area.	141,910	94.7
P1L1D1	Drained forested peatland. This stratum represents peatland where forest cover is present at project start date while drainage impacts from man-made canals are also present. This stratum is located in part of a *c.a.* 1 km belt along both sides of Hantipan canal, to the south of the project area.	354	0.2
WB	Water body. The water body stratum includes rivers and man-made canals present at the project start date. The only man-made canal, assumed significantly impacting water table depth in the project area is Hantipan canal to the south of the project area.	216	0.1
Total		146,638	97.9

Table 50. Changes in strata based on relative homogeneous emission characteristics from peat and water bodies in the project scenario

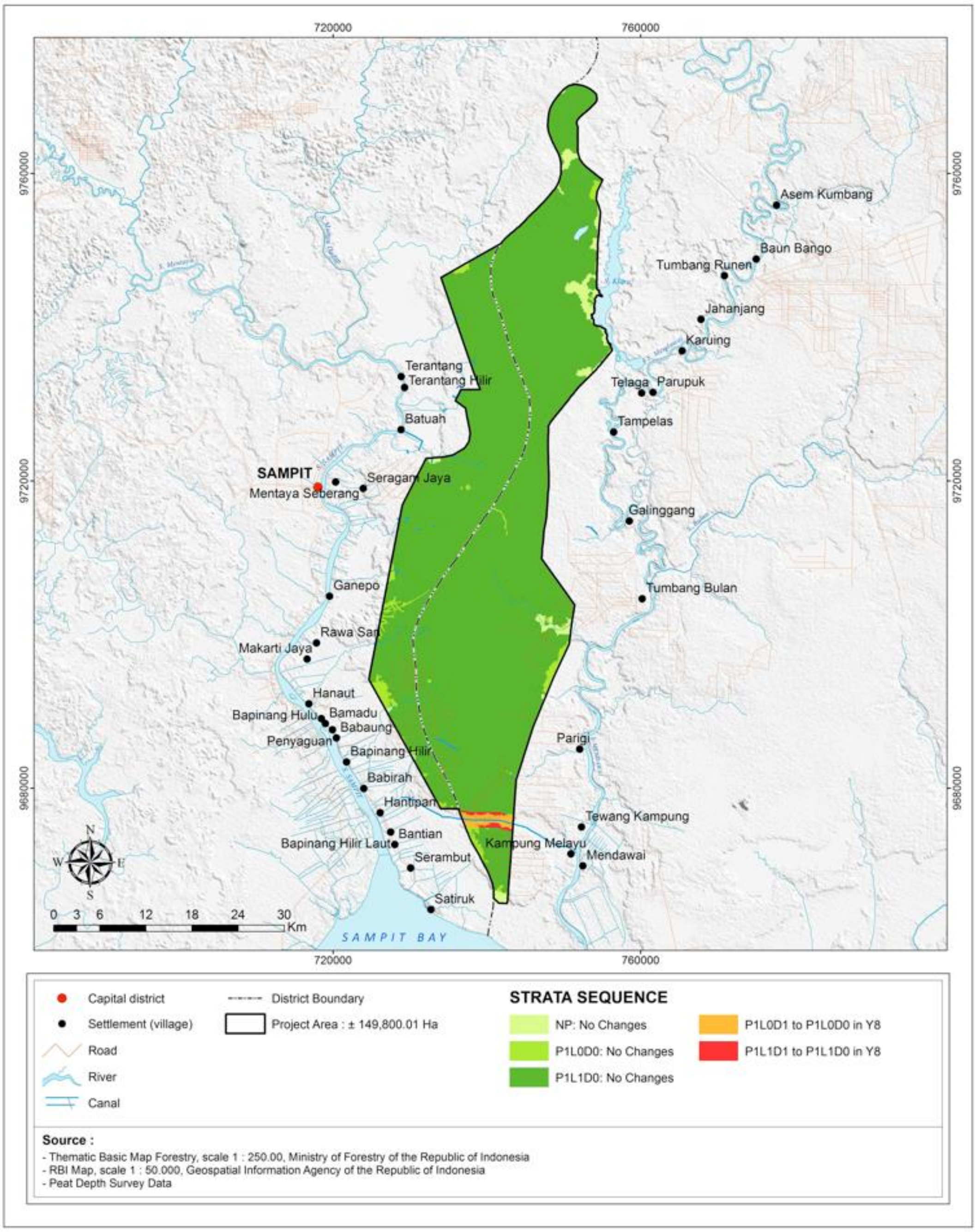
From Strata	To Strata	Area (hectares)	Year of changes	Description
P1L0D1	P1L0D0	987	2017	Planned rewetting activity expected to take effect in 2017
P1L1D1	P1L1D0	354		

From Strata	To Strata	Area (hectares)	Year of changes	Description
P1L1D0	P1L1D0	141,910		No changes in drainage status
P1L0D0	P1L0D0	3,172		
WB	WB	216		
Total		146,638		

Map 38. Strafication based on emission characteristics for WRC



Map 39. Strata changes in the project scenario



When sufficient direct measurements of peat GHG emissions and hydrological data have been collected, a site-specific proxy will be developed and hydrological modelling will be used to derive spatially and temporally specific estimates of water table depths under the project scenario. Details on hydrological modelling are given in Annex 11 and Annex 6. Together, land cover stratification and site-specific emission proxies will be used to restratify non-forest and strata with the most dynamic water table depths (rewetted strata that will undergo changes from P1L1D1 to P1L1D0 and from P1L0D1 to P1L0D0) based on emission characteristics in the project scenario. Strata with less dynamic water table depths (undrained forested stratum at project start date) will not be restratified (unless significant changes in emission characteristics have been observed) and GHG quantification method remains unchanged.

5.4.2.2 Emission characteristic stratification for REDD under project scenario

Project emissions and carbon stock changes related to land cover are driven by land cover changes as a result from deforestation and forest degradaton. Uncontrolled burning is assumed to be zero after project initiation, given the fire prevention programs.. During the project period, it is expected that 1699,1 ha of the project area is being deforested or degraded. Table 51 below shows the area in which deforestation, and forest degradation is expected. The dynamics of strata due to the expected threads in the project scenario are presented in Table 52.

Table 51. Land cover changes strata in the baseline scenario for REDD in the project scenario

Strata	Descripiton	GHG emission	Area (ha)
F0NF1	Forest to Non Forest	GHG emission from deforestation	199
F0DF1	Forest to degraded forest	GHG emission from forest degradation	1,500
Total			**1,699**

Under the project scenario, carbon enhancement is expected to take place as result from forest regrowth, anticipated to occur in all forested area after project initiation. Biomass accumulation will be measured during regular monitoring events.

.

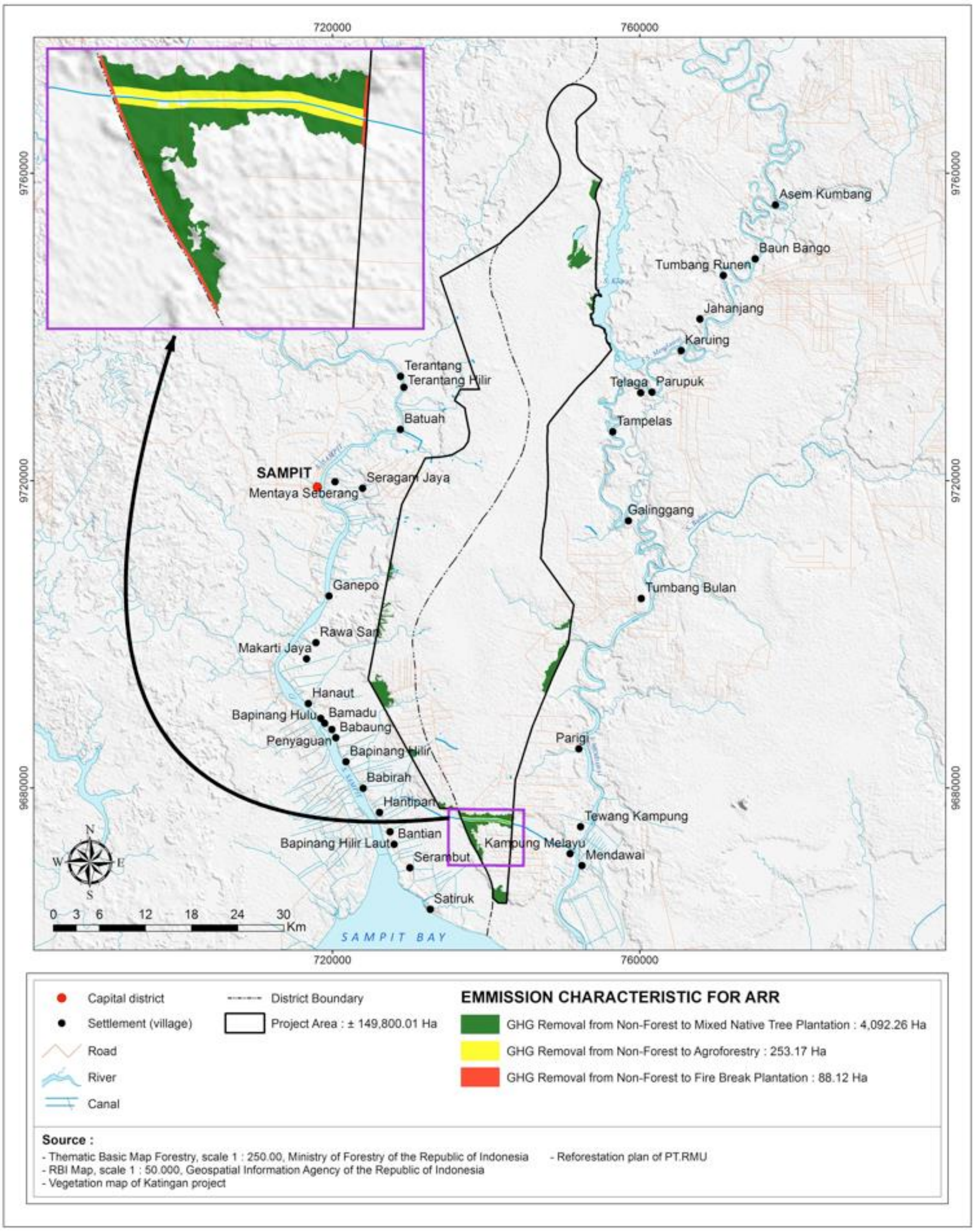
5.4.2.3 Emission characteristic stratification for ARR under project scenario

The main ARR activities in the project will include agroforestry, application of green fire breaks, and intensive reforestation. Based on spatial analysis, ARR activities are expected to be practiced in 4,433.56 ha of non-forest area (Table 52) of which 253.17 ha changes from non forest to mixed local and rubber tree plantation, 253.17 ha changes from non-forest to fire break stands and 4,092.26 ha changes from non-forest to mixed native PSF stands. The stratitication map and areas of emission stratification of ARR activities under the project scenario are shown in Map 40 and Table 52 below.

Table 52. Land cover changes strata in the baseline scenario for ARR in the project scenario

Strata	Description	Deliineated Areas	Area (Ha)
NF0Agr1	Non forest to agroforestry	Agroforestry areas	253
NF0FB1	Non forest to fire break plantation	Green Fire break areas	88
NF0Fplt1	Non Forest to native tree plantation	Intensive reforestation areas	4,092
TOTAL			**4,434**

Map 40. ARR emission characteristic stratification under project scenario



5.4.3 Project emissions from aboveground biomass due to deforestation and forest degradation

5.4.3.1 Emissions from deforestation

Based on the interpretation of landsat images for the period 2000-2010, the historical deforestation rate in the project area was estimated at 66 ha $year^{-1}$. Through project intervention (law enforcement, regular patrol, and communities engagement), it is assumed that the project is able to control deforestation. In the calculation, the historical rate of deforestation is assumed to be reduced by 70% to19.9 ha $year^{-1}$, and it is assumed that deforestation is totally avoided within 10 year (before 2020).

Per VCS methodology VM0007 moduel M-MON, the ex-ante net carbon stock change as result of deforestation is estimated by multiplying the deforested area and the net carbon stock by using the following equation (34).

$$\Delta C_{P.DefPA,i,t} = \sum_{u=1}^{U} A_{DefPA,u,i,t} * \Delta C_{pools,P.Def,u,i,t} \quad \textbf{(34)}$$

Where:

$\Delta C_{P,DeffPA,i,t}$ Net carbon stock change as a result of deforestation in the project case in the project area in stratum *i* at time *t*; tCO2-e

$A_{defPA,u,i,t}$ Area of recorded deforestation in the project area stratum i converted to land use *u* at time at time *t*; ha

$\Delta C_{pools,\ P,Def,\ u,i,t}$ Net carbon stock change in all pools in the project case in land use u in stratum *i* at the time *t*; tCO2-e ha^{-1}

Ex-ante GHG emissions as a result of deforestation in the project area within the project period is estimated to be 70,236.74 tCO_2, concentrated in the first 10 years after project initiation. We assume zero emission from deforestation after 2019, as a result of successful project implementation (Table 53)

Table 53. Ex-ante Net carbon stock change as a result of deforestation during the project period

Year	Area of recorded deforestation (ha)	Net carbon stock change as a result of deforestation (tCO2-e)
2010		-
2011	19.91	7,024
2012	19.91	7,024
2013	19.91	7,024
2014	19.91	7,024
2015	19.91	7,024
2016	19.91	7,024
2017	19.91	7,024
2018	19.91	7,024
2019	19.91	7,024
2020	19.91	7,024
2021		-
2070		-
Total	199.08	70,237

5.4.3.2 Emissions from forest degradation

Remote Sensing techniques have limitations regarding monitoring of forest degradation, therefore estimates of degradation rates in the project scenario are based on field observation and interviews with communities. The annual forest degradation rate is estimated at 500 ha $year^{-1}$. Through project intervention, it is assumed that the project is able to control degradation. In the calculation, forest degradation is assumed to be reduced by 70% of the historical rate to 150 ha $year^{-1}$, and it is assumed that forest degradation is totally banned within 10 year (before 2020).

Using the VCS methodology VM0007 module M-MON as a basis, ex-ante net carbon stock change as result from forest degradation is estimated by multiplying the extent of degraded forest and Net carbon stock in pools in the project case as described in the equation (35).

$$\Delta C_{P,DegW,i,t} = A_{DegW,i} * C_{DegW,i,t} \quad \textbf{(35)}$$

Where:

$\Delta C_{P,DegW,i,t}$ Net carbon stock change as a result of forest degradation in the project area at time t; tCO2-e

AdefPA,u,i,t Area of recorded forest degradation in stratum i; ha

$C_{DegW,i,t}$ Biomass carbon of trees cut and removed through degradation; tCO_2-e ha^{-1}

The carbon loss in AGB from degradation activities is assumed to be 70.15 tC ha-1, which is calculated by deducting the lowest carbon stock density (28.23 tC ha^{-1}) found in the biomass inventory from the average carbon density (98.38 $tCha^{-1}$) across 88 forest biomass plots distributed in project area.

Assuming for the purpose of this document that a total of 1500 ha of forest will experience degradation within the first ten years of the project period, ex-ante GHG emission as a result from forest degradation are estimated at 385,832.45 tCO_2-e (Table 54).

Table 54. Ex ante GHG emission from forest degradation during the project periode

Year	Area of recorded Forest degradation (ha)	Net carbon stock change as a result of forest degradation (tCO2-e)
2011	150	38,583
2012	150	38,583
2013	150	38,583
2014	150	38,583
2015	150	38,583
2016	150	38,583
2017	150	38,583
2018	150	38,583
2019	150	38,583
2020	150	38,583
2021		-
2070		-
Total	1,500	385,832

Forest degradation will be monitored according to the module M-MON. Associated emissions will be reported at each monitoring event.

5.4.3.3 Emissions from uncontrolled biomass burning

Assuming that the fire prevention program is succesfully implemeted by the project, it is assumed that no fire incident will occured after the project initiation.

5.4.4 Carbon enhancement from forest growth

Forest that are saved from conversion to plantations have potential for regrowth after project initiation due to historic degradation which occurred in the project area and hence are expected to accumulate biomass, removing CO_2. Per VMD0015 M-MON, ex-ante net carbon stock changes as a result of forest carbon stock enhancement estimated by multiplying the areas in which carbon stocks are accumulating and the carbon stock difference (between project and baseline case) as outlined by equation (36) below.

$$\Delta C_{P,Enh,i,t} = \sum_{t=1}^{t} \sum_{t=1}^{M} ((C_{P,i,t} - C_{BSL,i}) * A_{Enh,PL,i,t}) \quad \textbf{(36)}$$

Where

$\Delta C_{P,Enh,i,t}$	Net carbon stock changes as a result of forest carbon stock enhancement in stratum *i* in the project area at time *t*; t CO_2-e
$C_{P,i,t}$	Carbon stock in all pools in the project case in stratum *i* at time *t*; t CO_2-e
$C_{BSL,i}$	Carbon stock in all pools in the baseline in stratum *i*; t CO_2-e ha^{-1}
$A_{Enh,PL,i,t}$	Project area in stratum *i* in which carbon stocks are accumulating but that would have undergone planned deforestation in the baseline scenario at time *t*; ha
i 1, 2, 3 …	*M* strata
t 1, 2, 3, …	*t** years elapsed since the start of the REDD project activity

Carbon stock in the baseline stratum is equal to C stock of forest at project initiation year (98.38 tC/ha). The calculation of carbon stock in the project stratum is estimated by using annual C increment of tropical peat swamp forest in Indonesia (1.56 tC/ha/yr) [[31]]. The maximum cummulative stock is set to 191.98 tC/ha which refers to the sum up of the average C stock of forest and cummulative C increase within project period. As required by M-REDD, the areas projected to experience C enhancement from forest growth are limted to those that would be deforested in the baseline. Carbon stock enhancement is not accounted for in areas not deforestated in the baseline. Following projected deforestion presented in Table 51, ex-ante net carbon stock changes as a result of forest carbon stock enhancement estimated be **30,826,084 tCO2-e** within the project period, as presented by Table 55 below.

Table 55. Ex-ante net carbon stock changes as a result of forest carbon stock enhancement in the project area

Year	AA_def (ha)	A_enh,PL (ha)	ΔC_PEnh_WPS (tCO2-e)
2010	-	-	-
2011	2,146	2,146	-
2012	1,795	3,940	12,273
2013	6,529	10,470	22,539
2014	5,705	16,175	59,887
2015	5,961	22,136	92,520
2016	5,593	27,730	126,619
2017	6,076	33,806	158,613
2018	5,857	39,663	193,368
2019	5,811	45,474	226,871
2020	5,819	51,293	260,110
2021	5,930	57,223	293,395
2022	5,456	62,680	327,318
2023	5,727	68,407	358,528
2024	5,459	73,866	391,288
2025	5,585	79,451	422,512
2026	5,415	84,866	454,460
2027	5,598	90,464	485,433
2028	5,367	95,830	517,452
2029	5,837	101,667	548,150
2030	5,455	107,123	581,538
2031	3,567	110,690	612,743
2032	4,000	114,690	633,147
2033	-	114,690	633,147
2034	-	114,690	633,147
2035	-	114,690	633,147
2036	-	114,690	633,147
2037	-	114,690	633,147

Year	AA_def (ha)	A_enh,PL (ha)	ΔC_PEnh_WPS (tCO2-e)
2038	-	114,690	633,147
2039	-	114,690	633,147
2040	-	114,690	633,147
2041	-	114,690	633,147
2042	-	114,690	633,147
2043	-	114,690	633,147
2044	-	114,690	633,147
2045	-	114,690	633,147
2046	-	114,690	633,147
2047	-	114,690	633,147
2048	-	114,690	633,147
2049	-	114,690	633,147
2050	-	114,690	633,147
2051	-	114,690	633,147
2052	-	114,690	633,147
2053	-	114,690	633,147
2054	-	114,690	633,147
2055	-	114,690	633,147
2056	-	114,690	633,147
2057	-	114,690	633,147
2058	-	114,690	633,147
2059	-	114,690	633,147
2060	-	114,690	633,147
2061	-	114,690	633,147
2062	-	114,690	633,147
2063	-	114,690	633,147
2064	-	114,690	633,147
2065	-	114,690	633,147
2066	-	114,690	633,147
2067	-	114,690	633,147
2068	-	114,690	633,147
2069	-	114,690	633,147
2070	-	114,690	620,874
Total			**30,826,084**

Carbon stock enhancement will be monitored according to the VSC methodology VM0007 module M-MON and will be reported at each monitoring event.

5.4.5 Project emissions from peat and water body

2010 land use maps and 2008 official BIG (Indonesian Geospatial Information Agency) river maps are taken as a basis for developing relevant strata for WRC activities (see Table 49 in Sub-subsection 5.4.2.1). The strata that are distinguished in the project scenario based on this analyses are:

- Drained forested peatland
- Undrained forested peatland
- Drained non-forested peatland
- Undrained non-forested peatland, and
- Water body

Quantification of GHG emissions from microbial decompositions of peat and DOC loss through water bodies in peatlands has been performed by using a spatially and temporally explicit approach.

A) Spatial and temporal variability

Each stratum in the project scenario as set out in Table 49 was subdivided into parcels of the smallest land or water body unit with relatively uniform combinations of spatial variables as given in Table 56. Temporal variability in project emissions is captured by sequencing the calculations into 1 year time-steps. Variables that determine the sequence of strata changes, temporal variability of GHG emission parameters and temporal restrictions to GHG emissions are given in Table 56. The schematization provides an assurance of the proper use of GHG emission parameters at the correct spatial location and the correct time.

Table 56. Variables used in the schematization of quantification of GHG emissions from microbial decompositions of peat and dissolved organic carbon from water bodies in peatlands in the project scenario

Variables	Description
(A) Spatial Variables	
(A1) Type of soil	Distinction between peat or non-peat. This is used to exclude all non peat parcels from GHG calculation
(A2) Initial peat thickness available for microbial decompositions and burnings	Derived from DEM, DEL and Peat Thickness Map as described in 4.4.1.3. This is used as initial condition for subsequent calculations of the remaining available peat for microbial decompositions
(A3) Initial stratum within the peat area	Stratum of the corresponding parcel at project start date (as derived in 5.4.2.1) before conversion into other (rewetted) stratum takes effect. This is used to determine the correct Emission Factor for the corresponding parcel for the duration before B1 (in this table, below) takes effect
(B) Temporal Variables	
(B1) Year of rewetting	Determines the onset of conversion from initial stratum to rewetted stratum and sets all the drainage related parameters/variables accordingly, such as Emission Factor for the corresponding parcel
(B2) Remaining peat thickness available for microbial decompositions and burnings	Used to determine whether PDT in the project scenario has been reached for the corresponding parcel at the corresponding year. If the remaining peat available for microbial decomposition in a given stratum has been reduced to 20 cm all GHG emissions in that stratum are set to zero.

B) Emission calculations

Taking into account the spatial and temporal variability given in Table 49 and Table 50, for each parcel within the project strata the net CO_2-equivalent emissions from the peat microbial decompositions and water bodies were estimated using the same procedures provided in VCS methodology VM0007 module BL-PEAT as set out in module M-PEAT and by eliminating the term $E_{peatburn\text{-}WPS,i,t}$ from the equation (37):

$$GHG_{WPS-WRC} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(E_{peatsoil-WPS,i,t} + E_{peatditch-WPS,i,t}\right) \quad \textbf{(37)}$$

Where:

$GHG_{WPS\text{-}WRC}$ Net CO_2 equivalent peat GHG emissions in the project scenario up to year $t*$ (t CO_2e)

$E_{peatsoil\text{-}WPS,i,t}$ GHG emissions from microbial decomposition of the peat soil within the project boundary in the project scenario in stratum i in year t (t CO_2e yr^{-1})

$E_{peatditch\text{-}WPS,i,t}$ GHG emissions from water bodies within the project boundary in the project scenario in stratum i in year t (t CO_2e yr^{-1})

$E_{peatburn\text{-}WPS,i,t}$ GHG emissions from burning of peat within the project boundary in the project scenario in stratum i in year t (t CO_2e yr^{-1})). In this project this term equals

	zero.
i	1, 2, 3 …*M* strata in the project scenario (unitless)
t	1, 2, 3, … *t** time elapsed since the project start (years)

GHG emissions from peat soils comprise GHG emission as CO_2 and CH_4,, as calculated according to the following equation (38):

$$E_{peatsoil-WPS,i,t} = E_{Proxy-CO2,i,t} + E_{Proxy-CH4,i,t} \quad \textbf{(38)}$$

Where:

$E_{proxy-CO2,i,t}$	CO_2 emissions from the peat soil within the project boundary in the project scenario in stratum *i* at year *t* (t CO_2e yr^{-1})
$E_{Procy-CH4,i,t}$	CH_4 emissions from the peat soil within the project boundary in the project scenario in stratum *i* at year *t* (t CO_2e yr^{-1})

Procedures for the quantification of dynamics of carbon stock and peat losses are similar to those that apply to the baseline scenario (see Sub-section 5.3.4), with the only difference in the 1) stratification, 2) sequence of strata, and 3) the assumed absence of burning in the project scenario.

C) Subsidence related to microbial decomposition of peat
To maintain consistency between annual net CO_2-equivalent emissions and remaining peat carbon stock, annual rates of peat and carbon stock loss in the project scenario were quantified annually based on the rate of emissions from microbial decompositions of peat (CO_2 and CH_4 decomposition), bulk density of peat above water table, and a conservative carbon content value (48 kg.kg^{-1} dry mass) using the equation (39).

$$Rate_{peatloss-WPS,i,t} = \left(\frac{12}{44} \times \frac{E_{Proxy-CO2,i,t}}{BD_{WPS,i,t} \times C_c \times 10}\right) + \left(\frac{1}{GWP_{CH4}} \times \frac{12}{16} \times \frac{E_{Proxy-CH4,i,t}}{BD_{WPS,i,t} \times C_c \times 10}\right) \quad \textbf{(39)}$$

Where:

$Rate_{peatloss-WPS,I,t}$	Rate of peatloss due to microbial decompositions in project scenario of stratum i at year t (m.y^{-1})
$D_{peatburn-WPS,i,t}$	Burn scar depth under project scenario in stratum *i* at year *t* (m)
$BD_{WPS,i,t}$	Bulk density of peat soil above water table in project scenario in stratum *i* at year *t** (kg.m^{-3})
$E_{proxy-CO2,i,t}$	CO_2 emissions from microbial decomposition of peat in project scenario in stratum *i* at year *t* (tCO_2.ha^{-1}.y^{-1}). Equals CO_2 emission factor when peat available for decomposition > 20 cm, otherwise zero
$E_{proxy-CH4,i,t}$	CH_4 emissions from microbial microbial decomposition of peat in project scenario in stratum *i* at year *t* (tCO_2.ha^{-1}.y^{-1}). Equals CH_4 emission factor when peat available for decomposition > 20 cm, otherwise zero
GWP_{CH4}	Global Warming Potential of CH_4
Cc	Carbon content of peat soil (kg.kg^{-1})

Remaining peat thickness was assessed annually for project's life-time based on the rate of peat loss due to microbial decomposition of peat, using equation (40).

$$Depth_{peat-WPS,i,t} = Depth_{peat-WPS,i,t0} - \sum_{t=1}^{t=t*} Rate_{peatloss-WPS,i,t} \quad \textbf{(40)}$$

Where:

$Depth_{peat-WPS,i,t}$	Remaining peat thickness in the project scenario in stratum *i* at year *t** (m)
$Depth_{peat-WPS,i,t0}$	Peat thickness at the project scenario in stratum *i* at year *t0* = project start date (initial peat thickness) (m)
$Rate_{peatloss-WPS,i,t}$	Rate of peat loss due (subsidence) due to microbial decomposition of peat in the project scenario in stratum *i* in year *t* (m yr^{-1})
i	Strata

Peat carbon stock and its annual changes were calculated following annual peat carbon loss due to microbial decompositions using equation (41).

$$C_{stock-WPS,i,t} = C_{stock-WPS,i,t-1} - C_{loss-WPS,i,t-1} \quad \textbf{(41)}$$

Where:

$C_{stock-WPS,i,t}$	Remaining peat carbon stock in project scenario in stratum *i* at year *t* (t $C.ha^{-1}$)
$C_{stock-WPS,i,t-1}$	Remaining peat carbon stock in project scenario in stratum *i* at previous year (t $C.ha^{-1}$)
$C_{loss-WPS,i,t-1}$	Equivalent carbon stock loss from microbial decomposition of peat in project scenario in stratum *i* at previous year (t $C.ha^{-1}$)

By tracking annual peat carbon stock and peat thickness in the project scenario it has been assured that there is no GHG emissions has been accounted for within any parcel of each stratum once available carbon stock/peat has been depleted. Conservatively, peat is assumed depleted once peat thickness available for decompostions has been reduced to 20 cm

D) Summary of the projected GHG emissions from peat and water bodies in the project scenario

A summary of the projected GHG emissions from peat and water bodies in the project scenario are presented in Table 57.

Table 57. A summary of the annual GHG emissions from peat and water bodies under the project scenario up to 2070, in $tCO_2e.y^{-1}$.

Year	CO_2 from peat decomposition	CH_4 from peat decomposition	CO_2 from DOC	Total
2011	30,823	102,908	452	134,183
2012	30,823	102,908	452	134,183
2013	30,823	102,908	452	134,183
2014	30,823	102,908	452	134,183
2015	30,823	102,908	452	134,183
2016	30,823	102,908	452	134,183
2017	30,823	102,908	452	134,183
2018	6,238	103,172	452	109,862
2019	6,238	103,172	452	109,862
2020	6,238	103,172	452	109,862
2021	6,238	103,172	452	109,862
2022	6,238	103,172	452	109,862
2023	6,238	103,172	452	109,862

Year	CO_2 from peat decomposition	CH_4 from peat decomposition	CO_2 from DOC	Total
2024	6,238	103,172	452	109,862
2025	6,238	103,172	452	109,862
2026	6,238	103,172	452	109,862
2027	6,238	103,172	452	109,862
2028	6,238	103,172	452	109,862
2029	6,238	103,172	452	109,862
2030	6,238	103,172	452	109,862
2031	6,238	103,172	452	109,862
2032	6,238	103,172	452	109,862
2033	6,238	103,172	452	109,862
2034	6,238	103,172	452	109,862
2035	6,238	103,172	452	109,862
2036	6,238	103,172	452	109,862
2037	6,238	103,172	452	109,862
2038	6,238	103,172	452	109,862
2039	6,238	103,172	452	109,862
2040	6,238	103,172	452	109,862
2041	6,238	103,172	452	109,862
2042	6,238	103,172	452	109,862
2043	6,238	103,172	452	109,862
2044	6,238	103,172	452	109,862
2045	6,238	103,172	452	109,862
2046	6,238	103,172	452	109,862
2047	6,238	103,172	452	109,862
2048	6,238	103,172	452	109,862
2049	6,238	103,172	452	109,862
2050	6,238	103,172	452	109,862
2051	6,238	103,172	452	109,862
2052	6,238	103,172	452	109,862
2053	6,238	103,172	452	109,862
2054	6,238	103,172	452	109,862
2055	6,238	103,172	452	109,862
2056	6,238	103,172	452	109,862
2057	6,238	103,172	452	109,862
2058	6,238	103,172	452	109,862
2059	6,238	103,172	452	109,862
2060	6,238	103,172	452	109,862
2061	6,238	103,172	452	109,862
2062	6,238	103,172	452	109,862
2063	6,238	103,172	452	109,862
2064	6,238	103,172	452	109,862
2065	6,238	103,172	452	109,862
2066	6,238	103,172	452	109,862
2067	6,238	103,172	452	109,862

Year	CO_2 from peat decomposition	CH_4 from peat decomposition	CO_2 from DOC	Total
2068	6,238	103,172	452	109,862
2069	6,238	103,172	452	109,862
2070	6,238	103,172	452	109,862

The estimated project emissions shown in Table 57 are in the first instance based on TIER 1 default emission factors that apply to the various land uses. See Appendix 6 for the default factors used for the specific land uses. Details regarding the calculations of the emission numbers in Table 57 are provided in the Sub-subsections 5.4.3.1, 5.4.3.2 and 5.4.3.3.

5.4.5.1 Emissions from microbial decomposition of peat

This Section explains in more detail how the numbers for peat microbial decomposition in the project area in Table 57 are calculated.

For each land stratum emissions is calculated using equation (42):

$$E_{peatsoil\text{-}WPS,i,t} = E_{proxy\text{-}WPS,i,t} \quad \textbf{(42)}$$

Where:

$E_{peatsoil\text{-}WPS,i,t}$ Greenhouse gas emissions from the peat soil within the project boundary in the project scenario in stratum *i* in year *t* (t CO_2e yr^{-1})

$E_{proxy\text{-}WPS,i,t}$ GHG emissions as per the chosen proxy in the project scenario in stratum *i* in year *t*, in this project, based on IPCC default values (t CO_2e yr^{-1})

i 1, 2, 3 …M_{WPS} strata in the project scenario (unitless)

t 1, 2, 3, … t^* time elapsed since the project start (years)

GHG emissions from the peat soil per stratum in the project scenario are estimated using equation (43):

$$E_{proxy\text{-}WPS,i,t} = A_i \times (E_{proxy\text{-}CO2,i,t} + E_{proxy\text{-}CH4,i,t}) \quad \textbf{(43)}$$

Where:

$E_{proxy\text{-}WPS,i,t}$ GHG emissions as per the chosen proxy in the project scenario in stratum *i* in year *t* (t CO_2e yr^{-1})

A_i Total area of stratum *I* (ha)

$E_{proxy\text{-}CO2,i,t}$ Emission of CO_2 as per the chosen proxy in stratum *i* in year *t,* for TIER 1 approach this equals default CO_2 emission factor for stratum i (t CO_2e $ha^{-1}yr^{-1}$)

$E_{proxy\text{-}CH4,i,t}$ Emission of CH_4 as per the chosen proxy in stratum *i* in year *t,* for TIER 1 approach this equals default CH_4 emission factor for stratum i (t CO_2e $ha^{-1}yr^{-1}$)

i 1, 2, 3 …M_{WPS} strata[17] in the project scenario (unitless)

t 1, 2, 3, … t^* time elapsed since the project start (years)

Table 58 below, Table 35 and Table 49 in Sub-subsection 5.4.2.1 provide details on the WRC related project emission factors and stratification.

[17] Note that different water table classes result in different strata.

Table 58. The stratification used for the calculation of GHG emissions per stratum, the area (ha) per each stratum and the CO_2 and CH_4 default factors used for the specific land use

Strata	Description	Area (ha)	IPCC default emission factor for CO_2	IPCC default emission factor for CH_4	IPCC default emission factor for DOC
			(t CO_2-eq.ha^{-1} yr^{-1})	(t CO2-eq.ha^{-1} yr^{-1})	(t CO2-eq.ha^{-1} yr^{-1})
P1L0D0	Undrained deforested peatland	3,172	1.50	0.20	
P1L0D1	Drained deforested peatland	987	19.43	0.14	
P1L1D0	Undrained peatland forest	141,910	0	0.72	
P1L1D1	Drained peatland forest	354	19.43	0.14	
WB	Water bodies (rivers and canals) on peatland present at project start date	216			2.09

Note: Appendix 6 provides more details on the emission factors used.

A) Current projections for project emissions

At the start of the project, when sufficient long-term, site-specific measurements of peat related emissions have not yet been available for estimating overall emissions, GHG emission factors provided in Table 58 were used as a conservative and scientifically robust approach (TIER 1) IPCC default emission factors). Procedures follow the VCS methodology VM0007 modules BL-PEAT and M-PEAT. The estimation of GHG emissions in rewetted (RDP) or undrained or partially drained peat (CUPP) beyond 2017 follows similar procedures as described in the VCS methodology VM0007 module BL-PEAT. Projected annual GHG emissions from microbial decompositions of peat is peresented in Table 59.

Table 59. GHG emissions from microbial decompositions of peat in the project scenario in tCO_2-e.y^{1}.

Year	CO_2 from peat decomposition	CH_4 from peat decomposition	Total
2011	30,823	102,908	133,731
2012	30,823	102,908	133,731
2013	30,823	102,908	133,731
2014	30,823	102,908	133,731
2015	30,823	102,908	133,731
2016	30,823	102,908	133,731
2017	30,823	102,908	109,410
2018	6,238	103,172	109,410
2019	6,238	103,172	109,410
2020	6,238	103,172	109,410
2021	6,238	103,172	109,410
2022	6,238	103,172	109,410
2023	6,238	103,172	109,410
2024	6,238	103,172	109,410
2025	6,238	103,172	109,410
2026	6,238	103,172	109,410
2027	6,238	103,172	109,410
2028	6,238	103,172	109,410
2029	6,238	103,172	109,410

Year	CO_2 from peat decomposition	CH_4 from peat decomposition	Total
2030	6,238	103,172	109,410
2031	6,238	103,172	109,410
2032	6,238	103,172	109,410
2033	6,238	103,172	109,410
2034	6,238	103,172	109,410
2035	6,238	103,172	109,410
2036	6,238	103,172	109,410
2037	6,238	103,172	109,410
2038	6,238	103,172	109,410
2039	6,238	103,172	109,410
2040	6,238	103,172	109,410
2041	6,238	103,172	109,410
2042	6,238	103,172	109,410
2043	6,238	103,172	109,410
2044	6,238	103,172	109,410
2045	6,238	103,172	109,410
2046	6,238	103,172	109,410
2047	6,238	103,172	109,410
2048	6,238	103,172	109,410
2049	6,238	103,172	109,410
2050	6,238	103,172	109,410
2051	6,238	103,172	109,410
2052	6,238	103,172	109,410
2053	6,238	103,172	109,410
2054	6,238	103,172	109,410
2055	6,238	103,172	109,410
2056	6,238	103,172	109,410
2057	6,238	103,172	109,410
2058	6,238	103,172	109,410
2059	6,238	103,172	109,410
2060	6,238	103,172	109,410
2061	6,238	103,172	109,410
2062	6,238	103,172	109,410
2063	6,238	103,172	109,410
2064	6,238	103,172	109,410
2065	6,238	103,172	109,410
2066	6,238	103,172	109,410
2067	6,238	103,172	109,410
2068	6,238	103,172	109,410
2069	6,238	103,172	109,410
2070	6,238	103,172	133,731

B) Future approaches for calculating project emissions

For determining carbon and GHG fluxes from peat microbial decomposition in the project scenario different approaches (TIER 1 – TIER 3) will be used in the future. During the project life time, site-specific measurements (TIER 2 and TIER 3 approaches) will be undertaken and data will be collected to reduce uncertainties in emissions estimates related to water table spatial and temporal variations and to be able to build up a site-specific data set from which project emissions can be quantified for strata with most dynamic water table depths and all non forest strata (P1L0D0, P1L0D1, and P1L1D1). For stratum unaffected by drainage and deforestation (P1L1D0) water table depths are less dynamic, and TIER 1 approach will be used throughout the project life-time, unless significant changes in emission characteristics have been observed.

Beyond 2017, two TIER 3 methods will be applied to estimate project emissions. These methods complement each other and can be used for reducing uncertainty and for cross-checking methods (see also Annex 11):

- Soil subsidence monitoring. In the long term, soil subsidence is a reliable proxy for estimating carbon losses in peat soils.
- Direct emission measurements of CO_2 (and eventually CH_4). In combination with proxies such as water table depth, soil temperatures and soil moistures, the data will be used to build empirical site- and strata specific models.

Soil subsidence and water table depths are monitored in the project area since 2015, and monitoring will be continued throughout the project period of 60 years ahead.

5.4.5.2 Emissions from water bodies in peatlands

This Section explains in more detail how the numbers for emissions from water bodies in the project area in Table 57 have been calculated.

The water body stratum in the project scenario includes rivers and canals and changes in this stratum will be monitored during the project life-time. Per project rewetting activity plan, not all canals will be closed immediately and blocking of canals may result in additional open water bodies. Any change in the area of open water will be taken into account if it significantly influences project GHG emissions.

(TIER 1) IPCC values for DOC (Table 58) were used in first instance to estimate zero-situation and early project emissions from water bodies. A summary of emissions from Dissolved Organic Carbon in project scenario is given in Table 60. Beyond 2017, site-specific CO_2 andCH_4 or DOC measurements from water bodies will be performed based on which site-specific proxies for water body will be developed (see also Annex 11 for procedures).

Double accounting of water born losses will be avoided by using either DOC values or CO_2 and CH_4 only. GHG emission estimates from water bodies will be re-assessed annually during the project life-time

Calculating emissions from water body follows procedures set out in the VCS methodology VM0007 module M-PEAT for each water body stratum, using the equation (44).

$$E_{peatditch\text{-}WPS,i,t} = A_{ditch\text{-}WPS,i,t} \times EF_{DOC\text{-}WPS} \quad \textbf{(44)}$$

Where:

$E_{peatditch\text{-}WPS,i,t}$	GHG emissions from canals and other open water stratum *i* in year *t* in the project scenario (t CO_2e yr^{-1})
$A_{ditch\text{-}WPS,,i,,t}$	Total area of canal and other open water stratum *i* in year *t* in the project scenario (ha)

$EF_{DOC\text{-}WPS}$	IPCC emission factor of Dissolved Organic Carbon from canal and open in the project scenario (t CO_2e $ha^{-1}yr^{-1}$)
i	1, 2, 3 …M_{WPS} strata[18] in the project scenario (unitless)
t	1, 2, 3, … t^* time elapsed since the project start (years)

Table 60. GHG emissions from Dissolved Organic Carbon in water bodies in the project scenario in tCO_2-$e.y^{-1}$.

Year	CO_2 from DOC
2011	452
2012	452
2013	452
2014	452
2015	452
2016	452
2017	452
2018	452
2019	452
2020	452
2021	452
2022	452
2023	452
2024	452
2025	452
2026	452
2027	452
2028	452
2029	452
2030	452
2031	452
2032	452
2033	452
2034	452
2035	452
2036	452
2037	452
2038	452
2039	452
2040	452
2041	452
2042	452
2043	452
2044	452
2045	452
2046	452
2047	452

[18] Note that different proxy classes result in different strata.

Year	CO_2 from DOC
2048	452
2049	452
2050	452
2051	452
2052	452
2053	452
2054	452
2055	452
2056	452
2057	452
2058	452
2059	452
2060	452
2061	452
2062	452
2063	452
2064	452
2065	452
2066	452
2067	452
2068	452
2069	452
2070	452

5.4.5.3 Emissions from uncontrolled burning

Peatland rewetting and best-practice fire management (zero burning, fire control and fire prevention measures, as determined by the relevant authorities) are implemented as project activities, and therefore uncontrolled burning is assumed to be absent in the project scenario.

Regular fire-patrol teams are operating since the project start, and an online satellite-based early warning system is planned as part of the project program to detect fire in a very early stage. If uncontrolled burning occurs during the project period, the area of the fire scar and the burn scar depth will be mapped within no later than 3 months after the burning event (see Annex 12). Repetition of burning is determined by tracking historical hotspot and/or direct observation data for the project area coverage, and the maps of the burning area during the project period. Equivalent GHG emissions from uncontrolled burning will be quantified and deducted from emission reductions as per Section 5.6.

GHG emissions resulting from peat burning are calculated from dry mass loss based on burn scar, depths, bulk density of peat, combustion factors and GHG potential of GHG species. GHG emissions from biomass loss from burning are quantified based on land cover type, combustion factors and GHG potential of GHG species. Bulk density of peat is assumed constant throughout the project life-time and was found to be relatively homogeneous throughout horizontal and vertical peat soil profile (Annex 10).

For repeated burns, scar depths of the 1^{st}, 2^{nd} and 3^{rd} (plus) burnings are assumed 18, 11 and 4 cm in depth. Detailed parameters for quantifying GHG emissions from uncontrolled burning are given in Appendix 6.

Procedures for quantification of GHG emissions from peat burning follows the VCS methodology VM 0007 module E-BPB, using equation (45):

$$E_{peatburn-WPS,i,t} = \sum_{g=1}^{G} \left(\left(\left(A_{peatburn-WPS,i,t} \times (P_{WPS,i,t} + B_{WPS,i,t}) \times G_{g,i} \right) \times 10^{-3} \right) \times GWP_g \right) \quad \textbf{(45)}$$

Where:

$E_{peatburn-WPS,i,t}$	Greenhouse emissions due to peat and biomass burning under project scenario in stratum *i* in year *t* of each GHG (CO_2, CH_4, N_2O) (t CO_2e)
$A_{peatburn-WPS,i,t}$	Area peat burnt under project scenario in stratum *i* in year *t* (ha)
$P_{WPS,i,t}$	Average mass of peat burnt under project scenario in stratum *i*, year *t* (t d.m. ha^{-1})
$B_{WPS,i,t}$	Average biomass burnt under project scenario in stratum *i*, year *t* (t d.m. ha^{-1})
$G_{g,i}$	Emission factor in stratum *i* for gas *g* (kg t^{-1} d.m. burnt)
GWP_g	Global warming potential for gas *g (*t CO_2/t *g)*
g	1, 2, 3 .. *G* greenhouse gases including carbon dioxide, methane and nitrous oxide (unitless)
i	1, 2, 3 …*M* strata (unitless)
t	1, 2, 3, … *t* time elapsed since the start of the project activity (year)

The average mass of peat burnt for a particular stratum is estimated using equation (46) as follows:

$$P_{WPS,i,t} = D_{peatburn-WPS,i,t} \times BD_{upper} \times 10^{-4} \quad \textbf{(46)}$$

Where:

$P_{WPS,i,t}$	Average mass of peat burnt under project scenario in stratum *i*, year *t* (t d.m. ha^{-1})
$D_{peatburn-WPS,i,t}$	Average fire scar depth under project scenario in stratum *i* in year *t* (m)
$BD_{upper,i}$	Bulk density of the upper peat in stratum *I* (g cm^{-3})
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t* time elapsed since the start of the project activity (years)

5.4.5. Project emissions from ARR activities

Reforestation is planned as a project activity for areas that were deforested already before the project start, or became deforested within the first 10 years of the project. The project does not apply any ARR activity that includes timber harvesting or fertilization. Due to a variety of biophysical characteristics and social conditions in project area three reforestation designs are applied.

Agroforestry will be focused in an area of 253.17 ha, situated alongside the Hantipan canal. In this area, *Havea brasiliensis* and *Dyera lowii* will be planted with the spacing of 7 m x7 m.

Fire break plantations will be establihed in the area around the main canal in the south, and will be mainly concentrated in the areas along the boundary (east and west). These plantations aim to block fire spreading from neighbouring areas. For this purpose, two fire resistant tree species are selected; Cajuput tree (*Melaleuca spp*) and Tumih (*Combretocarpus rotundatus*). They will be planted with a spacing of of 3 m x 3 m.

Intensive reforestation will be fully carried out by PT. RMU, targeting almost all of the remaining non-forest area (4,092.26ha). There are at least three main species will be planted inlcuding Jelutong (*Dyera lowii*), Belangiran (*Shorea belangeran*), and Pulai (*Alstonia spp.*). Strip planting with the spacing line of 5 m x 10 m will be applied for intensive reforestation.

Table 61 describes the technical design of the reforestation program.

Table 61. Technical design of reforestation program

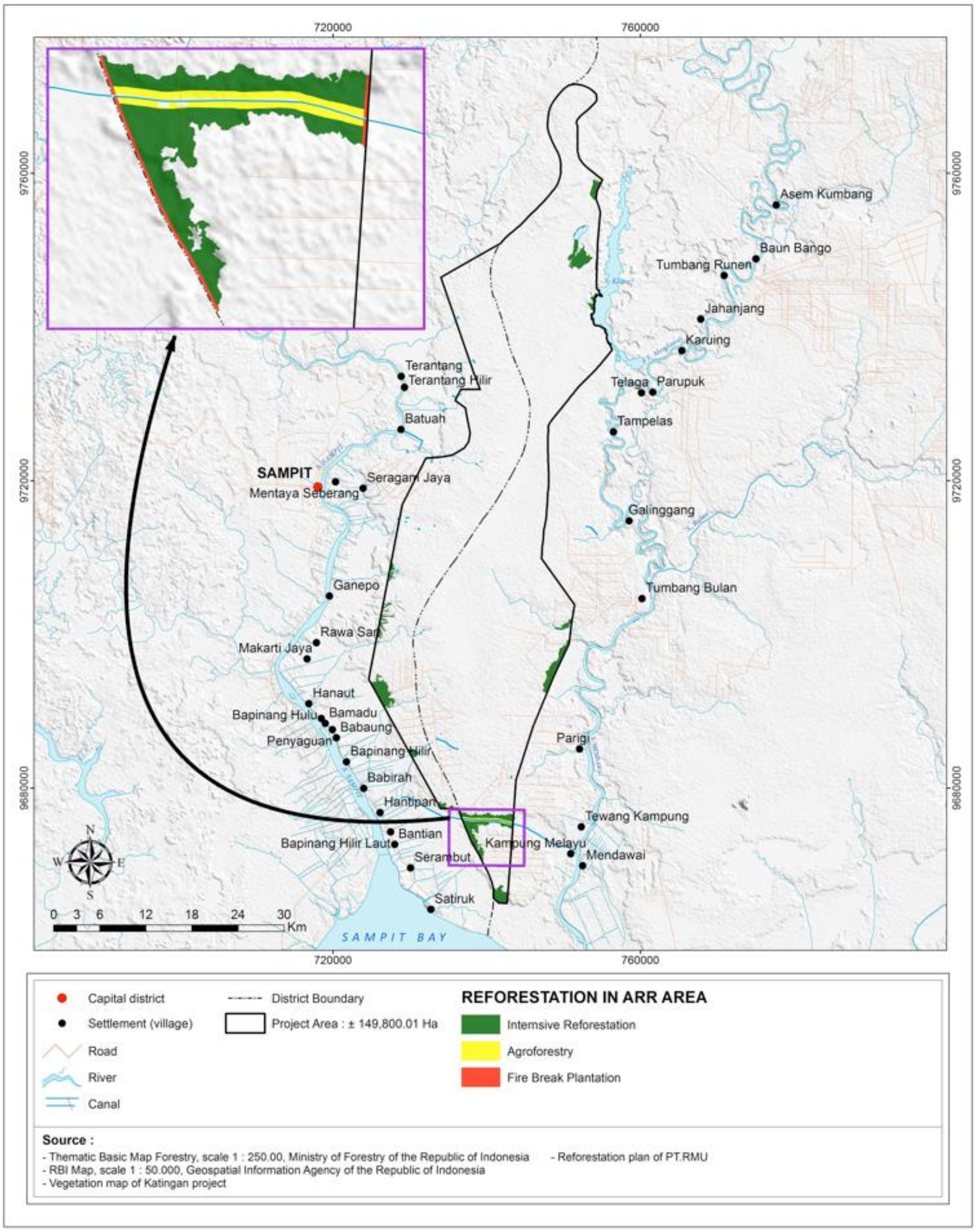
ARR plan	Agroforestry	Fire break plantation	Intensive reforestation
Area	253.17 ha, non-forest along canal	88.12 Ha, non forest along the boundary edge in south canal areas	4,092.26 Ha, non-forest areas
Species	20% : *Havea brasiliensis* 80% : *Dyera lowii*	50% : *Melalueca spp* 50% : *Combretocarpus rotundatus*	60% : *Dyera lowii* 20% : *Shorea belangeran* 10%: *Alstonia spp.* 10% : Other PSF species
Spacing line/sapling density	7 m x 7 m / 204 sapling/ha	3 m x 3 m/ 1111 saplings/ha	5 m x 10 m/ 200 saplings/ha
Starting year	2017	2016	2016
Implementer	Communities, supported by project	Project	Project

Based on the technical design above, the reforestation program in the project area will be implemented through the folllowing plan, presented by Map 41 and Table 62 below.

Table 62. Reforestation plan in the project boundary (Ha)

Year	Reforestation plan		
	Agroforestry	Green fire break	Intensive reforestation
2011	-	-	-
2012	-	-	-
2013	-	-	-
2014	-	-	-
2015	-	-	-
2016		44.06	272.82
2017	126.59	44.06	272.82
2018	126.59		272.82
2019	-	-	272.82
2020	-	-	272.82
2021	-	-	272.82
2022	-	-	272.82
2023	-	-	272.82
2024	-	-	272.82
2025	-	-	272.82
2026	-	-	272.82
2027	-	-	272.82
2028	-	-	272.82
2029	-	-	272.82
2030	-	-	272.82
2031	-	-	-
2070	-	-	-
Total	253.17	88.12	4,092.26

Map 41. Reforestation area in project boundary



Ex-ante GHG emissions and removal under the project scenario follow M-ARR which refers to the procedure provided in AR-ACM0003 *Afforestation and reforestation lands except wetlands and associated pool*. Net GHG removals under the ARR project scenario up to time t^*; t CO2-e ($\Delta C_{WPS\text{-}ARR}$) are equal to the summation from t=1 to t^* of the baseline net GHG removals by sinks in year t;(ΔC) in AR-ACM0003*.*

Under the assumptions that: 1) non CO_2 GHG emissions under the project scenario are zero, 2) Shrubs, dead wood, and litter are not significant in the C pool calculations, and 3) Net GHG emission related to WRC activities in the project scenario in 'ARR area' ($GHG_{WPS\text{-}WRC}$) are presented separately in the peat Section 5.3.1, Net GHG removals under the ARR project scenario are calculated using the equation (47):

$$\Delta C_{WPS-ARR} = \sum_{t=1}^{t} \left(\Delta C_{ACTUAL,i\ ACM0003}\right) = \sum_{t=1}^{t} \Delta C_{TREE,PROJ,t} \quad \textbf{(47)}$$

Where:

$\Delta C_{WPS\text{-}ARR}$ Net GHG removals under the ARR project scenario up to time t; t CO2-e

$\Delta C_{ACTUAL,t\ ACM0003}$ Actual net GHG removal by sinks in year t (from AR-ACM0003) (t CO2-e)

$C_{TREE,PROJ,t}$ Change in carbon stock in tree biomass in project, in year t: tCO2-e

t = 1,2,3,.. *t time since project start*

Annual C stock increment used in ARR calculation are respectivelly 2.44 $tCha^{-1}yr^{-1}$ for native species (table 3A.6 IPCC) , 1.84 $tCha^{-1}yr^{-1}$ for rubber tree (RSPO), and 1.32 $tCha^{-1}yr^{-1}$ (UGM).From calculation, cummulative net GHG removals related to ARR activities in the project scenario within the project period are estimated to be 1,864,644.09 tCO2-e. Annual GHG removals and emission are summarized in Table 63 below.

Table 63. Project net GHG removals by sinks from reforestation within project periode

Year	Change in the carbon stocks in project (tCO2-e) from			Total
	Agroforestry	Fire break plantation	Intensive reforestation	
2010	-	-	-	-
2011	-	-	-	-
2012	-	-	-	-
2013	-	-	-	-
2014	-	-	-	-
2015	-	-	-	-
2016	-	304	2,445	2,749
2017	1,079	607	4,890	6,576
2018	2,157	607	7,334	10,099
2019	2,157	607	9,779	12,544
2020	2,157	607	12,224	14,989
2021	2,157	607	14,669	17,434
2022	2,157	607	17,114	19,879
2023	2,157	607	19,558	22,323
2024	2,157	607	22,003	24,768
2025	2,157	607	24,448	27,213
2026	2,157	607	26,893	29,658
2027	2,157	607	29,338	32,103
2028	2,157	607	31,783	34,547
2029	2,157	607	34,227	36,992
2030	2,157	607	36,672	39,437
2031	2,157	607	36,672	39,437
2032	2,157	607	36,672	39,437
2033	2,157	607	36,672	39,437
2034	2,157	607	36,672	39,437
2035	2,157	607	36,672	39,437
2036	2,157	607	36,672	39,437
2037	2,157	607	36,672	39,437
2038	2,157	607	36,672	39,437
2039	2,157	607	36,672	39,437
2040	2,157	607	36,672	39,437
2041	2,157	607	36,672	39,437
2042	2,072	607	36,672	39,351
2043	1,986	607	36,672	39,266

Year	Change in the carbon stocks in project (tCO2-e) from			Total
	Agroforestry	Fire break plantation	Intensive reforestation	
2044	1,986	607	36,672	39,266
2045	1,986	607	36,672	39,266
2046	1,986	607	36,672	39,266
2047	1,986	607	36,672	39,266
2048	1,986	607	36,672	39,266
2049	1,986	607	36,672	39,266
2050	1,986	607	36,672	39,266
2051	1,986	607	36,672	39,266
2052	1,986	607	36,672	39,266
2053	1,986	607	36,672	39,266
2054	1,986	607	36,672	39,266
2055	1,986	607	36,672	39,266
2056	1,986	607	36,672	39,266
2057	1,986	607	36,672	39,266
2058	1,986	607	36,672	39,266
2059	1,986	607	36,672	39,266
2060	1,986	607	36,672	39,266
2061	1,986	607	36,672	39,266
2062	1,986	607	36,672	39,266
2063	1,986	607	36,672	39,266
2064	1,986	607	36,672	39,266
2065	1,986	607	36,672	39,266
2066	1,986	607	36,672	39,266
2067	1,986	607	36,672	39,266
2068	1,986	607	36,672	39,266
2069	1,986	607	36,672	39,266
2070	1,986	607	36,672	39,266
Total	108,559	32,494	1,723,591	1,864,644

Actual carbon stock increments due to ARR activities will be monitored and reported at each monitoring event.

5.5 Leakage (CL3)

Applicable leakage modules were determined according to requirements in the VCS methodology **VM0007 REDD+ MF**. As demonstrated in Section 4.5, the baseline activity is determined as planned deforestation and peatland drainage as a result of conversion to industrial acacia plantation. The project is therefore categorized as a combination of Avoiding Planned Deforestation (APD), Reforestation (ARR), in combination with Conservation of Undrained and Partially drained Peatland (CUPP) and Rewetting of Drained Peatland (RDP) activities.

As a result, potential sources of leakage emissions stem from the *displacement of planned deforestation activities* and *displacement of pre-project agricultural activities* on non-forest land, and *ecological leakage* due to possible alterations of mean annual water table depth in adjacent areas. These potential sources are covered in the VCS Methodology VM0007 Modules **LK-ASP**, **LK-ARR**, and **LK-ECO** respectively, which are therefore identified as the applicable modules for the quantification of total leakage emissions (see Table 64).

Table 64. Applicability of leakage modules

Module	Applicability
Estimation of emissions from activity shifting for avoiding planned deforestation and planned degradation (**LK-ASP**)	**Applicable.** The project may cause activity shifting of avoided planned deforestation.
Estimation of emissions from activity shifting for avoiding unplanned deforestation (**LK-ASU**)	**Not applicable.** The project is not categorized as avoiding unplanned deforestation.
Estimation of emissions from displacement of fuelwood extraction (**LK-DFW**)	**Not applicable.** The project is not categorized as avoiding unsustainable fuelwood extraction.
Estimation of emissions from displacement of pre-project agricultural activities (**LK-ARR**)	**Applicable.** The project is categorized as afforestation, reforestation, and revegetation and may cause displacement of pre-project agricultural activities.
Estimation of emissions from market-effects (**LK-ME**)	**Not applicable.** The project does not reduce the production of timber, fuelwood, or charcoal.
Estimation of emissions from ecological leakage (**LK-ECO**)	**Applicable.** The project is categorized as WRC and may cause ecological leakage.

5.5.1 Estimation of emissions from activity shifting for avoiding planned deforestation and planned degradation (LK-ASP)

As discussed in Section 4.5, there is evidence of the intent to convert ecosystems in the project area by at least one plantation operator. However, a specific baseline deforestation agent could not be identified. Therefore the *most likely class of deforestation agents* was identified as industrial acacia plantation operators.

Section 5.2 of the VM0007 Module LK-ASP provides two options for estimating emissions associated with activity shifting in cases where only the *most likely class of deforestation agents* has been identified, of which Approach 1 is chosen here. The below steps therefore follow section 5.1 of the VM0007 Module LK-ASP. It applies equations (1) to (7) to estimate leakage based upon the difference between historic and with-project rates of deforestation by the identified most likely class of deforestation agents within the country. Considering the potential of leakage to peatland areas, all required steps in Section 5.3 of the VM0007 Module LK-ASP were followed and equations (10) to (12) applied.

5.5.1.1 Steps to estimate activity shifting leakage for avoiding planned deforestation

STEP 1: Determination of the baseline rate of forest clearance by the class of deforestation agents

LK-ASP provides three options for estimating the baseline rate of forest clearance by the deforestation agent. Option 1.2 (historic average rate of clearance) may only be used if a historic trend analysis (Option 1.1) or a documented deforestation projection (Option 1.3) is not feasible.

While the Ministry of Environment and Forestry provides official projections for HIT plantation capacity development in Indonesia for 2010-2014 and through 2030, it does not currently provide more granular information such as annual projections of forest clearance by the class of deforestation agents.

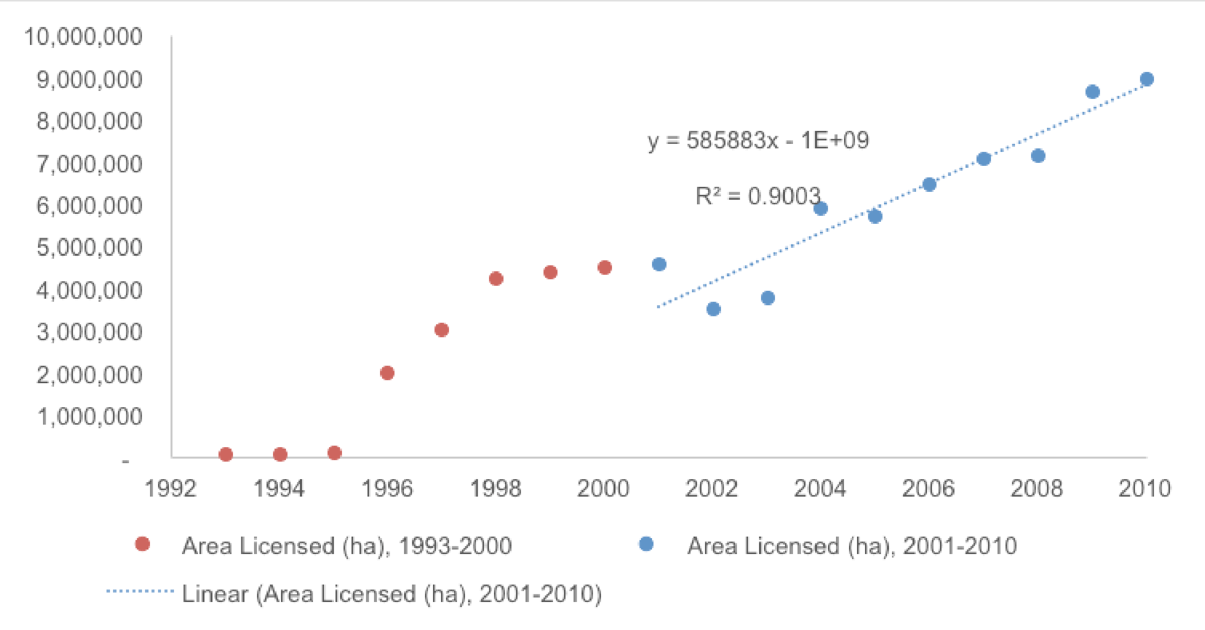
In order to determine the deforestation by the baseline agent of the planned deforestation in the absence of the project, we therefore first determine the historic trend (Option 1.1) in the total number of hectares licensed for HTI plantations which serves as the best indicator of increases in plantation establishment in Indonesia (see Table 65). In the absence of official data on clearance in these concessions and in line with the VM0007 Module LK-ASP, we set the rate of clearance to the conservative **baseline rate of deforestation (D%) of 3.91%** as derived from proxy areas and describe in Sub-section 5.3.2.

Table 65. Official data on historic HTI concession licenses granted

Year	HTI concessions licensed	Area licensed (ha)
1993	2	80,000
1994	2	80,000
1995	5	110,000
1996	27	2,010,000
1997	63	3,040,000
1998	94	4,250,000
1999	98	4,400,000
2000	100	4,501,375
2001	102	4,578,697
2002	91	3,523,256
2003	94	3,804,912
2004	112	5,910,295
2005	115	5,697,410
2006	133	6,467,515
2007	162	7,087,812
2008	165	7,154,832
2009	206	8,673,016
2010	218	8,975,375

A regression analysis was carried out to test the significance of the historic trend in the cumulative area licensed for conversion to HTI plantations between 2001 and 2010 (see Figure 18). This resulted in a p-value of <0.001 and an adjusted r^2 of 0.90, which fulfils requirements in LK-ASP ($p \leq 0.05$ and an adjusted r^2 of ≥ 0.75). The projected annual area licensed was then multiplied by the estimated deforestation rate of 3.91% to derive the estimated annual area converted to plantations between 2011 and 2030.

Figure 18. Regression analysis of cumulative HTI concession area licensed between 2001 and 2010



It is therefore estimated that an average area of 585,883 ha would be licensed annually for HTI plantation establishment between 2011 and 2030. According to applicable laws and common practice as defined in Section 4.5, 75% of the total concession area would be converted with the remainder set aside for conservation and other uses. Applying the conservative 3.91% deforestation rate as mandated by the VM0007 Module LK-ASP, the total area of HTI plantations in 2030 are projected to be 13,523,093.60 ha.

Given the statistically significant trend in HTI concession licenses granted and the area deforested, Option 1.1 is selected to determine the annual area of clearance by the class of agents in the absence of the project as shown in Table 66.

Table 66. Deforestation by the baseline class of agents in the absence of the project in stratum

Year	WoPR,i,t
2011	416,564
2012	432,600
2013	448,636
2014	464,671
2015	480,707
2016	496,742
2017	512,778
2018	527,486
2019	541,721
2020	557,259
2021	541,080
2022	497,267
2023	470,042
2024	456,362
2025	467,340
2026	479,811
2027	494,107
2028	505,467
2029	480,216
2030	448,881

STEP 2: Estimation of new projection of forest clearance by the baseline class of deforestation agents with project implementation at which no leakage is occurring

The total annual project area of planned baseline deforestation as determined in Sub-subsection 5.3.2.6 was subtracted from the annual area of clearance by the class of agents in the absence of the project to calculate the new area of annual deforestation by the baseline class of deforestation agents, at which no leakage is occurring (*NewRi,t*). The estimation was calculated using equation (48), and the result is provided in Table 67.

$$NewR_{i,t} = WoPR_{i,t} - \left(D\%_{planned,i,t} \times A_{planned,i}\right) \quad \textbf{(48)}$$

Where:

$NewR_{i,t}$	New calculated forest clearance in stratum *i* in year *t* by the baseline agent of the planned deforestation where no leakage is occurring (ha)
$WoPR_{i,t}$	Deforestation by the baseline agent of the planned deforestation in stratum *i* in year *t* in the absence of the project (ha)
$D\%_{planned,i,t}$	Projected annual proportion of land that will be deforested in project stratum *i* in year *t* (percent)
$A_{planned,i,}$	Total area of planned deforestation over the baseline period for project stratum *i* (ha)

i	1, 2, 3, … *M* strata (unitless)
t	1, 2, 3, … t^* time elapsed since the projected start of the project activity (years)

Table 67. New area of annual deforestation by the baseline class of deforestation agents at which no leakage is occurring

Year	NewRi,t
2011	414,419
2012	430,805
2013	442,106
2014	458,966
2015	474,745
2016	491,149
2017	506,702
2018	521,628
2019	535,910
2020	551,440
2021	535,149
2022	491,811
2023	464,314
2024	450,904
2025	461,755
2026	474,397
2027	488,509
2028	500,100
2029	474,379
2030	443,425

STEP 3: Monitoring of all areas deforested by baseline class of agents of deforestation through the years in which planned deforestation was forecasted to occur

The project will estimate all areas deforested by the class of agents throughout the country by monitoring the total area licensed for conversion to HTI plantations and the conversion rate as derived from proxy areas (D% = 3.91%). The project is in discussion with a range of NGOs and applicable government bodies to promote the development of a comprehensive deforestation monitoring systems which will allow the determination of areas deforested by land-use category throughout the country. Areas of deforestation will be reported in each Monitoring Report and leakage will be determined using equation (49):

$$LKA_{planned,i,t} = A_{defLK,i,t} - NewR_{i,t} \quad \textbf{(49)}$$

Where:

$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum *i* in year *t* (ha)
$NewR_{i,t}$	New calculated forest clearance by the baseline agent of the planned deforestation in stratum *i* in year *t* where no leakage is occurring (ha)
$A_{defLK,i,t}$	The total area of monitored deforestation by the baseline agent of the planned deforestation in stratum *i* in year *t* (ha)
i	1, 2, 3, … *M* strata (unitless)
t	1, 2, 3, … t^* time elapsed since the start of the project activity (years)

As a result of extensive leakage mitigation activities carried out by the project and its partners as described in Section 5.2 and for the purpose of this document, it is assumed that **no leakage will occur**. Actual leakage will be monitored throughout the project crediting period, and will be reported at each monitoring event.

STEP 4: Monitoring of GHG emissions outside the project boundary by baseline agent of deforestation

Leakage emissions related to biomass burning and fertilizer application need only be considered where a specific deforestation agent can be identified and thus need not be considered by this project.

STEP 5: Estimation of peat carbon in all of the class of agents' concessions

This section describes how the emission factors for activity shifting leakage to peatlands were determined based on carbon lost at Peat Depletion Time ($C_{peatloss,tPDT}$) in the undrained peatland of the alternative areas. The PDTs were estimated using the principles in Equations (1) to (13) set out in the VSC methodology VM0007 Module X-STR by applying drainability limit restrictions similar to principles applied to the project area, as described in Sub-subsection 4.4.1.3.

The areas which may produce emissions from peat as a result of activity shifting leakage are determined as undrained peatland areas under the land use designation of HP (*Hutan Produksi* or Production Forest) throughout Indonesia at the time of the project start. Some of these areas are yet to be granted concessions (unlicensed HP areas), and other areas have already been licensed to HTI acacia plantations (see Table 42). As explained in Sub-sections 1.3.1 and 4.5.1, the main portion of licensed HP areas have been increasingly occupied by HTI acacia plantations. Choosing unlicensed HP and licensed HTI acacia plantation areas as the basis for alternative areas for planned activity-shifting leakage is therefore considered conservative, since other types of industrial forestry-based plantations such as teakwood may also occupy the HP areas in future.

The project assumes that, on peatland, drainage and deforestation occur in parallel. Drained peatland is assumed equal to deforested peatland area. In order to determine the proportion of undrained peatland in HP areas and in line with Sub-subsection with 5.3.2.3, it is conservatively assumed that licensed HTI acacia areas in the HP area have been cleared at an historic annual rate of 3.91%. From the analysis, *c.a.* 4,653,834 hectares (39.7%) of the acacia licensed HP area was estimated to have been deforested at the project start date as given in Table 68. It is assumed that all peatlands in the unlicensed area are forested and undrained.

Table 68. Deforested and forested area in HTI acacia and unlicensed HP areas at the project start

Land cover types	Peatland		Non peatland		Peatland + Non peatland	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
Acacia plantations in HP areas						
Deforested in 2010	1,130,406	39.7%	3,523,427	39.7%	4,653,834	39.7%
Forested in 2010	1,717,286	60.3%	5,352,705	60.3%	7,069,991	60.3%
Total acacia plantation area	2,847,692		8,876,133		11,723,825	
Unlicensed HP areas						
Deforested in 2010	-	0.0%	-	0.0%	-	0.0%
Forested in 2010	8,599,844	100.0%	34,468,021	100.0%	43,067,865	100.0%
Total unlicensed HP area	8,599,844		34,468,021		43,067,865	
Acacia plantations in HP areas + Unlicensed HP areas						
Deforested in 2010	9,730,250	48.5%	37,991,448	48.8%	47,721,699	48.8%
Forested in 2010	10,317,130	51.5%	39,820,726	51.2%	50,137,856	51.2%

Land cover types	Peatland		Non peatland		Peatland + Non peatland	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
Total acacia + unlicensed HP area	20,047,380		77,812,174		97,859,554	

Peatland areas were delineated based on the Wetlands International peatland map 2013 (for Sumatra and Kalimantan) and Wetlands International Peat Atlas 2004 (for Papua). Total peatland area and carbon stock loss at tPDT ($C_{peatloss,tPDT}$) in licensed HTI acacia plantations and unlicensed HP areas are presented in Table 69 and Map 42. The amount of carbon loss at tPDT was conservatively calculated based on peat thickness loss at tPDT, bulk density similar to that of the project area (127 kg.m^{-3}) and carbon content (48 kg.kg^{-1} dry mass), as expressed in the equation (50):

$$C_{peatloss,tPDT,k} = P_{tPDT,k} \times BD \times C_c \times 10 \quad \textbf{(50)}$$

Where:

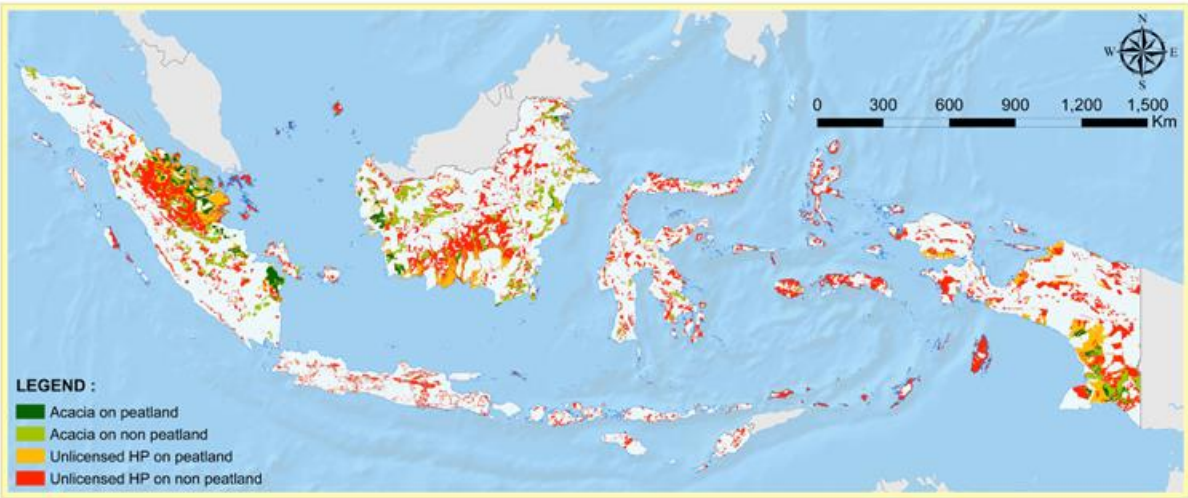
$C_{peatloss,tPDT,k}$	Carbon loss at t = PDT in peat stratum *k* (tC.ha^{-1})
$P_{tPDT,k}$	Available peat thickness for microbial decompositions and burning as restricted by drainability limit in peat stratum *k* (m)
BD	Bulk density of peat (kg.m^{-3})
C_c	Carbon content of peat (kg.kg^{-1} peat dry mass)
k	Peat thickness strata

Table 69. Summary of peat thickness and average carbon stock loss at tPDT and average carbon stock loss in all HTI areas in Indonesia

PLPDT*	HTI Acacia in HP Area			Unlicensed HP Area		
Range (m)	Area (ha)	$AvgC_{ploss,tPDT}$ ** (tC/ha)	$C_{peatloss,tPDT}$ *** (tCx1000)	Area (ha)	$AvgC_{ploss,tPDT}$ ** (tC/ha)	$C_{peatloss,tPDT}$ *** (tCx1000)
< 1	702,964	305	214,263	3,824,802	305	1,165,800
1 - 2	468,541	914	428,434	1,851,470	914	1,692,984
2 - 3	396,953	1,524	604,956	908,755	1,524	1,384,942
3 - 4	313,100	2,134	668,031	754,237	2,134	1,609,239
4 - 5	254,073	2,743	696,972	424,184	2,743	1,163,621
5 - 6	191,007	3,353	640,407	282,793	3,353	948,148
6 - 7	161,088	3,962	638,294	203,576	3,962	806,650
7 - 8	134,545	4,572	615,139	146,421	4,572	669,438
8 - 9	108,361	5,182	561,482	100,772	5,182	522,162
9 - 10	73,375	5,791	424,931	62,861	5,791	364,041
10 - 11	29,929	6,401	191,570	30,042	6,401	192,292
11 - 12	10,991	7,010	77,054	7,963	7,010	55,826
12 - 13	2,634	7,620	20,070	1,968	7,620	14,994
13 - 14	133	8,230	1,093	-	-	-
>14	-	-	-	-	-	-
Total	2,847,692		5,782,693	8,599,844		10,590,136
Average		4,267			3,679	

*** Peat thickness loss at t = PDT**
** Average
*** Average x Area

Map 42. Alternative areas for activity shifting leakage overlaid with peatland coverage



STEP 6: Estimation of CO_2 emission factor for leakage to peatland per ha

In the HP area licensed for HTI acacia plantations, the proportion of deforested area (39.7%, see Table 70) was used in estimating proportion of deforested/drained peatland at the project start date. Projected undrained peatland that would be drained, in the baseline, in the HP area licensed for HTI acacia plantations is assumed equal to the forested peatland minus area set aside for conservation area (25% of the peatland area), as applicable by regulations described in Sub-section 4.5.2. Projected undrained peatland that would be drained in the unlicensed HP area was estimated as equal to 75% of peatland area. Detail of projected drained peatland in baseline HP area is provided in Table 70.

Table 70. Projection of undrained peatland in HP areas as alternative areas for leakage to peatland

Category	Acacia		Unlicensed	
	Area (ha)	Percent	Area (ha)	Percent
Peatland	2,847,692	100.0%	8,599,844	100.0%
Deforested/drained peatland	1,130,406	39.7%	0	0.0%
Forested petland	1,717,286	60.3%	8,599,844	100.0%
Conservation area	711,923	25.0%	2,149,961	25.0%
Projected undrained peatland (in the baseline scenario)	1,005,363	35.3%	6,449,883	75.0%

The emission factor for leakage to peatland is calculated as the average per hectare loss of carbon from peat soils in all of the class of agents' concessions at PDT, expressed as tCO_2, using equation (51).

$$LK_{EF} = \left(C_{peatloss,tPDT} \times 44/12\right) / A_{conc-ag} \quad \textbf{(51)}$$

Where:

LK_{EF} — CO_2 emission factor from leakage to undrained peatlands (t CO_2e ha^{-1})

$C_{peatloss,tPDT}$ — Cumulative peat carbon loss due to activity shifting leakage at *tPDT* (t C) (Note: derived from module *X-STR*)

$A_{conc\text{-}ag}$ — Total number of hectares with undrained peatlands under concession to the agent of deforestation or total number of ha with peatlands in the alternative areas (ha)

Based on Table 70 and Table 71, the CO_2 emission factor for leakage to peatland per hectare was calculated. Total $C_{peatloss,tPDT}$ in Table 69 was factored by the percentage of drained peatland as provided in Table 70. Estimated LK_{EF} for licensed and unlicensed HP areas are presented in Table 71.

Table 71. Estimated emission factors of leakage to peatland

Parameters	HTI Acacia in HP area	Unlicensed HP area
$C_{peatloss,tPDT}$ (tC)	2,041,549,528	7,942,602,296
Total undrained area of peatlands in the alternative areas (ha)	1,005,363	6,449,883
LK_{EF} (tCO_2-e.ha^{-1})	7,446	4,515

STEP 7: Estimation of net GHG emissions due to leakage to undrained peatlands as a result of project implementation

Proportions of undrained peatland in the alternative areas were estimated based on licensed HTI acacia plantations and unlicensed HP area (Table 68) and undrained peatland areas provided in Table 70, as provided in Table 72.

Table 72. Proportion of undrained peatland areas in the alternative area

Category	HTI Acacia in HP area	Unlicensed HP area
Alternative area (HP area) (ha)	11,723,825	43,067,865
Undrained peatlands (ha)	1,005,363	6,449,883
$PROP_{PEAT-AGENT}$	0.09	0.15

At each monitoring event, emissions due to leakage to undrained peatlands will be calculated using equation (52):

$$LK_{peat,t} = LKA_{planned,i,t} \times PROP_{PEAT-AGENT} \times LK_{EF} \quad \textbf{(52)}$$

Where:

$LK_{peat,t}$ Net greenhouse gas emissions due to activity shifting to undrained peatlands as a result of implementation of a planned deforestation project in year t (t CO_2e)

$LKA_{planned,i,t}$ The area of activity shifting leakage in stratum i in year t (ha)

$PROP_{PEAT-AGENT}$ Proportion of undrained peatland areas in the agent´s concessions with respect to the total area of such concessions (unitless)

LK_{EF} CO_2 emission factor from leakage to undrained peatlands (t CO_2e ha^{-1})

5.5.1.2 Total emissions from activity shifting for avoiding planned deforestation

At each monitoring event, total emissions from activity shifting for APD will be calculated based on the parameters determined in the above Step 1 to 7, using equation (53):

$$\Delta C_{LK-AS,planned} = \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(\left(LKA_{planned,i,t} \times \Delta C_{BSL,i} \right) + GHG_{LK,E,i,t} + LK_{peat} \right) \quad \textbf{(53)}$$

Where:

$\Delta C_{LK-AS,planned}$ Net CO_2 emissions due to activity shifting leakage for projects preventing planned deforestation (t CO_2e)

$LK_{peat,t}$ Net greenhouse gas emissions due to activity shifting to undrained peatlands as a result of implementation of a planned deforestation project in year t (t CO_2e)

$\Delta C_{BSL,planned}$	Net CO_2 emissions in the baseline from planned deforestation in the project area (t CO_2e)
$GHG_{LK,E,i,t}$	Greenhouse gas emissions as a result of leakage of avoiding deforestation activities in stratum *i* in year *t* (t CO_2e)
$LKA_{planned,i,t}$	The area of activity shifting leakage in stratum *i* in year *t* (ha)

As a result of extensive leakage mitigation activities carried out by the project and its partners as described in Section 5.2 and for the purpose of this document, it is assumed that no leakage will occur. Actual leakage will be monitored throughout the project crediting period and will be reported at each monitoring event.

5.5.2 Estimation of emissions from displacement of pre-project agricultural activities (LK-ARR)

The VM0007 Module LK-ARR requires the use of the latest version of the CDM tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity" [32]. Step 1 of the CDM tool requires that the area subject to pre-project agricultural activities that is expected to be afforested/reforested (therefore the activities having to be displaced) be identified.

The project area includes only comparatively small areas of non-forest land which will be reforested in the project scenario (see Sub-section 2.2.1 – B). The vast majority of these areas are not forested due to uncontrolled burning which occurred prior to the project start. Only a small fraction of area (< 2 ha) has some existing planted rubber trees, however this will be fully incorporated within a larger (262 ha) area of community-managed rubber/Jelutong agroforests which will border the Hantipan canal area (see Sub-section 2.2.1 – B). As a result, no pre-project agricultural activities will be displaced by ARR project activities, and hence Change_C_LK-ARR = 0.

5.5.3 Estimation of emissions from ecological leakage (LK-ECO)

Applicability conditions of the VM0007 Module LK-ECO require that ecological leakage affecting the soil (peat) carbon pool does not occur. This can be achieved demonstrating that the effect of hydrological connectivity with adjacent areas is insignificant, specifically by ensuring an appropriate design (e.g., by establishing an impermeable dam, by rewetting peatland that is surrounded by undrained peatland or by rivers) or by a buffer zone within the project boundary.

As described in Table 49, the project area primarily consists of intact peat swamp forest (94.7% of project area) which requires very little intervention in terms of rewetting. As such, the risk of ecological leakage is by definition limited to comparatively small areas along the Hantipan canal in which rewetting activities are to be undertaken (see Map 6 of Sub-section 2.2.1 – C). The risk of ecological leakage is minimal as demonstrated by conditions in this area and its surrounding peatlands at project start:

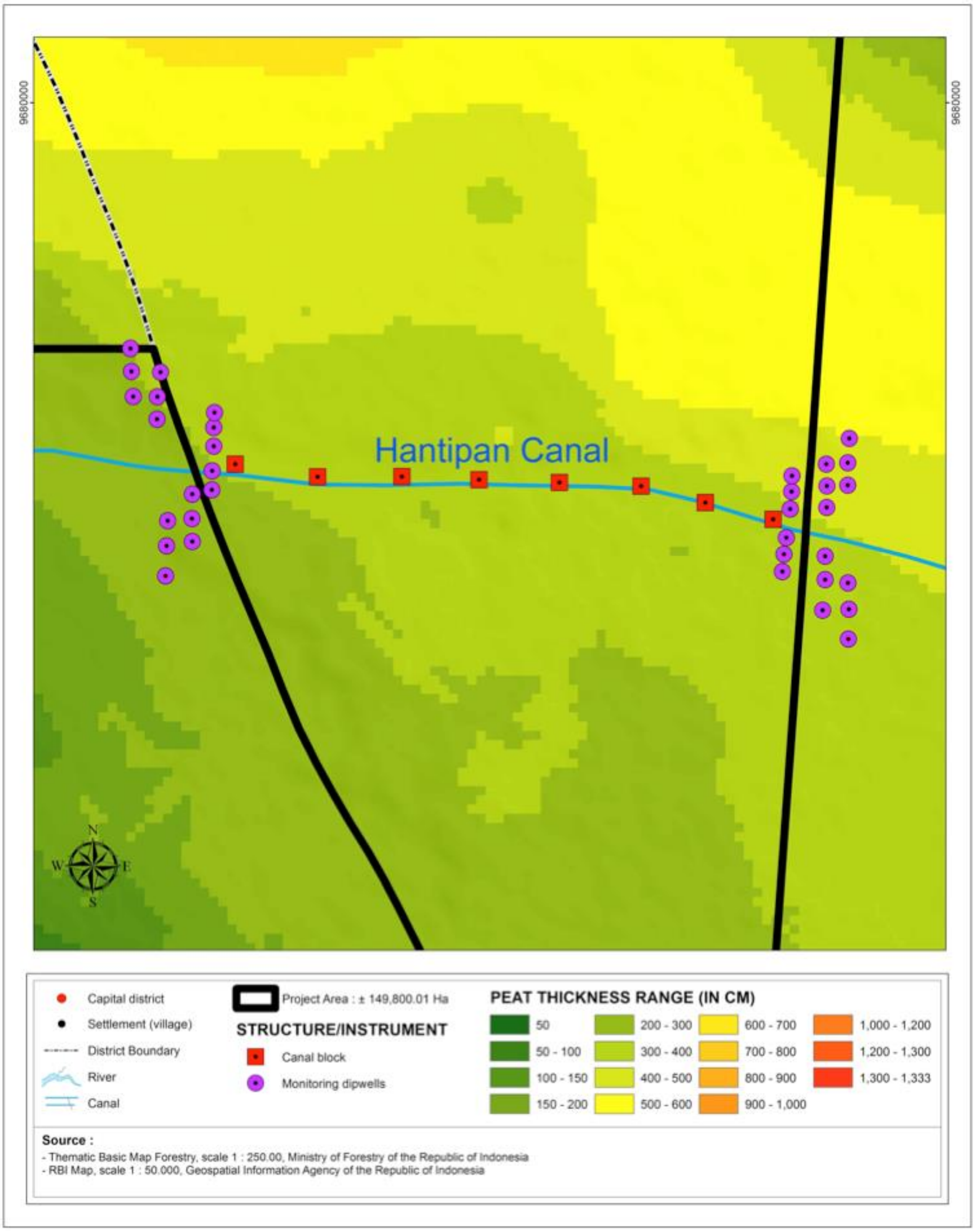
- Prolonged drainage history of the Hantipan canal has caused an alteration of the topography of the drained area in such a way that minidomes have formed and a complete restoration to original condition is not possible anymore Annex 1. Thus the maximum magnitude of water table raise is limited by the steeper slope towards the canal, and the risk of floods caused by rewetting activities is minimal.
- Initial conditions of the project area and its surrounding peatlands show that floods occur regularly in wet seasons. Therefore, wet season floods after project start date and after rewetting is not likely associated with the project interventions.

- Considering canal dimension that will be blocked in rewetting effort (*c.a* 10 meters wide and 2 meters deep) the volume of water that may be discharged downstream should canal blocks failures occur is not sufficient to cause significant flood outside the project area.

Where rewetting is undertaken, it is designed in such a way that the impacts of rising water tables within the rewetting area do not significantly affect water tables outside the project area and is achieved by the following measures:

- The outer-most canal blocks are positioned with at least 200 meter distance between the blocks and the project boundary (see Map 43). This space will act as ecological leakage buffer zone to ensure that water table rise inside project area is not directly impacting water table depths outside project boundary. The exact positions and space will be determined when technical rewetting plan has been formulated in 2017.
- Canal blocks will be placed in cascade design to ensure any breach of the blocks will not cause significant volumes of water to be discharged downstream.

Map 43. Illustration of cascade canal block positions and dipwell locations for ecological leakage monitoring



It is expected that no ecological leakage will occur in the project scenario. The integrity of the rewetting activities with no ecological leakage will be demonstrated at each monitoring event. Monitoring of ecological leakage is undertaken by installing staff gauges and monitoring wells within the vicinity of canal block positions inside and outside the project area. Monitoring will be performed regularly with daily to weekly interval. In wet season when high water table depths are expected daily monitoring will be necessary. In dry season weekly monitoring is deemed sufficient.

5.6 Summary of GHG Emission Reductions and Removals (CL2.2)

Net GHG emission reductions from REDD, WRC, and ARR activities are calculated using equation (54). This section provides an overview of total net emission reductions and details activity specific calculations in sub-sections.

$$NER_{REDD+} = NER_{REDD} + NGR_{ARR} + NER_{WRC} \quad \textbf{(54)}$$

Where:

NER_{REDD}	Total net GHG emission reductions of the REDD project activity up to year *t**; t CO_2-e
NGR_{ARR}	Total net GHG removals of the ARR project activity up to year *t**; t CO_2-e
NER_{WRC}	Total net GHG emission reductions of the WRC project activity up to year *t**; t CO_2-e

5.6.1 Uncertainty Analysis

Per module X-UNC, uncertainties were calculated for the project's REDD and WRC components in both the project and baseline scenarios.

5.6.1.1 REDD Uncertainty

As mentioned in sections 5.3.2.2, the uncertainty in the baseline rate of deforestation was determined as zero since an unquestionably conservative deforestation rate was used. Furthermore, as mentioned in section 4.4.1.1, the total uncertainty in the combined carbons stocks and greenhouse gas sources in the REDD baseline was determined to be 10.61%. Therefore, the cumulative uncertainty in the REDD baseline scenario is 10.61%. The Ex Post uncertainty in the REDD project scenario was set to zero, since no *ex post* (re-)measurements of carbon pools or GHG sources have been made. Uncertainties will be reassessed when carbon pools are re-measured.

5.6.1.2 WRC Uncertainty

Using the standard error data for the peat emission factors provided by the IPCC (IPCC Wetlands Supplement 2013, see Appendix 6) the uncertainties of CO_2 and CH_4 emissions from microbial decompositions of peat and Dissolved Organic Carbon from water bodies were calculated in both the baseline and project scenario. The uncertainty of CH_4 emissions from water body was set to zero since it was conservatively excluded from all emission calculations. The uncertainty of GHG emissions from uncontrolled peat burning in the project scenario was also set to zero as it was assumed all fires in the project will be prevented. The uncertainty in GHG emissions from peat burning in the baseline scenario was calculated using the dry mass burnt per stratum per year and their standard errors. Since module X-UNC doesn't distinguish between CO_2 and CH_4 emissions from peat burning, emissions from the data was combined to produce an overall uncertainty in CO_2 equivalent. Based on these assumptions the WRC uncertainty in the baseline and project scenario were calculated to be 0.82% and 2.93% respectively.

The total error in the REDD+ project activity was calculated as 0.87%. Considering the 15% uncertainty threshold, no VCU deductions were made due to uncertainty. Further detail on all calculations is provided in Annex 17.

5.6.2 Total net GHG emission reductions of the REDD project activity

Net GHG emission reductions from REDD project activities are calculated by substracting project emissions and emissions due to leakage from baseline emissions (see Table 73).

Table 73. Total net GHG emission reductions of the REDD project activity

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2011	657,473	45,607	-	611,866
2012	529,293	33,334	-	495,960
2013	1,970,386	23,068	-	1,947,319
2014	1,682,357	(14,280)	-	1,696,637
2015	1,768,045	(46,913)	-	1,814,958
2016	1,650,617	(81,012)	-	1,731,629
2017	1,813,345	(113,006)	-	1,926,351
2018	1,726,187	(147,761)	-	1,873,947
2019	1,725,278	(181,265)	-	1,906,542
2020	1,715,008	(214,503)	-	1,929,512
2021	1,769,047	(293,395)	-	2,062,442
2022	1,611,098	(327,318)	-	1,938,416
2023	1,702,230	(358,528)	-	2,060,758
2024	1,612,300	(391,288)	-	2,003,588
2025	1,670,386	(422,512)	-	2,092,898
2026	1,596,948	(454,460)	-	2,051,408
2027	1,663,977	(485,433)	-	2,149,410
2028	1,585,198	(517,452)	-	2,102,649
2029	1,744,383	(548,150)	-	2,292,533
2030	1,609,972	(581,538)	-	2,191,510
2031	1,052,344	(612,743)	-	1,665,087
2032	1,181,457	(633,147)	-	1,814,604
2033	-	(633,147)	-	633,147
2034	-	(633,147)	-	633,147
2035	-	(633,147)	-	633,147
2036	-	(633,147)	-	633,147
2037	-	(633,147)	-	633,147
2038	-	(633,147)	-	633,147
2039	-	(633,147)	-	633,147
2040	-	(633,147)	-	633,147
2041	-	(633,147)	-	633,147
2042	-	(633,147)	-	633,147
2043	-	(633,147)	-	633,147
2044	-	(633,147)	-	633,147
2045	-	(633,147)	-	633,147
2046	-	(633,147)	-	633,147
2047	-	(633,147)	-	633,147
2048	-	(633,147)	-	633,147
2049	-	(633,147)	-	633,147
2050	-	(633,147)	-	633,147
2051	-	(633,147)	-	633,147
2052	-	(633,147)	-	633,147
2053	-	(633,147)	-	633,147
2054	-	(633,147)	-	633,147
2055	-	(633,147)	-	633,147

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2056	-	(633,147)	-	633,147
2057	-	(633,147)	-	633,147
2058	-	(633,147)	-	633,147
2059	-	(633,147)	-	633,147
2060	-	(633,147)	-	633,147
2061	-	(633,147)	-	633,147
2062	-	(633,147)	-	633,147
2063	-	(633,147)	-	633,147
2064	-	(633,147)	-	633,147
2065	-	(633,147)	-	633,147
2066	-	(633,147)	-	633,147
2067	-	(633,147)	-	633,147
2068	-	(633,147)	-	633,147
2069	-	(633,147)	-	633,147
2070		(620,874)		620,874
Total	**34,037,329**	**(30,370,015)**	**-**	**64,407,344**

5.6.3 Total net GHG emission reductions of the WRC project activity

Net GHG emission reductions from WRC project activities are calculated by substracting project emissions and emissions due to leakage from baseline emissions (see Table 74). The project does not claim the fire reduction premium which is therefore omitted from calculations.

Table 74. Total net GHG emission reductions of the WRC project activity

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2011	1,082,979	134,183	-	948,796
2012	1,193,020	134,183	-	1,058,837
2013	2,577,755	134,183	-	2,443,572
2014	2,925,961	134,183	-	2,791,778
2015	3,238,629	134,183	-	3,104,446
2016	3,560,321	134,183	-	3,426,138
2017	4,029,146	134,183	-	3,894,963
2018	4,360,576	109,862	-	4,250,714
2019	4,746,000	109,862	-	4,636,138
2020	5,084,656	109,862	-	4,974,794
2021	5,447,067	109,862	-	5,337,205
2022	5,745,349	109,862	-	5,635,487
2023	6,125,244	109,862	-	6,015,382

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2024	6,390,075	109,862	-	6,280,213
2025	6,782,830	109,862	-	6,672,968
2026	7,043,055	109,862	-	6,933,193
2027	7,404,961	109,862	-	7,295,099
2028	7,693,839	109,862	-	7,583,977
2029	8,122,636	109,862	-	8,012,774
2030	8,376,224	109,862	-	8,266,362
2031	8,539,740	109,862	-	8,429,878
2032	8,757,313	109,862	-	8,647,451
2033	8,745,058	109,862	-	8,635,196
2034	8,688,826	109,862	-	8,578,964
2035	8,641,850	109,862	-	8,531,988
2036	8,636,144	109,862	-	8,526,282
2037	8,629,072	109,862	-	8,519,210
2038	8,560,198	109,862	-	8,450,336
2039	8,590,699	109,862	-	8,480,837
2040	8,565,622	109,862	-	8,455,760
2041	8,560,273	109,862	-	8,450,411
2042	8,484,961	109,862	-	8,375,099
2043	8,491,122	109,862	-	8,381,260
2044	8,486,345	109,862	-	8,376,483
2045	8,458,970	109,862	-	8,349,108
2046	8,431,210	109,862	-	8,321,348
2047	8,429,712	109,862	-	8,319,850
2048	8,407,884	109,862	-	8,298,022
2049	8,384,618	109,862	-	8,274,756
2050	8,391,334	109,862	-	8,281,472
2051	8,377,267	109,862	-	8,267,405
2052	8,355,991	109,862	-	8,246,129
2053	8,346,635	109,862	-	8,236,773

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2054	8,333,601	109,862	-	8,223,739
2055	8,306,120	109,862	-	8,196,258
2056	8,307,668	109,862	-	8,197,806
2057	8,287,901	109,862	-	8,178,039
2058	8,292,137	109,862	-	8,182,275
2059	8,270,101	109,862	-	8,160,239
2060	8,256,074	109,862	-	8,146,212
2061	8,246,826	109,862	-	8,136,964
2062	8,230,353	109,862	-	8,120,491
2063	8,220,815	109,862	-	8,110,953
2064	8,200,168	109,862	-	8,090,306
2065	8,176,517	109,862	-	8,066,655
2066	8,173,951	109,862	-	8,064,089
2067	8,143,443	109,862	-	8,033,581
2068	8,128,402	109,862	-	8,018,540
2069	8,117,720	109,862	-	8,007,858
2070	8,098,779	109,862		7,988,917
Total	**437,681,743**	**6,761,967**	**-**	**430,919,776**

5.6.4 Total net GHG removals of the ARR project activity

Net GHG removal of the ARR project activities are calculated by substracting baseline removals and emissions due tot leakage from the project removals (see Table 75).

Table 75. Total net GHG removals of the ARR project activity

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2011	295	-	-	(295)
2012	628	-	-	(628)
2013	1,686	-	-	(1,686)
2014	2,632	-	-	(2,632)
2015	2,924	-	-	(2,924)
2016	4,757	2,749		

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
			-	(2,009)
2017	6,213	6,576	-	362
2018	6,664	10,099	-	3,435
2019	8,306	12,544	-	4,239
2020	8,608	14,989	-	6,380
2021	9,892	17,434	-	7,541
2022	11,973	19,879	-	7,906
2023	14,839	22,323	-	7,484
2024	17,201	24,768	-	7,568
2025	19,331	27,213	-	7,882
2026	20,097	29,658	-	9,561
2027	22,123	32,103	-	9,979
2028	23,752	34,547	-	10,795
2029	25,368	36,992	-	11,624
2030	26,336	39,437	-	13,101
2031	27,062	39,437	-	12,375
2032	28,595	39,437	-	10,842
2033	28,595	39,437	-	10,842
2034	28,595	39,437	-	10,842
2035	28,595	39,437	-	10,842
2036	21,213	39,437	-	18,224
2037	20,286	39,437	-	19,151
2038	2,142	39,437	-	37,295
2039	4,940	39,437	-	34,497
2040	21,298	39,437	-	18,139
2041	-17,243	39,437	-	56,680
2042	-7,816	39,351	-	47,168
2043	17,316	39,266	-	21,950
2044	-12,451	39,266	-	51,717
2045	21,011	39,266	-	18,254

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Estimated net GHG emission reductions or removals (tCO2e)
2046	-3,514	39,266	-	42,780
2047	-23,426	39,266	-	62,691
2048	-43,068	39,266	-	82,334
2049	-30,457	39,266	-	69,723
2050	-24,863	39,266	-	64,129
2051	9,239	39,266	-	30,027
2052	-22,282	39,266	-	61,548
2053	-12,336	39,266	-	51,601
2054	-12,002	39,266	-	51,268
2055	4,191	39,266	-	35,075
2056	10,234	39,266	-	29,032
2057	-9,931	39,266	-	49,196
2058	28,388	39,266	-	10,878
2059	28,388	39,266	-	10,878
2060	28,388	39,266	-	10,878
2061	21,006	39,266	-	18,259
2062	20,079	39,266	-	19,187
2063	1,935	39,266	-	37,330
2064	4,734	39,266	-	34,532
2065	21,091	39,266	-	18,175
2066	-17,450	39,266	-	56,716
2067	-7,760	39,266	-	47,026
2068	17,128	39,266	-	22,138
2069	-12,689	39,266	-	51,955
2070	20,490	39,266	-	18,775
Total	**441,275**	**1,903,910**	**-**	**1,462,635**

5.6.5 Calculation of the VCS Non-Permanence Risk Buffer Withholding

Per Sub-section 2.3.1, the combined non-permanence risk buffer for the project was determined as 10%. Per VSC methodology VM0007 modules REDD+ MF, the annual buffer withholding for all activities was determined as a percentage of the total carbon stock benefits which excludes emissions due to leakage (see Table 76). As the project does not account for emissions from fossil fuel combustion, direct N_2O emissions and emissions from biomass burning were also omitted from calculations.

Table 76. Annual non-permanence risk buffer withholding

Years	REDD total carbon stock benefits	WRC total carbon stock benefits	ARR total carbon stock benefits	Non-Permanence Risk Buffer (10%)
2011	611,866	948,796	(295)	156,037
2012	495,960	1,058,837	(628)	155,417
2013	1,947,319	2,443,572	(1,686)	438,921
2014	1,696,637	2,791,778	(2,632)	448,578
2015	1,814,958	3,104,446	(2,924)	491,648
2016	1,731,629	3,426,138	(2,009)	515,576
2017	1,926,351	3,894,963	362	582,168
2018	1,873,947	4,250,714	3,435	612,810
2019	1,906,542	4,636,138	4,239	654,692
2020	1,929,512	4,974,794	6,380	691,069
2021	2,062,442	5,337,205	7,541	740,719
2022	1,938,416	5,635,487	7,906	758,181
2023	2,060,758	6,015,382	7,484	808,362
2024	2,003,588	6,280,213	7,568	829,137
2025	2,092,898	6,672,968	7,882	877,375
2026	2,051,408	6,933,193	9,561	899,416
2027	2,149,410	7,295,099	9,979	945,449
2028	2,102,649	7,583,977	10,795	969,742
2029	2,292,533	8,012,774	11,624	1,031,693
2030	2,191,510	8,266,362	13,101	1,047,097
2031	1,665,087	8,429,878	12,375	1,010,734
2032	1,814,604	8,647,451	10,842	1,047,290
2033	633,147	8,635,196	10,842	927,919
2034	633,147	8,578,964	10,842	922,295
2035	633,147	8,531,988	10,842	917,598
2036	633,147	8,526,282	18,224	917,765
2037	633,147	8,519,210	19,151	917,151
2038				912,078

Years	REDD total carbon stock benefits	WRC total carbon stock benefits	ARR total carbon stock benefits	Non-Permanence Risk Buffer (10%)
	633,147	8,450,336	37,295	
2039	633,147	8,480,837	34,497	914,848
2040	633,147	8,455,760	18,139	910,705
2041	633,147	8,450,411	56,680	914,024
2042	633,147	8,375,099	47,168	905,541
2043	633,147	8,381,260	21,950	903,636
2044	633,147	8,376,483	51,717	906,135
2045	633,147	8,349,108	18,254	900,051
2046	633,147	8,321,348	42,780	899,728
2047	633,147	8,319,850	62,691	901,569
2048	633,147	8,298,022	82,334	901,350
2049	633,147	8,274,756	69,723	897,763
2050	633,147	8,281,472	64,129	897,875
2051	633,147	8,267,405	30,027	893,058
2052	633,147	8,246,129	61,548	894,082
2053	633,147	8,236,773	51,601	892,152
2054	633,147	8,223,739	51,268	890,815
2055	633,147	8,196,258	35,075	886,448
2056	633,147	8,197,806	29,032	885,999
2057	633,147	8,178,039	49,196	886,038
2058	633,147	8,182,275	10,878	882,630
2059	633,147	8,160,239	10,878	880,426
2060	633,147	8,146,212	10,878	879,024
2061	633,147	8,136,964	18,259	878,837
2062	633,147	8,120,491	19,187	877,283
2063	633,147	8,110,953	37,330	878,143
2064	633,147	8,090,306	34,532	875,799
2065	633,147	8,066,655	18,175	871,798
2066	633,147	8,064,089	56,716	875,395
2067	633,147	8,033,581	47,026	871,375

Years	REDD total carbon stock benefits	WRC total carbon stock benefits	ARR total carbon stock benefits	Non-Permanence Risk Buffer (10%)
2068	633,147	8,018,540	22,138	867,383
2069	633,147	8,007,858	51,955	869,296
2070	620,874	7,988,917	18,775	862,857
Total	**64,407,344**	**430,919,776**	**1,462,635**	**49,678,976**

5.6.6 Calculation of Verified Carbon Units

VCU are calculated by substrating the VCS non-permanence risk buffer withholding from the uncertainty adjusted net emission reductions for each project activitiy (see Table 77).

Table 77. Calculation of estimated verified carbon units

Years	NGR_{ARR}	$NER_{REDD+WRC}$	$Adjusted\_NER_{REDD+WRC+ARR}$	Non-Permanence Risk Buffer	Estimated VCU
2011	(295)	1,560,662	1,560,367	156,037	1,404,329.9
2012	(628)	1,554,797	1,554,169	155,417	1,398,752.3
2013	(1,686)	4,390,891	4,389,205	438,921	3,950,284.5
2014	(2,632)	4,488,415	4,485,783	448,578	4,037,204.5
2015	(2,924)	4,919,404	4,916,480	491,648	4,424,832.2
2016	(2,009)	5,157,767	5,155,758	515,576	4,640,182.4
2017	362	5,821,314	5,821,677	582,168	5,239,509.0
2018	3,435	6,124,661	6,128,097	612,810	5,515,286.9
2019	4,239	6,542,680	6,546,919	654,692	5,892,227.0
2020	6,380	6,904,306	6,910,686	691,069	6,219,617.4
2021	7,541	7,399,647	7,407,188	740,719	6,666,469.3
2022	7,906	7,573,903	7,581,809	758,181	6,823,627.8
2023	7,484	8,076,140	8,083,624	808,362	7,275,261.7
2024	7,568	8,283,801	8,291,368	829,137	7,462,231.6
2025	7,882	8,765,866	8,773,749	877,375	7,896,373.7
2026	9,561	8,984,601	8,994,163	899,416	8,094,746.3
2027	9,979	9,444,509	9,454,488	945,449	8,509,039.1
2028	10,795	9,686,626	9,697,421	969,742	8,727,679.0
2029	11,624	10,305,307	10,316,931	1,031,693	9,285,238.0
2030	13,101	10,457,872	10,470,973	1,047,097	9,423,876.1
2031			10,107,340		

Years	NGR_{ARR}	$NER_{REDD+WRC}$	$Adjusted\_NER_{REDD+WRC+ARR}$	Non-Permanence Risk Buffer	Estimated VCU
	12,375	10,094,965		1,010,734	9,096,606.0
2032	10,842	10,462,055	10,472,897	1,047,290	9,425,607.7
2033	10,842	9,268,343	9,279,186	927,919	8,351,267.0
2034	10,842	9,212,111	9,222,954	922,295	8,300,658.2
2035	10,842	9,165,135	9,175,978	917,598	8,258,379.8
2036	18,224	9,159,429	9,177,653	917,765	8,259,887.7
2037	19,151	9,152,357	9,171,508	917,151	8,254,357.5
2038	37,295	9,083,483	9,120,778	912,078	8,208,700.2
2039	34,497	9,113,984	9,148,481	914,848	8,233,632.7
2040	18,139	9,088,907	9,107,046	910,705	8,196,341.7
2041	56,680	9,083,558	9,140,238	914,024	8,226,214.6
2042	47,168	9,008,246	9,055,414	905,541	8,149,872.4
2043	21,950	9,014,407	9,036,357	903,636	8,132,721.6
2044	51,717	9,009,630	9,061,347	906,135	8,155,212.1
2045	18,254	8,982,255	9,000,510	900,051	8,100,458.7
2046	42,780	8,954,495	8,997,275	899,728	8,097,547.7
2047	62,691	8,952,997	9,015,688	901,569	8,114,119.6
2048	82,334	8,931,169	9,013,503	901,350	8,112,152.5
2049	69,723	8,907,903	8,977,626	897,763	8,079,863.2
2050	64,129	8,914,619	8,978,748	897,875	8,080,873.0
2051	30,027	8,900,552	8,930,579	893,058	8,037,521.1
2052	61,548	8,879,276	8,940,824	894,082	8,046,742.0
2053	51,601	8,869,920	8,921,522	892,152	8,029,369.4
2054	51,268	8,856,886	8,908,154	890,815	8,017,338.3
2055	35,075	8,829,405	8,864,480	886,448	7,978,031.9
2056	29,032	8,830,953	8,859,985	885,999	7,973,986.9
2057	49,196	8,811,186	8,860,383	886,038	7,974,344.4
2058	10,878	8,815,422	8,826,300	882,630	7,943,670.2
2059	10,878	8,793,386	8,804,264	880,426	7,923,837.8
2060	10,878	8,779,359	8,790,237	879,024	7,911,213.5
2061	18,259	8,770,111	8,788,371	878,837	7,909,533.6

Years	NGR_{ARR}	$NER_{REDD+WRC}$	$Adjusted\_NER_{REDD+WRC+ARR}$	Non-Permanence Risk Buffer	Estimated VCU
2062	19,187	8,753,638	8,772,825	877,283	7,895,542.5
2063	37,330	8,744,100	8,781,431	878,143	7,903,287.6
2064	34,532	8,723,453	8,757,985	875,799	7,882,186.9
2065	18,175	8,699,802	8,717,977	871,798	7,846,179.4
2066	56,716	8,697,236	8,753,952	875,395	7,878,556.9
2067	47,026	8,666,728	8,713,754	871,375	7,842,378.5
2068	22,138	8,651,687	8,673,825	867,382	7,806,442.3
2069	51,955	8,641,005	8,692,960	869,296	7,823,663.9
2070	18,775	8,609,791	8,628,566	862,857	7,765,709.7
Total	**1,462,635**	**495,327,120**	**496,789,755**	**49,678,976**	**447,110,780**

5.7 Climate Change Adaptation Benefits

5.7.1 Likely regional climate change (GL1.1, GL1.2)

5.7.1.1 Climate variability scenarios for the project zone

Regional climate change was projected using the SERVIR-based Climate One-Stop[19] portal. In summary, the project zone is likely to exhibit various effects of climate change over the next 50 years with greater weather anomalies. Temperatures will increase consistently over the years, and there will be a considerable shift in precipitation patterns, evapotranspiration rates, humidity, surface runoffs and soil moisture levels. Seasonal climate variability is expected to be greater, which suggests a substantial increase in rainfall and its intensity for the wet season (December to May), and warmer and longer dry months during the dry season (June to November). This is likely to pose a high risk of floods, surface runoffs, severe droughts and heat waves. Because of climate variability and anomalies, it will be difficult to predict weather and seasons in the project zone.

5.7.1.2 Likely impacts of regional climate change

Climate change will pose various impacts on the project zone's environment, economy and society, as it is likely to result in extreme weather conditions. Table 78 highlights most affected sectors and likely impacts on them.

Table 78. Likely climate change impacts

Sector	Likely impacts
Environmental	Loss of aquatic biodiversity and fish population
	Damage to mangroves and peat swamp ecosystems
	Forest degradation and biodiversity loss
	Decreased quality and quantity of surface and ground water
Economic	Loss of rural productivity and infrastructure
	Loss of crop productivity and yields

[19] Jointly developed by NASA, USAID, the National Science Foundation, the Institute for the Application of Geospatial Technology, the University of Alabama-Huntsville, and CATHALAC in Panama, Climate One-Stop uses NASA's SERVIR datasets and UNFCCC data and downscaled models to show average historical and projected climate information in many locations across the globe.

Sector	Likely impacts
	Loss of economic activities from forest/non-timber forest products
	Livestock deaths
	Increased burden from disaster management
Social	Spread of water and vector borne infectious diseases
	Reduced food security and loss of incomes
	Reduced quantity and quality of potable drinking water
	Increased number of human injuries and deaths
	Increased risk of cardiovascular and respiratory diseases

5.7.2 Climate change adaptation measures (GL1.3)

The project-zone communities are extremely vulnerable to probable climate change impacts because their livelihoods and well-being are dependent on the healthy ecosystem of the surrounding peat swamp forest in the project area. Although some negative impacts of climate change are inevitable and beyond the control of the Katingan Project, we aim to strengthen community and biodiversity resilience by implementing adaptation options through various project activities. They include:

- Integrated fishery management through water management and improved aquaculture techniques
- Restoration of peat swamp ecosystems and reforestation
- Planning and designing of climate resilient infrastructural development
- Agroforestry capacity building
- Adjustment of agricultural calendars, crop patterns and planting practices
- Diversification of economic activities by introducing sustainable livelihood options
- Capacity building for forest management and NTFP development
- Improvement of animal husbandry practices
- Integrated natural disaster management and prevention systems (e.g., early warning systems, monitoring protocols, and improved techniques and technologies)
- Improved access to public health care services
- Disease prevention and control through early warning education and information dissemination
- Improved access to clean water and sanitation facilities
- Improved access to rain/river water collection systems

6 COMMUNITY

6.1 Net Positive Community Impacts

6.1.1 Summary of net positive community impacts (CM1, CM2)

The project is expected to generate significant net positive community impacts for communities in the project zone. These are listed in Table 80, based on the criteria and indicators of the CCB Standards Third Edition. This table presents a summary against the criteria and should be read in conjunction with Sub-section 1.3.5 ("Communities in the project zone"), Sub-section 1.3.8 ("Identification of High Conservation Values"), Sub-section 2.2.1 ("Project Activities"), Section 2.3 ("Management of risks to project benefits"), Section 2.4 ("Measures to maintain high conservation values"), Section 4.5 "Baseline scenario and additionality"), Annex 2 ("communities in the project zone") and Annex 3 ("HCV assessment").

To measure community well-being, in addition to other criteria listed in Table 80, the Katingan Project adopts the measure of five key livelihood assets – human, social, financial, physical and natural capitals – as defined by the UK Department for International Development [33]. These assets are fundamental elements in achieving community benefits and are summarized below (see Table 79).

Table 79. Livelihood assets and key criteria

Livelihood asset	Criteria
Natural capital	Natural resource stocks (soil, water, air, genetic resources, etc.) and environmental services
Human capital	Education, health, physical capability, knowledge and skills possession
Social capital	Community cohesiveness, responsibility, affiliation and socio-political relations
Physical capital	Access to infrastructure (e.g., roads, transport, electricity), production equipment, shelter, and technology (e.g., communication systems)
Financial capital	Access to financing support and financial assets including cash, loans, savings and cattle

***** Table adapted from references [34] and [35].

Table 80. Summary of net positive community benefits, based on CCB critera

Criteria	Status	Baseline scenario	With-project scenario	Activities/mitigation
A: Area-based				
1. Areas with critical ecosystem services (**HCV4**)	The Katingan Project area plays a critical role in maintaining hydrological function and water supply, preventing erosion and subsidence risk from peat oxidation, and mitigating fire risk through maintained forest cover. For more detail see Sub-section 1.3.8 and Annex 3.	Under the baseline scenario hydrological function would be irreversibly lost, leading to increased erosion, oxidation of peat, loss of clean water supply and increased risk of salt-water intrusion. Fire risk would increase dramatically and natural forest cover would be destroyed (see Section 4.5).	Under the project scenario the hydrology of the core peat dome would be maintained and partially drained areas will be restored. Forest cover will be protected and reforestation will be conducted in cleared areas reducing fire risk. The threat of subsidence and salt-water intrusion will be avoided.	The central objective of the Katingan Project is to protect and restore core peat dome and the natural forests it supports. For full details of the project activities which will deliver this objective see Sub-section 2.2.1
2. Areas fundamental to meeting the basic needs of local communities (**HVC5**)	The central forests of the Katingan Project area are traditionally used by project-zone communities for the provision of numerous non-timber forest products, ranging from Rattan, to Jelutong latex, honey and medicinal plants. For more details see Sub-section 1.3.8 and Annex 3.	Under the baseline scenario the natural forests of the Katingan Project area would be replaced almost entirely with mono-culture acacia plantation. This will lead to the loss of all access to all non-timber forest products currently utilized by project-zone communities (see Section 4.5).	Under the project scenario the natural forests of the project area will be protected and currently degraded areas will be restored. Further work will specifically seek to enhance the sustainable use and marketing of non-timber forest products by project-zone communities as a means to improving livelihoods.	As above, the central objective of the Katingan Project is based around the protection of the forest and enhancing the sustainable use of the products and services it provides to project-zone communities. For further details of activities seeking to enhance sustainable use of such products see Sub-section 2.2.1 - H).

Criteria	Status	Baseline scenario	With-project scenario	Activities/mitigation
3. Areas critical for traditional identity of communities (**HCV6**)	Through the participatory mapping and rural appraisal processes undertaken with project-zone communities, a number of small areas within the project zone have been identified as being of cultural or religious significance. These include ritual and ancestral sites, shrines, and restricted-traditional area for fishing. See Sub-section 1.3.8 for more details.	Under the baseline scenario areas identified as culturally important are likely to be at risk of loss. While regulations would compel a licence-holding plantation company to identify such areas and ensure protection and access, this practice is widely ignored or only partially implemented, putting such areas at risk.	Under the project scenario all area identified as being of cultural or religious significance within the project area will be fully protected in close collaboration with the respective village communities. The project will also seek to assist communities to protect such areas within the wider project zone as far as possible.	Within the project area, where the Katingan project has legal mandate, such areas will be fully protected. Within the wider project zone the Katingan Project will assist local communities through the village-based planning processes (see Sub-section 2.2.1 - G) to seek and obtain formal legal protection of such areas through negotiation with local government and land users.
B: Well-being based				
1. Natural capital	Currently natural capital within the project area is extremely high. The Vast natural forest and peat system supports critical ecosystem services such as provision of clean water and mitigating fire risk, while containing natural resources utilized by the project-zone communities (see above, Sub-section 1.3.8 and Annex 2).	Under the baseline scenario, the natural capital of the Katingan Project area would be exploited for short-term gain largely to the benefit of a distant elite. While there may be some short-term benefits to some individuals within the project area communities, through employment or provision of services, the effects would be short-lived and negated by the long-term impacts as described above.	Under the project scenario, the vast natural capital of the Katingan Project area will be safeguarded and project-zone communities will be assisted to develop ways that sustainably exploit these resources in a way in which the benefits are retained locally.	The Katingan Project aims to protect and enhance the natural capital of the project area, and so support the development of local initiatives that can sustainably utilize it. For further details of activities seeking to enhance sustainable use of forest products and services, see Sub-section 2.2.1 - H).
2. Human capital	Project area communities are typically small, isolated and lack access to basic social services like health and education. While traditional knowledge may be high, knowledge is lacking in how to utilise this within a modern market-driven society or within the context of prevailing political and regulatory systems.	Under the baseline scenario it is likely that mixed results will be seen on human capital. In the short-term some aspects may be enhanced through increased commercial employment opportunities and a potential increase in social services, but this will be counterbalanced by the loss of traditional knowledge and the creation of dependency on a short-lived commercial provider. Communities will become less self-reliant and as a result more at risk.	Under the project scenario project-zone communities will be assisted to develop sustainably and self-reliantly, making full use of existing knowledge. Access to education and basic services will be increased through close collaboration with local government and efforts will focus on developing sustainable business opportunities that remove dependency and build resilience.	A wide range of project activities are designed to improve access to education, training and basic services. Small and Medium sized business development is a central pillar of this approach, incorporating access to further education, direct training and capacity building, access to technical advice and access to capital.

Criteria	Status	Baseline scenario	With-project scenario	Activities/mitigation
3. Social capital	Social capital within the project zone is currently high. Village communities are typically cohesive units that function through well-established institutions and values. These are backed by Indonesia law the recognised and regulates the role of such institutions.	Under the baseline scenario social capital will be at risk. The typical response to the arrival of a large commercial exploiter is the erosion of social cohesion as benefits and costs become unequally distributed and factions form. Increased immigration and competition for scarce resources further creates opportunities for conflict.	Under the project scenario social capital will be enhanced by the project working with, and in support of, legitimate social institutions at and within project-zone communities. The decisions of such institutions will be respected and support delivered in line with their requirements, while great efforts will be made to ensure benefits are equitably distributed.	Project activities central to the strengthening of social capital include measures to support and assist collaborative village-level spatial and development planning, and in the provision of support for the priorities identified through these processes. For further details see Sub-section 2.2.1 - G).
4. Physical capital	Physical capital in the project zone is currently poor. Infrastructure ranging from power generation to communication, to transport is lacking, with knock-on effects that limit access to production equipment or markets.	Under the baseline scenario it is likely that there would be some short-term increase in infrastructure, however this would be primarily in support of commercial operations, and so both short-term and poorly aligned with local needs. In such cases long-term impacts may be even greater as local government may abrogate responsibility to the commercial exploiter, eventually leaving communities worse off when production stops.	Under the project scenario the Katingan Project will work closely with both project area communities and local government to ensure the sustainable development of infrastructure. This will include improved communication by sharing resources put in place by the project, improved river transport by the maintenance of hydrology, and development of renewable energy sources. Business development activities will focus on both access to processing equipment and markets.	Infrastructure needs will primarily be addressed through the village level planning processes, collaboration with local government, measures to increase use of sustainable and renewable energy sources (including solar, biogas and energy efficient stoves and lamps), and through small- to medium-sized business development, as described in detail in Sub-section 2.2.1 - H) and J).
5. Financial capital	The Indonesian Bureau of Statistics (*Badan Pusat Statistik*) defines the national poverty line as the minimum purchasing power to be able to afford staple food and non-food items. Social baseline surveys (see Annex 2) indicate that the average income of the project-zone households falls below this level. In addition, access to investment capital is very limited, with no banks or lending institutions active in the project zone.	Under the baseline scenario effects on financial capital are likely to be unbalanced. Some members of the projects area may benefit in the short-term through employment or the provision of goods and services, while other will be negatively impacted by the loss of livelihood. Eventually all will lose however, as the underlying natural capital is consumed leaving a degraded wasteland to follow.	The goal of the Katinagn Project is to bring substantial benefits to the project-zone communities through sustainable economic development and land use. This will be achieved through a range of measures including direct employment, preferential purchasing of local services and goods, improved planning, both agricultural and local business development support and increased access to investment capital.	A wide range of project activities are designed to assist sustainable local development and to increase financial capital. Many are described above and in Sub-section 2.2.1 - H) and I). In particular, the project will work with a variety of mechanisms to increase access to investment financing including the direct provision of microfinance to facilitating access to government-backed financing schemes

Criteria	Status	Baseline scenario	With-project scenario	Activities/mitigation
				and grants.
C: Exceptional Benefits (Gold Standard)				
1. Improved land rights	Clarity of land rights is variable amongst project-zone communities. Some have clarity of tenure while for other considerable uncertainty remains, with commercial land use designations overlapping village land claims. For more information see Sub-section 1.3.6.	Under the baseline scenario, it is likely that commercial land-use designations would prevail over village-based claims. Commercial companies typically base their claims on centrally-created tenure maps and only pay lip-service to local claims that are not yet legally designated. Where conflicts exist the typical response is short-term payment at undervalued rates.	The Katingan Project works with all project-zone communities to create spatially accurate maps that define the agreed extent of village land and the agreed boundary of the project area, as well as recognition of other spatially explicit landscape features. The project will then assist local communities to incorporate these maps into local planning regulatory processes and so obtain full legal recognition.	Activities related to the creation of participatory land use maps, in conjunction with formal village and local government regulated planning process, are central to improving land tenure issues. Such maps allow the project-zone communities to understand their spatial positions in relation to the project area, to plan their future land use and to resolve disputes with other village territories or the land uses. See Sub-section 2.2.1 - G).
2. Positive well-being	See above (Part B in this table)	See above (Part B)	See above (Part B)	See above (Part B)
3. Risk reduction	Currently project-zone communities lack social, physical and financial resilience (see above) and so are at risk from economic or environmental shock and external forces beyond their control. For more information, see Section 2.3.	As described above, under the baseline scenario, certain members of village communities may benefit from the commercial conversion of the project area, but given the short-term nature of this, the increased dependency on a commercial provider, coupled with the reduction in natural, human and social capital will all make risk higher over the long-term.	Under the project scenario, community resilience will be increased and risks will be reduced. While it is possible that in the short-term a small minority of community members will be negatively impacted by the project (such as those involved with illegal logging) and others may miss out on the short-term gain from commercial conversion, in the long-term the projects activities will benefit all.	Project activities aimed at sustainable development are all, by their nature, also aimed at reducing risks to the project-zone communities. In particular, those aimed as clarifying land tenure, improving agricultural practices and local business development and sustainable livelihood options. For more details see Sub-section 2.2.1.
4. Marginal groups	As stated above, many of the project-zone communities are considered as vulnerable, Within the communities, there also exists groups that are further marginalized, including the poor, women, elderly and the disabled, although such groups are not consistently marginalised (See Sub-section 2.7.1, Section 6.3, and Annex 2 for more details).	Under the baseline scenario is likely that there will become an increasing lack of participation and transparency in decision-making, leading to an opportunity for elite captures in which dominant groups can steer decisions to their favour, while hindering the flow of benefits to the marginalized households (for more	The project aims to identify and reach poorer and marginalized communities and community members through a variety of socio-economic programs. These are designed to lift the poorest out of poverty by engaging them in community-based business development such as microfinance, women's	Activities designed to identify marginalized groups are detailed in Sub-section 2.7.1. Activities designed to address this marginalization through targeted inclusion within sustainable development activities is described in Section 6.3. As with all activities, constant monitoring will provide feedback

Criteria	Status	Baseline scenario	With-project scenario	Activities/mitigation
		discussion of this issue see Section 6.3).	empowerment, sustainable agroforestry, renewable energy development, and non-timber forest product use.	to ensure this objective is met (see Sub-section 8.3.1).
5. Women's well-being	Many communities in the project zone have patriarchal culture, and women typically have specific roles in households and society. Their participation in social activities is often limited.	As above (marginal groups)	The project will actively engage women through a variety of activities such as microfinance, community-based business development, and public health programs (e.g., mother and child healthcare). The timing and location of meetings will be carefully considered to accommodate specific needs of women.	Our microfinance program (see Sub-section 2.2.1 – I) is designed to engage women in the project zone and increase their capacity by strengthening the social capital. The project also aims to improve women's well-being by building awareness about and providing better access to basic health and sanitation services (see Sub-section 2.2.1 – K).
6. Benefit sharing	Currently no system exists to provide equitable benefit sharing of commercial exploitation of local natural resources amongst local communities.	Under the baseline scenario, a commercial plantation company is unlikely to implement any form of local benefit sharing beyond statutory minimums. These simply define the need for a CSR policy without defining minimum requirements of such a program.	The Katingan Project will implement a full and transparent program of benefit sharing. In addition to ensuring all statutory dues are paid to central and local government, the project will implement a full program of support to project-zone communities to assist their sustainable development. Further, the project will promote this as a model approach to be adopted by more widely.	The Katingan Project aims to channel project funds through existing village-level financial mechanisms, fully aligned with jurisdictional arrangements and regional development goals; developed from the results of participatory planning, stakeholder consultations and FPIC processes. The process will mitigate the risk of elite capture, support the livelihoods and social welfare of those most dependent on the natural resources that the project will protect.
7. Information dissemination	Indonesia in general lacks formal systems that allow local communities to access information that is available to government or the private sector, including information relating to lands in which they have legitimate claims. This often leads to inequalities when such information is used by elites for short-term gain.	Under the baseline scenario there is likely to be no change from the norm. Commercial operators can manipulate access to information to ensure they achieve their objectives, often at the expense of social cohesion (see above).	The Katingan Project is committed to a policy of transparency, and will go to great lengths to ensure that information on the projects, its activities, its progress and its results are openly available. Where this relates to issue that may impact local communities, FPIC principles are	Information dissemination and transparency is built into all project activities, primarily though the participatory planning and consultations processes described in detail in Sub-sections 2.2.1 - G) and 2.7.3. Monitoring, grievance and

Criteria	Status	Baseline scenario	With-project scenario	Activities/mitigation
			followed, as described in detail in Sub-section 2.7.2.	feedback process are then used to ensure these systems work effectively, with adaptations being made as required.
8. Active involvement	Since the inception of the Katingan Project, prior to any formal applications being made, communities in the project zone area were approached as potential future partners. Since that time village communities shave been engaged at all levels of the projects operation	Under the baseline scenario the most likely form of engagement local communities could expect would be direct employment. There may be some communication with village-level institutions, but there is little precedence among plantation companies for active community-engagement in operations or decision-making.	The Katingan Project is primarily implemented at the village level, in collaboration with village communities. Opportunities for involvement range from participation in planning and mapping initiatives, to direct employment (in both junior and senior positions, on a full-time, part-time or casual basis), to participation in a range of thematic initiatives.	Project activities across the board, are implemented with staff recruited from local communities and in close collaboration with village institutions (as described above). Where possible village community members are also recruited to middle- and senior-level management positions, and the number thus employed is expected to rise as the projects invests heavily in the local human resource base (see below).
9. Capacity building	Currently there are few opportunity for training and capacity building within the project zone. Only a limited number of government-led initiatives reach the remote villages, and these often lack resources or follow-up.	Under the baseline scenario there is unlikely to be a significant rise in training and capacity building opportunities, beyond the potential for specific training given to employees of the plantation companies, linked solely to those activities. Local employment is likely to be predominantly of unskilled manual labourers.	The Katingan Project will implement a comprehensive program of training and capacity building. Part linked to those directly employed by the project; whereby the project will seek develop junior and unskilled staff so that they can take on more responsibilities over time. Part linked to the engagement of communities in specific activities such as business and agriculture development.	Many of the activities focused on sustainable development of the project-zone communities are centred on programs of training and capacity building (by their nature the activities aim to transfer knowledge to local communities). For more details specific to particular activities see Sub-secton 2.6.2.

6.1.2 Mitigation measures for any negative impacts on HCV attributes (CM1.2, CM2.2, CM2.3, CM2.4)

Table 80 shows measures taken to enhance community impacts and to mitigate any anticipated negative impacts. See also Sub-section 2.2.1 (“Project Activities”), Section 2.3 (“Management of risks to project benefits”), Section 2.4 (“Measures to maintain high conservation values”). Based on an evaluation of all criteria and indicators, in no case are negative impacts anticipated, and therefore no mitigation measures are proposed as necessary. However, this will be monitored closely (see Chapter 8), and if negative impacts are detected, immediate remedial actions will be taken.

6.2 Other Stakeholder impacts (CM3)

No offsite stakeholder impacts are anticipated. During the design phase of the project potential offsite groups were identified (see Sub-section 2.7.1), but none is considered likely to be impacted by the project – indeed, the Project Zone itself was designed to incorporate all those groups who were likely to be affected. Offsite impacts on commercial companies are discussed in detail in Section 5.2.

6.3 Exceptional Community Benefits (GL2)

Criteria for the evaluation of exceptional community benefits are included in Part C of Table 21 and urther information is available in Sub-section 1.3.5 ("Communities in the project zone"), Sub-section 1.3.8 ("Identification of High Conservation Values"), Sub-section 2.2.1 ("Project Activities"), Section 2.3 ("Management of risks to project benefits"), Section 2.4 ("Measures to maintain high conservation values"), Section 4.5 "Baseline scenario and additionality"), Annex 2 ("Communities in the project zone") and Annex 3 ("HCV assessment").

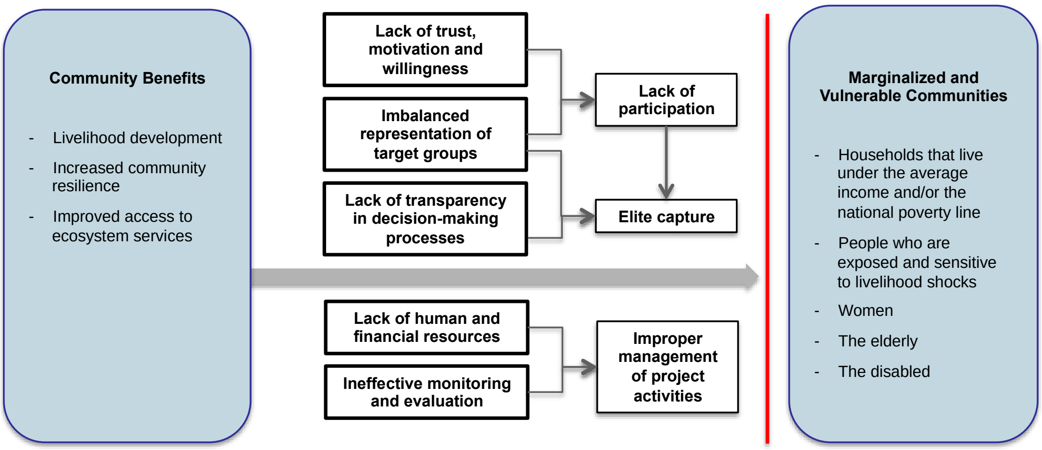
The Katingan Project conducted a social survey (see Appendix 7), referring to the global socio-economic indicator of the Human Development Index (HDI). This survey indicated that the average income of the project-zone households ranges between IDR 250,000 and IDR 1,500,000 per month. In comparison, while the HDI classifies Indonesia as a Medium Human Development country, with a rank of 108 amongst 169 countries across the world [36], the Indonesian Bureau of Statistics (*Badan Pusat Statistik)* defines the national poverty line for Central Kalimantan Province as the minimum purchasing power per capita to be able to afford staple food and non-food items, equivalent in cash terms to IDR 212,790 per month [37]. While the baseline survey results indicated that the average income in the project zone is already below the regional poverty level, in reality the average income per capita is likely to be even lower – well under the national extreme poverty level – as typical household around the concession area consists of 4 to 8 family members including children and the elderly. Thus, the project zone is qualified as a rural area of a high concentration of population living under the national poverty line.

In the project zone, basic social services are extremely limited. Social service disparity extends to access to electricity, quality education, public health facilities, clean drinking water, and sanitation systems. While people in Kotawaringin Timur District who have easier access to Sampit tend to earn higher incomes and receive better public services, the majority of communities in the project zone, particularly those in Katingan District, make lower average incomes due to the lack of access to markets and employment opportunities. Furthermore, inadequate land transportation systems isolate many project-zone communities and push the cost of living higher because the daily activities of these communities depend on water transportation. The project-zone communities are extremely vulnerable to various external shocks including environmental stresses if left without social safety nets.

The Katingan Project seeks to benefit communities through a variety of socio-economic activities which also target the most vulnerable and marginalized community members. This includes the poor, women, elderly and the disabled. The project aims at reaching these poorer and marginalized communities through a variety of socio-economic programs described in Sub-section 2.2.1 that would otherwise be unavailable to them without the Katingan Project. These programs are designed to lift the poorest out of poverty by engaging them in community-based business development such as microfinance, women's empowerment, sustainable agroforestry, renewable energy development, and NTFPs. Furthermore, the project is expected to create a multitude of positive economic effects from these programs, as they increase employment opportunities, crop yields, access to markets and revolving finances, and new business and investment opportunities. Therefore, the Katingan Project directly delivers benefits to a large proportion of the vulnerable and marginalized people and bring about positive impacts on the overall economy of the area.

The success of community programs is largely dependent on participation, transparent decision-making processes based on mutual trust, and proper management of project activities. Three main potential barriers to community benefits in reaching the marginalized and/or vulnerable communities were identified, and mitigation measures are discussed below (also see Figure 19).

Figure 19. Potential barriers to benefits reaching the marginalized and vulnerable communities



Lack of participation: The marginalized poor communities tend to live remotely away from village centres, and often lack the means or time required to attend community meetings, due to distance and other constraints. Also, it is common for the project-zone communities that the marginalized feel discouraged to voice their opinions in front of dominant groups. This can trigger mistrust toward other community members, and leads to lack of motivation and willingness to participate. Also, unbalanced or misrepresented target groups for certain project activities could entail non-participation of the poorer and marginalized community members. The Katingan Project will encourage all community stakeholders, particularly the poorer and marginalized, to participate in project activities through differentiated approaches. As described in Sub-section 2.2.1, our participatory planning processes enables all project-zone communities to be involved in decision-makings. Understanding barriers to meaningful participation to the project, socialization, information dissemination and community meetings take place at various locations and times by considering the needs of the marginalized. For example, some meetings are facilitated only for women, and take place at their houses in the evening when they usually have spare time. Community message boards, booklets, flyers and videos, and local radio programs will also be used to reach target audience effectively.

Elite captures: A lack of participation and transparency in decision-making processes generally creates an opportunity for elite captures in which dominant groups can steer decisions to their favour, while hindering the flow of benefits to the marginalized households. When making decisions regarding an infrastructural development project such as road construction, for example, community board members may choose a location based on their personal benefits, rather than communal benefits as a whole. Without transparent decision-making systems and well-represented board of communities in place, community programs may be manipulated to satisfy the personal interests of certain individuals and may not produce overall positive impacts on the marginalized households. In order to address the risk of elite captures, the Katingan Project will encourage the poorer and marginalized communities to participate (see above) and aim to enhance the balance of community representation. To increase transparency in decision-making processes, meeting records and decisions will be maintained and made publically available. A mixed representation of community members, including the marginalized groups, will reinforce more equitable and democratic distribution of benefits, thereby placing checks and balances on decision-making processes and safeguarding the interest of communities as a whole.

Improper management of project activities: Another potential barrier to anticipated project benefits reaching target community members is improper management of project activities due to the lack of human and financial resources and effective monitoring and evaluation systems. The implementation and progress of project activities should be regularly monitored in order to assess the impacts of these activities on the marginalized households, to ensure appropriate allocation and use of community funds, and to enforce rules. Without a stringent system of checks and balances, the risk of the elite capture of benefits, ineffective performance and misappropriation of funds remains high. The Katingan Project seeks to remove this barrier by supporting the project-zone communities to have access to sufficient resources which are necessary to carry on project activities. Proper training will also be provided to build the capacity of local people (see Sub-section 2.6.2 on training and capacity building). Community-based adaptive management will reinforce checks and balances on decision-making processes and lead to a form of democratic natural resources governance.

7 BIODIVERSITY

7.1 Net Positive Biodiversity Impacts

7.1.1 Summary of net positive biodiversity impacts (B1, B2)

The project is expected to generate significant net positive biodiversity benefits. These are listed in Table 81 based on the criteria and indicators of the CCB Standards Third Edition. This table presents a summary against the criteria and should be read in conjunction with Sub-section 1.3.7 ("Current biodiversity"), Sub-section 1.3.8 ("Identification of high conservation values"), Sub-section 2.2.1 ("Project activities"), Section 2.3 ("Management of risks to project benefits"), Section 2.4 ("Measures to maintain high conservation values"), Section 4.5 "Baseline scenario and additionality"), Appendix 1 ("Key species"), Annex 3 ("HCV assessment"), and references [8] and [9].

Table 81. Summary of net positive biodiversity benefits

Biodiversity criteria	Status	Baseline scenario	With-project scenario	Protection/mitigation measures
Area-based Criteria				
1. Globally, regionally or nationally significant concentrations of biodiversity values (**HCV1**)	The project zone contains 61% natural mixed peat swamp forest, and a further 7% of freshwater swamp forest. In these forests over 380 species of animal species and 300 plant species have been recorded (see Appendix 1). This includes 44 species listed as CR, EN or VU (see below) and a further 55 listed as NT, protected by Indonesian law or endemic. Of these the project zone is estimated to contain globally significant populations of many (See Annex 3 & below), and as such to qualify as Key Biodiversity Area. The project zone also forms a continuous area with Sebangau National Park to the east, and as such creates the largest remaining intact area of peat swamp forest	Under the baseline scenario (see Section 4.5) almost the entire project area (149,800 ha) would be cleared, drained and converted to industrial acacia plantations. This would have a catastrophic effect on the biodiversity value of the area as almost all of the key species present at the site are dependent on the presence of large blocks of undisturbed intact forest (see below). The continued	Under the project scenario the entire project area (149,800 ha) will be protected, and any degraded areas restored. This will ensure the long-term survival of the habitat and the species supported by it. Outside of the core project area, within the wider project zone, project activities will seek to protect and conserve all remaining intact forest areas, despite the project not having legal management rights.	Project measures to ensure the projection of high conservation value areas within the project zone are described in detail in 7.1. Specific measures related to key species are described below. Project activities are designed to consistently *protect* and *enhance* high conservation value areas and so as a result no negative impacts are anticipated and no mitigation measures are therefore anticipated. The impact of project

Biodiversity criteria	Status	Baseline scenario	With-project scenario	Protection/mitigation measures
	in South-East Asia.	presence of these species would become untenable. Outside of the project area, within the wider project zone, further degradation is also inevitable, including small-medium scale conversion of forest to agriculture, including oil palm plantations and drainage. Fire risk would remain very high. The negative effect of these impacts in terms of biodiversity would be multiplied by the loss of the core project area leaving only isolated fragments of natural habitat remaining none of which are likely to be able to support long terms viable populations of key species.	This will include working with communities, government and industry to maintain and enhance all current biodiversity values through sounds planning and by promoting sustainable agricultural practices. As a result the project is anticipated to provide net positive benefits within the wider project zone both directly, through these activities, and indirectly through the complete protection of the core project area and the viable source populations of biodiversity contained within it.	activities on all high conservation value areas will be constantly monitored (See Chapter 8) and if at any point negative impacts are indicated remedial action will immediately be taken.
2. Globally, regionally or nationally significant large landscape-level areas where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance (**HCV2**)	The project zone contains one of the largest remaining intact and continuous areas of mixed peat swamp forest outside of protected areas in Indonesia (see Annex 3). It also contains natural transitions to other ecosystem types including freshwater swamp forest and heath forest (see Annex 3). In addition to the globally significant populations of key species (see below), the area supports the full range of species representative of this habitat type regionally (see Annex 3 & Appendix 1).			
3. Threatened or rare ecosystems (**HCV3**)	Intact, un-drained peat swamp forest is one of the most threatened habitats in Indonesia. Between 1995 and 2003 over 30% of such forests were lost or severely degraded (see Sub-section 1.3.1). In addition to the area's peat swamps, freshwater swamp forest and seasonally flooded river plain forest are also both considered rare and/or endangered (see Annex 3).			
Species-based Criteria				
1. Critically Endangered (CR) and Endangered (EN) species - presence of at least a single individual				
Critically Endangered Mammal: Sunda Pangolin (*Manis javanica*)	Widely distributed in Borneo but population highly threatened by unsustainable hunting and now fully protected under Indonesian law. Preliminary surveys suggested the confirmed presence of this notoriously difficult to survey species throughout the project area.	Threatened by loss of forest habitat and unsustainable hunting, mainly for the Chinese medicine market. Under the baseline such hunting pressure would likely increase as isolated forest fragments became more accessible.	Under the project scenario the core project area will remain protected and largely inaccessible, as such will provide a safe haven for this species. Measures to control illegal hunting will further alleviate pressure.	Project activities will focus on identification of distribution and population status, followed by forest protection and hunting control measures.
Critically Endangered Bird: White-shouldered ibis (*Pseudibis davisoni*)	Indonesian population estimated at <100 individuals, mainly within an isolated population in East Kalimantan. The continued presence of this species in the project area confirms its critical global importance as a second Indonesian population centre.	Threatened by habitat loss, disturbance and hunting pressure. Under the baseline scenario this species is unlikely to survive.	Under the project scenario the species habitat will be protected and local hunters will be educated as to its protected status and global importance.	Project activities will focus on the protection of intact forest, particularly along small watercourses, and measures targeted at reducing illegal and unsustainable hunting.
Critically Endangered Plant: Kahui/Red Balau (*Shorea*	This tree species is restricted to Bornean peat swamp forests. Preliminary surveys suggested the project area may contain over 600,000 stems (>5cm) making the site of key	Threatened by commercial over-extraction and general forest loss. This species would be lost from the	Under the project scenario this species will be protected within the project area and efforts will be made to reduce	Protection of the project zone, restoration of degraded areas (potential for selective replanting) and measures to reduce

Biodiversity criteria	Status	Baseline scenario	With-project scenario	Protection/mitigation measures
balangeran)	significance for this species.	project area and remain over-exploited within the wider project zone.	its exploitation within the wider project zone.	illegal and unsustainable timber extraction in the wider project zone.
Endangered Mammal: Proboscis monkey (*Nasalis larvatus*)	Endemic to Borneo with a total population estimated in the region of 10,000 individuals. Preliminary surveys indicated the project zone may support over 500 individuals which would represent over 5% of the global population.	Threatened by habitat loss and disturbance, particularly along forested river borders. Such areas would be amongst the most negatively affected under the baseline scenario.	Areas where this species is found to be present, both within the project area and wider project zone will be targeted for protection from forest loss and disturbance.	Project activities will focus on identifying key areas for the species followed by measures to prevent their loss, and disturbance. Hunting control measures will also ensure this species is not targeted.
Endangered Mammal: Bornean Gibbon (*Hylobates albibarbis*)	Endemic to Borneo. Generally widespread within forest habitat, including peat swamp forest, but estimated to be in serious decline due to the loss of such habitat. Population in the project zone estimated at almost 10,000 individuals.	Threatened by forest habitat loss. Population would be drastically reduced under the baseline scenario.	Protection of forest within the core project area and wider zone will ensure continued high population presence.	Project activities will focus on general forest protection and hunting control measures.
Endangered Mammal: Bornean Orangutan (*Pongo pygmaeus*)	Endemic to Borneo. Widespread but rapidly declining in forest including peat swamp forest. The global population is tentatively estimated at between 45,000 and 69,000 individuals. The population within the project zone is estimated at between 3,600 and 5,800 individuals. Even the lower end of this estimate represents over 5% of the global population, confirms the critical importance of the project for this species.	Threatened by forest habitat loss and hunting. Population would be drastically reduced under the baseline scenario, further exacerbated by a likely rise in hunting of any remaining individuals, as usually accompanies commercial conversion.	Protection of forest within the core project area and wider zone will ensure continued high population presence. Measures to reduce and/or remove hunting pressure and mitigate any conflict with local communities will also further enhance the population security.	Project activities will focus on forest protection, restoration and measures to eradicate hunting and to mitigate any conflict between local communities and crop-raiding. In selected areas, and with strict controls, the site may also be used as a release site for rehabilitated orangutan from elsewhere in Kalimantan.
Endangered Mammal: Hairy-nosed Otter (*Lutra sumatrana*)	Little known species. Protected under Indonesian law. Presence in project area is yet to be confirmed but based on presence in nearby Sebangau NP thought likely.	Threatened by forest habitat loss and hunting. Both likely to increase under the baseline scenario.	Forests will remain protected, particularly along small river and waterways. Measures to control illegal hunting will further alleviate pressure.	Project activities will focus on confirming the presence of this species followed by measures to prevent habitat loss, disturbance and illegal hunting.
Endangered Mammal: Flat-headed Cat (*Prionailurus planiceps*)	Widespread but patchy distribution among swamp forests, including peat swamps. Presence in the project area was indicated by results of interview surveys but requires further confirmation.	Threatened by forest habitat loss and hunting. Any remaining population would be drastically reduced under the baseline scenario.	Protection of forest within the core project area and wider zone will ensure continued high population presence.	Project activities will focus on confirming the presence of this species followed by measures to prevent habitat loss, disturbance and illegal hunting.
Endangered Bird: Storms Stork (*Ciconia stormi*)	Widespread but very fragmented distribution amongst lowlands swamp forest. Presence within project area confirmed by preliminary surveys.	Very vulnerable to forest loss, fragmentation and disturbance. This species would likely become locally	Forests will remain protected, particularly along small river and waterways, safeguarding the	Project activities will focus on the protection of intact forest, particularly along small watercourses and swampy areas.

Biodiversity criteria	Status	Baseline scenario	With-project scenario	Protection/mitigation measures
		extinct under the baseline scenario.	local population.	
Endangered Reptile: Bornean River Turtle (*Orlitia borneensis*)	Widespread but declining across Borneo, Malaysia and Sumatra. Inhabits rivers and lakes, particularly within peat swamp areas. Confirmed presence in project area.	Threatened by habitat loss and unsustainable hunting for food and the pet trade; both likely to increase under the baseline scenario.	Under the project scenario the species habitat will be protected and local hunters will be educated as to its protected status and global importance.	Project activities will focus on the protection of intact forest, particularly along small watercourses, and measures targeted at reducing illegal and unsustainable hunting.
Endangered Reptile: Spiny Hill Turtle (*Heosemys spinosa*)	Widespread but declining across south-east Asia. Inhabits rivers and lakes, particularly within peat swamp areas. Confirmed presence in project area.	Threatened by habitat loss and unsustainable hunting for food and the pet trade; both likely to increase under the baseline scenario.	Under the project scenario the species habitat will be protected and local hunters will be educated as to its protected status and global importance.	Project activities will focus on the protection of intact forest, particularly along small watercourses, and measures targeted at reducing illegal and unsustainable hunting.
Endangered Plant: Meranti Semut (*Shorea teysmaniana*)	This tree species is restricted to Sundaic peat swamp forests. Preliminary surveys confirmed the presence of this species in the project area.	Threatened by commercial over-extraction and general forest loss. This species would be lost from the project area and remain over-exploited within the wider project zone.	Under the project scenario this species will be protected within the project area and efforts will be made to reduce its exploitation within the wider project zone.	Protection of the project zone, restoration of degraded areas (potential for selective replanting) and measures to reduce illegal and unsustainable timber extraction in the wider project zone.
2. Vulnerable species (VU) - presence of at least 30 individuals or 10 pairs				
Preliminary surveys identified the presence of a further 30 species listed as Vulnerable. These species are listed opposite. For full details see Appendix 1.	Bornean Slow Loris (*Nycticebus menagensis*) Horsfield's tarsier (*Tarsius bancanus*) Pig-tailed Macaque (*Macaca nemestrina*) Whiskered Flying Squirrel (*Petinomys genibarbis*) Red Spiny Rat (*Maxomys rajah*) Whiteheads Rat (*Maxomys whiteheadi*) Dark-tailed Tree Rat (*Niviventer cremoriventer*) Malayan Sun-bear (*Helarctos malayanus*) Small-clawed Otter (*Aonyx cinerea*) Binturong (*Arctictis binturong*) Clouded Leopard (*Neofelis nebulosa*) Marbled Cat (*Pardofelis marmorata*) Bearded Pig (*Sus barbatus*) Sambar Deer (*Cervus unicolor*) Crestless Fireback (*Lophura erythrophthalma*) Black Partridge (*Melanoperdix nigra*) Lesser adjutant stork (*Leptoptilos javanicus*) Bonaparte's Nightjar (*Caprimulgus concretus*) Hook-billed Bulbul (*Setornis*	All of these species are dependent on large intact, undisturbed forests and waterways. Many are also threatened by illegal or unsustainable hunting. Under the baseline scenario of almost total forest loss and a resulting increase in human disturbance and hunting pressure, few would remain present in viable populations for any length of time.	Under the project scenario forests will be protected, disturbance reduced and measures will be taken to reduce illegal and unsustainable hunting, resulting in the maintenance of viable populations within the project zone.	General project activities will focus on the protection of intact forest, particularly along watercourses, and measures targeted at reducing illegal and unsustainable hunting. Where particular species require dedicated intervention such activities will be implemented.

Biodiversity criteria	Status	Baseline scenario	With-project scenario	Protection/mitigation measures
	criniger) False Gharial (*Tomistoma schlegelii*) Asian Box Turtle (*Cuora amboinensis*) Softshell Turtle (*Amyda cartilaginea*) Giant Soft shell Turtle (*Pelochelys bibroni*) Binjai (*Mangifera sp.*) Tumih (*Combretocarpus rotundatus*) Jelutung (*Dyera lowii/polyphylla*) Geronggang Putih (*Canarium sp.*) Meranti Batu (*Shorea uliginosa*) Ramin (*Gonystylus bancanus*)			

7.1.2 Mitigation measures for any negative impacts on HCV attributes (B1.2, B2.3, B2.4)

The above Table 81 shows measures taken to enhance biodiversity values and to mitigate any anticipated negative impacts. See also Sub-section 2.2.1 ("Project activities"), Section 2.3 ("Management of risks to project benefits"), and Section 2.4 ("Measures to maintain high conservation values").

Based on an evaluation of all criteria and indicators, in no case are negative impacts anticipated, and therefore no mitigation measures are proposed as necessary (see also Sub-section 7.1.3 below). However, this will be monitored closely (see Chapter 8), and if negative impacts are detected, immediate remedial actions will be taken.

7.1.3 Identification of species to be used in project activities and confirmation of status (B2.5, B2.6)

The project will undertake rehabilitation of degraded areas within the project area. This will include some replanting of tree species (see Sub-section 2.2.1). Species intended to be used in such replanting are listed above in Table 81. All species used in natural forest replanting and for firebreaks are native to Borneo and non-invasive in peat swamp forest habitats. One species, rubber (*Hevea braziliensis*), used in community-managed agroforests is not native to South-East Asia, but is grown widely. Its inclusion in the reforestation program is viewed as an interim measure to ensure community participation while native jelutong trees become fully productive. Once the hydrology of the area is fully restored, rubber trees will be out-completed by jelutong, as they are unable to tolerate the high water table.

7.1.4 Use of non-native species, fertilizers, chemical pesticides and other inputs (B2.6, B2.7, B2.8)

No genetically modified organisms, fertilizers or chemical pesticides will be used by the project.

7.1.5 Description of waste products management resulting from project activities (B2.9)

The Katingan Project adopts the principles of Reduce, Reuse and Recycle. Organic waste will be separated and composted through village composting initiatives, or disposed of through burial. Inorganic waste will be separated into recyclable components – which will be entered into village- and local- government led recycling initiatives – while residual inorganic waste will be removed from the site and disposed of through government-run waste disposal facilities in Sampit.

7.2 Offsite Biodiversity Impacts (B3)

All project activities are designed to deliver positive biodiversity impacts, as such, none are anticipated to lead to negative impacts, either on site or off. There does remain the possibility that protection of forest on site will lead to displacement of activities offsite (leakage), with resulting impact, however this will be carefully monitored and any resulting impacts quantified (see Section 5.5 and Sub-section 8.3.3).

As provided above in Sub-section 7.1.2, no negative impacts off-site impacts are anticipated, and so no mitigation strategy is required. However, this will be monitored closely, and if negative impacts are detected, remedial actions will be taken immediately.

7.3 Exceptional Biodiversity Benefits (GL3)

The project is expected to generate exceptional biodiversity benefits based on multiple achievement of the criteria defined in the CCB Standards Third Edition. Table 81 summarizes achievement of the 'Exceptional Biodiversity Benefit' criteria with respect to the population status of key species. This includes four species considered critically Endangered, 10 considered Endangered, and 31 species considered Vulnerable (IUCN 2015). For two of these at least, Orangutan and Proboscis Monkey, the project zone is estimated to hold over 5% of the entire global population.

For each species identified as Critically Endangered, Endangered or Vulnerable a summary of project activities that will be taken to enhance the population within the project zone is given in Table 81. For further information on project activities see also Sub-section 2.2.1.

For further information, see Sub-section 1.3.7 ("Current biodiversity"), Sub-section 1.3.8 ("Identification of high conservation values"), Sub-section 2.2.1 ("Project activities"), Section 2.3 ("Management of risks to project benefits"), Section 2.4 ("Measures to maintain high conservation values"), Section 4.5 "Baseline scenario and additionality"), Appendix 1 ("Key species"), Annex 3 ("HCV assessment"), and references [8] and [9].

8 MONITORING

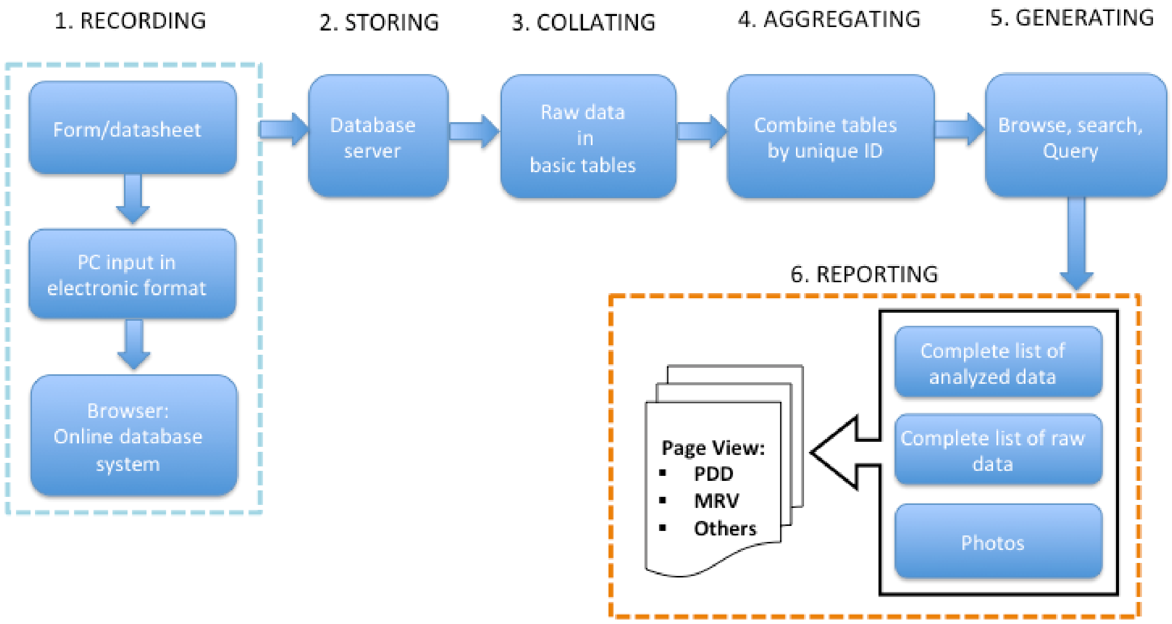
8.1 Description of the Monitoring Plan (CL4, CM4, B4)

8.1.1 Data management methods and structure

All data generated by the Katingan Project is centrally managed in an online-based database (see Figure 20). Hard copies of all data sheets are archived in field offices, with duplicate copies stored centrally in PT. RMU's headquarter in Bogor. Field data is uploaded directly into the online database system from the field office, allowing simultaneous multi-user input through a local server network. After the data is collated by the database server, it can be adapted to fulfil all monitoring and reporting needs using standard and custom-made report formats.

All climate, community and biodiversity monitoring parameters, including both raw and processed data, together with their frequency, are detailed in Appendix 9, Appendix 10 and Appendix 11 (MRV Trackers).

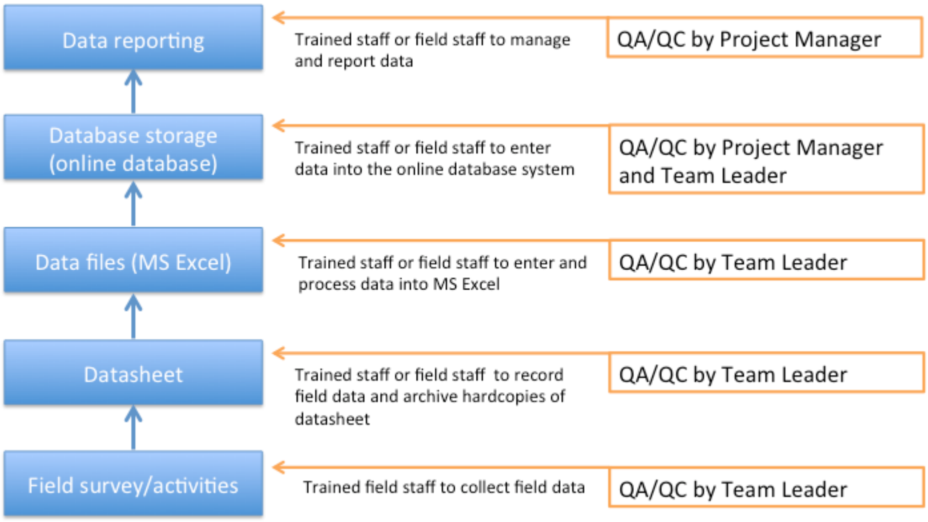
Figure 20. Simple schematic of data management structure



8.1.2 Procedures for handling internal auditing and non-conformities

Internal auditing and non-conformities are addressed through standard operation procedures (SOPs) that incorporate multiple quality assurance and quality control (QA/QC) measures. All data collected, recorded, stored and reported are subject to review and approval by team leaders and/or project managers with reference to written SOPs covering each level of data management (see Figure 21). A list of SOPs which have already been or will be developed is presented in Appendix 8, and a copy of SOPs are available to validators on request. In order to ensure the security and traceability of data entry and QA/QC procedures, all users are allocated unique user IDs and passwords in order to access the database, and in turn their access and roles can be restricted as appropriate.

Figure 21. Data management QA/QC procedures



8.1.3 Climate impact monitoring plan and methodological approach (CL4.1)

Climate impacts will be monitored, reported and evaluated according to the Climate MRV Tracker (Appendix 9). This includes monitoring changes in land cover, land use, peat thickness and water table depth, as per the VCS VM0007 methodological requirements. A summary of the main monitoring methods is given below.

8.1.3.1 Remote sensing

Satellite imagery will be obtained and analysed in order to monitor the integrity of the project area, as per the methods outlined in Sub-section 5.3.2. The data will be used to detect land cover change, such as deforestation caused by illegal gold mining or degradation caused by illegal logging. In cases where forest changes are detected, the procedures outlined in VCS methodology VM0007 module M-MON and detailed in the Climate Impact MRV Tracker will be followed to quantify the relevant parameters.

The area of recorded deforestation (*ADefPA,u,i,t*) will be quantified by substracting areas of forest cover between two timesteps. Emissions (Δ*CP,Def,i,t*) resulting from deforestation will be estimated by multiplying areas (*ADefPA,u,i,t*) of deforestation by the average forest carbon stock per hectare (*CBSL,i*). The area of remaining forest in the RRL (*ARRL,forest,t*) will be derived by subtracting non-forest area within the RRL and will be recorded in a forest benchmark map. This map will be updated at each monitoring period. As mandated by the Ministry of Environment and Forestry, this will be carried out annualy.

In addition to the above, the incidence of fires will be monitored using a Fire Information for Resource Management System (FIRMS). This system, developed by NASA [38], uses MODIS fire data to provide near real-time updates on fire activity in the project zone and notifies team members of a fire within 24 hours.

8.1.3.2 Field measurement

A) Monitoring forest degradation

As per VM0007 Module M-MON, a participatory rural appraisal (PRA) survey will be conducted every two years to assess illegal logging impact in the project area. If the survey indicates that more than 10% of individuals interviewed believe there are illegal logging activities, a field sampling survey will be conducted to delineate the area subject to degradation ($A_{DegW,i,t}$), while transects of $A_{DegW,i,t}$ will be surveyed to quantify any biomass loss. Emissions due to forest degradation (Δ*CP,DegW,i,t*) are estimated by multiplying area (*ADegW,i*) by average biomass carbon of trees cut and removed per unit area (*CDegW,i,t* / *APi*). This sampling procedure will be repeated every 5 years and the results annualized by dividing the total emissions by five.

Monitoring methods for GHG emissions from microbial decomposition of peat, carbon loss in water bodies and peat and biomass burning folows guidance provided the VSC methodology VM0007 M-PEAT. Details are given in Annex 1 and a short description is given below

B) Monitoring C stock

Monitoring the change in carbon stocks of tree biomass will be conducted through field measurements using a point sampling method with an allometic equation on tree diameter (DBH) [39]. The monitoring of REDD activities will be carried out in all 91 permanent nested biomass plots that were measure in determining the baseline. This will start in 2020 and continue to monitor every 5 years. Per CDM A/R Methodological Tool “Calculation of the number of sample plots for measurements within A/R CDM project activities” [40], the project will establish new monitoring plots for areas representing the ARR activities in 2020, and continue to monitor thereafter every 5 years. Allometric equation will be chosen based on the species or species group planted under the ARR activities, and DBH will be used as the main parameter for this monitoring. The detailed procedure on field measurements for AGB is provided in Annex 15.

C) Monitoring GHG Emissions from microbial decomposition of peat

Monitoring GHG emissions from microbial decompositions of peat is carried out by directly monitoring GHG flux and variables that are used as proxies in calculating GHG emissions for each stratum. For forested stratum with less dynamic water table depths (undrained forested peatland, P1L1D0), the conditions of forest cover and water table depths will be monitored continuously to verify annual forest cover conditions and drainage status. Forest cover conditions will be monitored by using combined methods of remote sensing and regular land surveys. Drainage status will be monitored by using dipwells (point-based monitoring) installed along transects that are designed to be representative of the stratum. Monitored point-based water table depths will be extrapolated into areal-based water depths by using hydrological model(s). Based on water table depths and forest cover data, annual status of the stratum will be evaluated. Any significant changes in forest cover and/or drainage status will be followed up by restratifying the "changed" area into new correct stratum. GHG emissions from microbial decompositions of peat in stratum P1L1D0 will be monitored and summarized annually by using IPCC default emission factor and following procedures given in the VSC methodology VM0007 module M-PEAT.

For strata where water tables are more dynamic and without forest cover, hydrological variables and subsidence will be monitored during project crediting period. Direct monitoring of GHG flux will be carried out within the period deemed suitable for generating site-specific proxies (2-3 years). By using site-specific proxies, and following procedures given in module the VSC methodology VM0007 M-PEAT, GHG emissions from microbial decompositions of peat per stratum will be monitored and summarized annually.

D) Monitoring GHG Emissions from water bodies

Disolved organic carbon (DOC) from water bodies inside the project area will be monitored during the period deem representative of developing site-specific DOC value(s) (2 – 3 years). The value(s) will be used in calculating emisions from water bodies by taking into account areas of water bodies inside project area. Changes in water body areas will be monitored based on channel widths and lengths derived from combination of regular field measurements and remote sensing techniques.

E) Monitoring GHG Emissions from peat and biomass burning

GHG emissions from peat and biomass burning will be monitored continously during project crediting period by combining regular patrol and remote sensing technique. At every burning incident, burning area will be mapped by recording vertex coordinate of the boundary of the burnt area, no later than 3 month since the date of the burning incident. Historical burning record of the burnt area will also be trackced to determine the repetition of burning. GHG burning will be summarized annually following module E-BPB. Detailed method for monitoring GHG emissions from peat and biomass burning is given in Annex 12. Monitoring of relevant climate parameters is detailed in Annex 4 and summarized in the Climate MRV Tracker (Appendix 9).

8.1.4 Community impact monitoring plan and methodological approach (CM4.1, CM4.2, GL1.4, GL2.3, GL2.5)

8.1.4.1 Community impact monitoring plan

Impacts of the Katingan Project on the project-zone communities will be closely monitored, reported and evaluated according to the Community MRV tracker (Appendix 10). Monitoring results will be used to evaluate the progress of community-based activities, lessons learned and community inputs, and to implement adaptive management. Methods to be adopted for community impact monitoring include:

- Step 1: Village-based survey teams, consisting of a community facilitator and two organizers;
- Step 2: Random sampling amongst representative village groups within each village;
- Step 3: Standardized questionnaires that are adaptable to fit target groups;
- Step 4: Standardized measures to manage and analyze sample data;

Step 5: Quantitative and qualitative data analysis to evaluate community impacts;
Step 6: Dissemination of results to all stakeholders to maintain transparency and participation.

In addition to on-the-ground surveys, data will also be collected through secondary sources (e.g., village and local government census data, third-party studies). See the Community MRV Tracker for more details.

8.1.4.2 High conservation value plan

As described in Sub-section 1.3.8 and Chapter 6, HCV5, 6 & 7 areas have significant impacts on community well-being (see Table 20 in Sub-section 6.1.1). The Katingan Project will monitor and evaluate the effectiveness of measures taken to maintain or enhance HCV attributes through the community impact monitoring program. Groundtruthing of information and maps will also be conducted on a regular basis in order to assess the accuracy of spatial impacts on communities. Through community involvement in the identification of key HCV sites and species, PT. RMU will ensure that project activities will not disturb or degrade ecosystem functions and cultural values of such areas (see Chapter 6 for more details).

8.1.5 Biodiversity impact monitoring plan and methodological approach (B4.1, B4.2, GL1.4, GL3.4)

8.1.5.1 Biodiversity monitoring plan

Biodiversity impacts in the project zone will be monitored based on the Biodiversity MRV Tracker (Appendix 11). Biodiversity monitoring will focus on the project zone's HCV areas and key species (see Table 21 in Sub-section 7.1.1). Monitoring will be carried out using a variety of field survey techniques, including, local community interview surveys to assess hunting level and threats. Rigorous data analysis will then determine whether the Katingan Project has achieved its objectives of net positive biodiversity benefits. Methods to be employed include:

Step 1: Trained and dedicated survey teams for each survey protocol.
Step 2: Standardized field survey methods for each key species, habitat of HCV group to be monitored.
Step 3: Dedicated survey protocols for Critically Endangered and Endangered species.
Step 4: Interview based survey methods to complement field surveys
Step 5: Baseline data at each monitoring site, including permanent plots and survey transects.
Step 6: Standardized data analysis and reporting methods for each survey protocol.

In addition to on-the-ground surveys, data will also be collected through secondary sources (e.g., GIS and remote sensing data, third-party studies). See the Biodiversity MRV Tracker (Appendix 11) for more details.

8.1.5.2 High conservation value monitoring plan

As outlined in Sub-section 7.1.1, it is anticipated that project activities will lead to positive enhancement of HCV areas, particularly HCV 1, 2 and 3 areas (see Table 21 in Sub-section 7.1.1). This will include a particular focus on those areas critical for the survival of Critically Endangered and Endangered species including all those listed in the table. For more details see the Biodiversity MRV Tracker (Appendix 11). This HCV monitoring program will allow the project to demonstrate that the Katingan Project has achieved the stated HCV objectives for maintaining and enhancing these HCV species' populations.

8.2 Data and Parameters Available at Validation (CL4)

Data and parameters available at validation per VCS methodology VM0007 MF are provided in the tables below. A full list of all relevant data and parameters are further provided in the Climate MRV Tracker (Appendix 9).

Data / Parameter	$\Delta C_{BSL,planned}$
Data unit	t CO_2-e
Description	Net greenhouse gas emissions in the baseline from planned deforestation
Equations	*3*
Source of data	Module BL-PL
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module BL-PL
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$\Delta C_{BSL\text{-}ARR}$
Data unit	t CO_2-e
Description	Net GHG removals in the ARR baseline scenario up to year *t**
Equations	*5*
Source of data	Module BL-ARR
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module BL-ARR
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$GHG_{BSL\text{-}WRC}$
Data unit	t CO_2-e
Description	Net GHG emissions in the WRC baseline scenario up to year *t**
Equations	*6*
Source of data	Module BL-PEAT
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	See Module BL-PEAT
Purpose of Data	Calculation of baseline emissions
Comments	N/A

8.3 Data and Parameters Monitored (CL4, CM4 & B4)

8.3.1 Climate impact monitoring parameters and relevant data

Data and parameters to be monitored per VCS methodology VM0007 MF are provided in the tables below. A full list of all relevant data and parameters are further provided in the Climate MRV Tracker (Appendix 9).

Data / Parameter:	$\Delta C_{WPS-REDD}$
Data unit:	t CO_2-e
Description:	Net GHG emissions in the REDD project scenario up to year *t**
Equations	*2*
Source of data:	Module M-MON
Description of measurement methods and procedures to be applied:	See Module M-MON
Frequency of monitoring/recording:	See Module M-MON
QA/QC procedures to be applied:	See Module M-MON
Purpose of data:	*Calculation of project emissions*
Calculation method:	See Module M-MON
Comments:	

Data / Parameter	$\Delta C_{LK-AS,planned}$
Data unit	t CO_2-e
Description	Net greenhouse gas emissions due to activity shifting leakage for projects preventing planned deforestation
Equations	*4*
Source of data	Module LK-ASP
Value applied	n/a
Justification of choice of data or description of measurement methods and procedures applied	See Module LK-ASP
Purpose of Data	Calculation of *leakage*
Comments	

Data / Parameter	ΔC_{LK-ME}
Data unit	t CO_2-e
Description	Net greenhouse gas emissions due to market-effects leakage
Equations	*4*
Source of data	Module LK-ME
Value applied	
Justification of choice of data or description of measurement methods and procedures applied	See Module LK-ME
Purpose of Data	Calculation of *leakage*
Comments	

Data / Parameter:	$\Delta C_{WPS-ARR}$
Data unit:	t CO_2-e
Description:	Net GHG emissions in the ARR project scenario up to year *t**
Equations	*5*
Source of data:	Module M-ARR
Description of measurement methods and procedures to be applied:	See Module M-ARR
Frequency of monitoring/recording:	See Module M-ARR
QA/QC procedures to be applied:	See Module M-ARR
Purpose of data:	*Calculation of project emissions*
Calculation method:	See Module M-ARR
Comments:	

Data / Parameter:	ΔC_{LK-ARR}
Data unit:	t CO_2-e
Description:	Net GHG emissions due to leakage from the ARR project activity up to year *t**
Equations	*5*
Source of data:	Module LK-ARR
Description of measurement methods and procedures to be applied:	See Module LK-ARR
Frequency of monitoring/recording:	See Module LK-ARR
QA/QC procedures to be applied:	See Module LK-ARR
Purpose of data:	*Calculation of leakage*
Calculation method:	See Module LK-ARR
Comments:	

Data / Parameter:	$GHG_{WPS-WRC}$
Data unit:	t CO_2-e
Description:	Net GHG emissions in the WRC project scenario up to year *t**
Equations	*6*
Source of data:	Module M-PEAT
Description of measurement methods and procedures to be applied:	See Module M-PEAT
Frequency of monitoring/recording:	See Module M-PEAT
QA/QC procedures to be applied:	See Module M-PEAT
Purpose of data:	*Calculation of project emissions*
Calculation method:	See Module M-PEAT
Comments:	See Module M-PEAT

Data / Parameter	GHG_{LK-ECO}
Data unit	t CO_2-e
Description	Net GHG emissions due to ecological leakage from the WRC project activity up to year *t*
Equations	*6*
Source of data	Module LK-ECO
Value applied	n/a
Justification of choice of data or description of measurement methods and procedures applied	See Module LK-ECO
Purpose of Data	Calculation of *leakage*
Comments	

8.3.2 Community impact monitoring parameters and relevant data

See the Community MRV tracker (Appendix 10) for parameters and relevant data to be monitored through the life of the community-based project activities.

8.3.3 Biodiversity impact monitoring parameters and relevant data

See the Biodiversity MRV Tracker (Appendix 11) for parameters and relevant data to be monitored through the life of the biodiversity-related project activities.

LIST OF APPENDICIES

APPENDIX 1. FAUNA AND FLORA OF THE PROJECT ZONE

APPENDIX 2. VCS AFOLU NON-PERMANENCE RISK ANALYSIS

APPENDIX 3. COPY OF THE ECOSYSTEM RESTORATION CONCESSION LISENCE GRANTED TO PT. RMU

APPENDIX 4. STRATA CHANGES IN BASELINE SCENARIO FOR WRC ACTIVITY

APPENDIX 5. BASELINE STRATIFICATION BASED ON EMISSION CHARACTERISTICS

APPENDIX 6. DEFAULT VALUES USED IN QUANTIFICATION OF GHG EMISSIONS

APPENDIX 7. THE SIZE AND POPULATION OF THE PROJECT-ZONE VILLAGES

APPENDIX 8. LIST OF STANDARD OPERATION PROCEDURES (SOP)

APPENDIX 9. CLIMATE MRV TRACKER

APPENDIX 10. COMMUNITY MRV TRACKER

APPENDIX 11. BIODIVERSITY MRV TRACKER

APPENDIX 1. FAUNA AND FLORA OF THE PROJECT ZONE

This appendix lists all species of fauna and flora recorded in the project zone. For further details see Sub-section 1.3.7 ("Current Biodiversity") and Sub-section 1.3.8 ("Identification of High Conservation Values"), Annex 3 ("HCV Assessment") and references [8] and [9].

Each table shows IUCN categories (CR = critically endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC= Least Concern DD = Data Deficient, NE= Not Evaluated); CITES categories (I = international trade prohibited, except in exceptional non-commercial cases; II = international trade may be permitted, but requires export permit; III = limited trade); Protected status in Indonesia (Peraturan Pemerintah No. 7/1999; Y = protected), and endemicity (Y = endemic to Borneo).

1. Mammals

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
INSECTIVORA						
Soricudae	*Crocidura fuliginosa*	South-east Asian white-toothed shrew	LC			
Soricudae	*Tupaia glis*	Common treeshrew	LC	II		
Soricudae	*Tupaia gracilis*	Slender treeshrew	LC	II		
Soricudae	*Tupaia minor*	Lesser treeshrew / Pygmy tree shrew	LC	II		
Soricudae	*Tupaia picta*	Painted treeshrew	LC	II		
Soricudae	*Tupaia splendidula*	Ruddy treeshrew	LC	II		
DERMOPTERA						
Cynocephalidae	*Galeopterus variegatus*	Colugo / Sunda flying lemur	LC		Y	
CHIROPTERA						
Pteropidae	*Megaerops ecaudatus*	Tailless fruit bat	LC			
Pteropidae	*Pteropus vampyrus natunae*	Large flying fox	NT	II		
Rhinolophidae	*Rhinolophus trifoliatus*	Trefoil horseshoe bat	LC			
Vespertilionidae	*Kerivoula hardwickii*	Hardwicke's / Common woolly bat	LC			
Vespertilionidae	*Kerivoula intermedia*	Small woolly bat	NT			
Vespertilionidae	*Kerivoula minuta*	Least woolly bat	NT			
Vespertilionidae	*Kerivoula pellucida*	Clear-winged woolly bat	NT			
Vespertilionidae	*Kerivoula whiteheadi*	Whitehead's woolly bat	LC			
Vespertilionidae	*Murina suilla*	Lesser / Brown tube-nosed bat	LC			
Vespertilionidae	*Myotis muricola*	Nepalese whiskered myotis bat	LC			

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
PRIMATA						
Lorisidae	*Nycticebus menagensis*	Bornean Slow loris	VU	I	Y	
Tarsiidae	*Tarsius bancanus borneanus*	Western/Horsfield's tarsier	VU	II	Y	
Cercopithecidae	*Macaca fascicularis*	Long-tailed/crab eating macaque	LC	II		
Cercopithecidae	*Macaca nemestrina*	Southern pig-tailed macaque	VU	II		
Cercopithecidae	*Nasalis larvatus*	Proboscis monkey	EN	I	Y	Y
Cercopithecidae	*Presbytis rubicunda*	Red langur	LC	II	Y	Y
Cercopithecidae	*Trachypithecus cristatus*	Silver langur/Silvery Luntung	NT	II		
Hylobatidae	*Hylobates albibarbis*	Bornean southern gibbon	EN	I	Y	Y
Hominidae	*Pongo pygmaeus*	Bornean orangutan	EN	I	Y	Y
PHOLIDOTA						
Manidae	*Manis javanica*	Sunda Pangolin	CR	II	Y	
RODENTIA						
Sciuridae	*Aeromys tephromelas*	Black flying squirrel	DD			
Sciuridae	*Callosciurus notatus*	Plantain squirrel	LC			
Sciuridae	*Callosciurus prevostii*	Prevost's squirrel	LC	II		
Sciuridae	*Exilisciurus exilis*	Plain/least pygmy squirrel	DD			Y
Sciuridae	*Nannosciurus melanotis*	Black-eared pygmy squirrel	LC			
Sciuridae	*Petinomys genibarbis*	Whiskered flying squirrel	VU			
Sciuridae	*Ratufa affinis*	Pale Giant squirrel	NT	II		
Sciuridae	*Rhinosciurus laticaudatus*	Shrew-faced ground squirrel	NT			
Sciuridae	*Sundasciurus hippurus*	Horse-tailed squirrel	NT			
Sciuridae	*Sundasciurus lowii*	Low's squirrel	LC			
Erinaceidae	*Echinosorex gymnura*	Moonrat	LC			
Muridae	*Lenothrix canus*	Grey tailed tree rat	LC			
Muridae	*Maxomys rajah*	Red spiny rat	VU			
Muridae	*Maxomys whiteheadi*	Whiteheads rat	VU			
Muridae	*Niviventer cremoriventer*	Dark tailed tree rat	VU			
Muridae	*Rattus exulans*	Polynesian rat	LC			
Muridae	*Sundamys muelleri*	Mulle'rs Giant Sunda rat	LC			
Hystricidae	*Hystrix brachyura*	Common/Malayan porcupine	LC		Y	
Hystricidae	*Hystrix crassispinis*	Thick-spined porcupine	LC			Y
CARNIVORA						

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
Ursidae	*Helarctos malayanus*	Malayan Sun-bear	VU	I	Y	
Mustelidae	*Lutra sumatrana*	Hairy-nosed otter	EN	II	Y	
Mustelidae	*Martes flavigula*	Yellow-throated marten	LC	III		
Mustelidae	*Mustela nudipes*	Malay weasel	LC			
Mustelidae	*Aonyx cinerea*	Oriental/Asian small-clawed otter	VU	II		
Viverridae	*Arctictis binturong*	Binturong	VU	III	Y	
Viverridae	*Arctogalidia trivirgata*	Small-toothed palm civet	LC			
Viverridae	*Herpestes brachyurus*	Short-tailed mongoose	LC		Y	
Viverridae	*Herpestes semitorquatus*	Collared mongoose	DD			
Viverridae	*Paradoxurus hermaphroditus*	Common palm civet	LC	III		
Viverridae	*Prionodon linsang*	Banded Linsang	LC		Y	
Viverridae	*Viverra tangalunga*	Malay civet	LC			
Felidae	*Neofelis nebulosa*	Clouded leopard	VU	I	Y	
Felidae	*Pardofelis marmorata*	Marbled cat	VU	I	Y	
Felidae	*Prionailurus bengalensis*	Leopard cat	LC	I	Y	
Felidae	*Prionailurus planiceps*	Flat-headed cat	EN	I	Y	
ARTIODACTYLA						
Suidae	*Sus barbatus*	Bearded pig	VU			
Tragulidae	*Tragulus kanchil*	Lesser mouse-deer/Chevrotain	LC		Y	
Tragulidae	*Tragulus napu*	Greater mouse-deer	LC		Y	
Cervidae	*Cervus unicolor*	Sambar deer	VU		Y	
Cervidae	*Muntiacus atherodes*	Bornean yellow muntjac	LC			Y

2. Birds

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
GALLIFORMES						
Phasianidae	*Argusianus argus*	Great argus	NT	II	Y	
Phasianidae	*Lophura erythrophthalma*	Crestless fireback	VU			
Phasianidae	*Melanoperdix nigra*	Black partridge	VU			
CICONIIFORMES						
Ardeidae	*Ardea purpurea*	Purple heron	LC			
Ardeidae	*Ardea sumatrana*	Great billed heron	LC			

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
Ardeidae	*Ardeola speciosa*	Javan pond-heron	LC			
Ardeidae	*Butorides striatus*	Striated heron	LC			
Ardeidae	*Egretta garzetta*	Little egret	LC		Y	
Ardeidae	*Ixobrychus cinnamomeus*	Cinnamon bittern	LC			
Ciconiidae	*Ciconia stormi*	Storms stork	EN			
Ciconiidae	*Leptoptilos javanicus*	Lesser adjutant stork	VU		Y	
Threskiorbithidae	*Pseudibis davisoni*	White-shouldered ibis	CR		Y	
ANSERIFORMES						
Anatidae	*Dendrocygna javanica*	Lesser whistling duck	LC			
PELICANIFORMES						
Anhingidae	*Anhinga melanogaster*	Oriental Darter	NT		Y	
FALCONIFORMES						
Accipitridae	*Accipiter trivirgatus*	Crested goshawk	LC	II	Y	
Accipitridae	*Aviceda jerdoni*	Jerdon's baza	LC	II	Y	
Accipitridae	*Haliaeetus leucogaster*	White-bellied fish eagle	LC	II	Y	
Accipitridae	*Haliastur indus*	Brahminy kite	LC	II	Y	
Accipitridae	*Spilornis cheela*	Crested serpent-eagle	LC	II	Y	
Accipitridae	*Spizaetus cirrhatus*	Changeable hawk eagle	LC		Y	
Falconidae	*Microhierax fringillarius*	Black-thighed falconet	LC	II	Y	
GRUIFORMES						
Rallidae	*Amaurornis phoenicurus*	White breasted waterhen	LC			
CHARADIFORMES						
Laridae	*Sterna nilotica*	Gull-billed tern	LC		Y	
Scolopacidae	*Actitis hypoleucos*	Common sandpiper	LC			
COLUMBIFORMES						
Columbidae	*Chalcophaps indica*	Emerald dove	LC			
Columbidae	*Ducula aenea*	Green imperial pigeon	LC			
Columbidae	*Ducula badia*	Mountain imperial pigeon	LC			
Columbidae	*Ducula bicolor*	Pied imperial pigeon	LC			
Columbidae	*Streptopelia chinensis*	Spotted dove	LC			
Columbidae	*Treron curvirostra*	Thick-billed green pigeon	LC			
Columbidae	*Treron fulvicollis*	Cinnamon headed green pigeon	NT			
Columbidae	*Treron vernans*	Pink-necked green pigeon	LC			

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
PSITTIFORMES						
Psittacidae	*Loriculus galgulus*	Blue-crowned hanging parrot	LC			
Psittacidae	*Psittacula longicauda*	Long-tailed parakeet	NT			
CUCULIFORMES						
Cuculidae	*Cacomantis merulinus*	Plaintive cuckoo	LC			
Cuculidae	*Cacomantis sonneratii*	Banded bay cuckoo	LC			
Cuculidae	*Carpococcyx radiatus*	Bornean ground-cuckoo	NT			Y
Cuculidae	*Centropus bengalensis*	Lesser coucal	LC			
Cuculidae	*Centropus sinensis*	Greater coucal	LC			
Cuculidae	*Chrysococcyx xanthorhynchus*	Violet cuckoo	LC			
Cuculidae	*Phaenicophaeus chlorophaeus*	Raffles malkoha	LC			
Cuculidae	*Phaenicophaeus curvirostris*	Chestnut breasted malkoha	LC			
Cuculidae	*Phaenicophaeus sumatranus*	Chestnut bellied malkoha	NT			
Cuculidae	*Surniculus lugubris*	Drongo cuckoo	LC			
STRIGIFORMES						
Tytonidae	*Phodilus badius*	Oriental bay owl	LC			
Strigidae	*Ketupa ketupu*	Buffy fish-owl	LC	II		
Strigidae	*Ninox scutulata*	Brown hawk-owl	LC	II		
Strigidae	*Strix leptogrammica*	Brown wood owl	LC	II		
CAPRIMULGIFORMES						
Caprimulgidae	*Caprimulgus affinis*	Savanna nightjar	LC			
Caprimulgidae	*Caprimulgus concretus*	Bonaparte's/Sunda nightjar	VU			
Caprimulgidae	*Eurostopodus temminckii*	Malaysian Eared nightjar	LC			
Podargidae	*Batrachostomus stellatus*	Gould's frogmouth	NT			
APODIFORMES						
Apodidae	*Apus affinis*	Little swift	LC			
Apodidae	*Caprimulgus concretus*	Bonaparte's nightjar	VU			
Apodidae	*Collocalia esculenta*	Glossy swiftlet	LC			
Apodidae	*Collocalia fuciphaga*	Edible-nest Swiftlet	LC			
Apodidae	*Hemiprocne longipennis*	Grey rumped tree swift	LC			
Apodidae	*Rhaphidura leucopygialis*	Silver rumped spinetail	LC			
TROGONIFORMES						
Alcedinidae	*Alcedo coerulescens*	Small Blue kingfisher	LC		Y	

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
Alcedinidae	*Ceyx erithacus*	Black backed kingfisher	LC		Y	
Alcedinidae	*Ceyx rufidorsa*	Rufous backed kingfisher	LC		Y	
Alcedinidae	*Pelargopsis capensis*	Stork-billed kingfisher	LC		Y	
Alcedinidae	*Todirhamphus chloris*	Collared kingfisher	LC		Y	
Bucerotidae	*Aceros corrugatus*	Wrinkled hornbill	NT	II	Y	
Bucerotidae	*Anorrhinus galeritus*	Bushy-crested hornbill	LC	II	Y	
Bucerotidae	*Anthracoceros albirostris*	Oriental Pied Hornbill	LC	II	Y	
Bucerotidae	*Anthracoceros malayanus*	Asian black hornbill	NT	II	Y	
Bucerotidae	*Buceros rhinoceros*	Rhinoceros hornbill	NT	II	Y	
Bucerotidae	*Buceros vigil*	Helmeted hornbill	NT	I	Y	
Coraciidae	*Eurystomus orientalis*	Asian Dollarbird	LC			
CORACIIFORMES						
Meropidae	*Merops philippinus*	Blue-tailed bee-eater	LC			
Meropidae	*Merops viridis*	Blue-throated bee-eater	LC			
Trogonidae	*Harpactes diardii*	Diard's trogon	NT		Y	
Trogonidae	*Harpactes duvaucelii*	Scarlet rumped trogon	NT		Y	
Trogonidae	*Harpactes kasumba*	Red-naped trogon	NT		Y	
PICIFORMES						
Picidae	*Blythipicus rubiginosus*	Maroon woodpecker	LC			
Picidae	*Dendrocopos moluccensis*	Sunda woodpecker	LC			
Picidae	*Dendrocopus canicapillus*	Grey capped woodpecker	LC			
Picidae	*Dinopium rafflesii*	Olive-backed woodpecker	NT			
Picidae	*Dryocopus javensis*	White-bellied woodpecker	LC	I		
Picidae	*Hemicircus concretus*	Grey and buff woodpecker	LC			
Picidae	*Meiglyptes tristis*	Buff-rumped woodpecker	LC			
Picidae	*Meiglyptes tukki*	Buff-necked woodpecker	NT			
Picidae	*Mulleripicus pulverulentus*	Great slaty woodpecker	LC			
Picidae	*Picus puniceus*	Crimson-winged woodpecker	LC			
Picidae	*Reinwardtipicus validus*	Orange-backed woodpecker	LC			
Picidae	*Sasia abnormis*	Rufous piculet	LC			
Ramphastidae	*Calorhamphus fuliginosus*	Brown barbet	LC			
Ramphastidae	*Megalaima australis*	Blue-eared barbet	LC			
Ramphastidae	*Megalaima rafflesii*	Red-crowned barbet	NT			

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
PASSERIFORMES						
Aegithinidae	*Aegithina tiphia*	Common iora	LC			
Aegithinidae	*Aegithina viridissima*	Green iora	NT			
Artamidae	*Artamus leucorynchus*	White breasted woodswallow	LC			
Campephagidae	*Coracina fimbriata*	Lesser cuckooshrike	LC			
Campephagidae	*Coracina striata*	Bar-bellied cuckooshrike	LC			
Campephagidae	*Pericrocotus flammeus*	Scarlet minivet	LC			
Campephagidae	*Pericrocotus igneus*	Fiery minivet	NT			
Chloropseidae	*Chloropsis cyanopogon*	Lesser green leafbird	NT			
Chloropseidae	*Chloropsis sonnerati*	Greater green leafbird	LC			
Cisticolidae	*Orthotomus ruficeps*	Ashy tailorbird	LC			
Cisticolidae	*Orthotomus sericeus*	Rufous-tailed tailorbird	LC			
Cisticolidae	*Prinia flaviventris*	Yellow-bellied prinia	LC			
Corvidae	*Corvus enca*	Slender-billed crow	LC			
Corvidae	*Platysmurus leucopterus*	Black Magpie	NT			
Dicaeidae	*Dicaeum cruentatum*	Scarlet-backed flowerpecker	LC			
Dicaeidae	*Dicaeum trigonostigma*	Orange-bellied flowerpecker	LC			
Dicaeidae	*Prionchilus percussus*	Crimson breasted flowerpecker	LC			
Dicaeidae	*Prionochilus maculatus*	Yellow-breasted flowerpecker	LC			
Dicaeidae	*Prionochilus thoracicus*	Scarlet-breasted flowerpecker	NT			
Dicruridae	*Dicrurus paradiseus*	Greater racket-tailed drongo	LC			
Estrildidae	*Lonchura fuscans*	Dusky munia	LC			Y
Eurylaimidae	*Calyptomena viridis*	Asian Green broadbill	NT			
Eurylaimidae	*Cymbirhynchus macrorhynchos*	Black and red broadbill	LC			
Eurylaimidae	*Eurylaimus javanicus*	Banded broadbill	LC			
Eurylaimidae	*Eurylaimus ochromalus*	Black and yellow broadbill	NT			
Hirundinidae	*Hirundo rustica*	Barn swallow	LC			
Hirundinidae	*Hirundo tahitica*	Pacific swallow	LC			
Incertae	*Hemipus hirundinaceus*	Black-winged flycatcher shrike	LC			
Incertae	*Philentoma pyrhopterum*	Rufous-winged philentoma	LC			
Irenidae	*Irena puella*	Asian fairy-bluebird	LC			
Laniidae	*Lanius schach*	Long-tailed shrike	LC			
Monarchidae	*Hypothymis azurea*	Black naped monarch	LC			

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
Monarchidae	*Terpsiphone paradisi*	Asian paradise flycatcher	LC			
Muscicapidae	*Copcychus malabaricus*	White-rumped shama	LC			
Muscicapidae	*Copcychus saularis*	Magpie robin	LC			
Muscicapidae	*Muscucapadauurica*	Asian brown flycatcher				
Muscicapidae	*Pycnonotus goiavier*	Yellow vented bulbul	LC			
Muscicapidae	*Rhinomyias umbratilis*	Grey-chested jungle-flycatcher	NT			
Muscicapidae	*Trichixos pyrrhopygus*	Rufous tailed shama	NT			
Nectarinidae	*Aethopyga siparaja*	Crimson sunbird			Y	
Nectarinidae	*Anthreptes malacensis*	Plain throated sunbird	LC		Y	
Nectarinidae	*Anthreptes rhodolaema*	Red-throated sunbird	NT		Y	
Nectarinidae	*Anthreptes singalensis*	Ruby cheeked sunbird	LC		Y	
Nectarinidae	*Arachnothera longirostra*	Little spiderhunter	LC		Y	
Nectarinidae	*Arachnothera sp.*	Spiderhunter sp.			Y	
Nectarinidae	*Hypogramma hypogrammicum*	Purple-naped sunbird	LC		Y	
Nectarinidae	*Nectarinia jugularis*	Olive-backed sunbird	LC		Y	
Nectarinidae	*Nectarinia sperata*	Purple throated sunbird	LC		Y	
Oriolodae	*Oriolus xanthonotus*	Dark-throated oriole	NT			
Pachycephalidae	*Pachycephala grisola*	Mangrove whistler	LC			
Passeridae	*Passer montanus*	Eurasian tree sparrow	LC			
Pittidae	*Pitta granatina*	Garnet pitta	NT		Y	
Pityriaseidae	*Pityriasis gymnocephala*	Bornean bristlehead	NT			Y
Pycnonotidae	*Pycnonotus atriceps*	Black headed bulbul	LC			
Pycnonotidae	*Pycnonotus simplex*	Cream vented bulbul	LC			
Pycnonotidae	*Setornis criniger*	Hook-billed bulbul	VU			
Rhipiduridae	*Rhipidura javanica*	Pied fantail	LC		Y	
Sittidae	*Sitta frontalis*	Velvet-fronted nuthatch	LC			
Sturnidae	*Gracula religiosa*	Hill mynah	LC	II		
Timaliidae	*Macronous gularis*	Pin striped tit babbler	LC			
Timaliidae	*Macronous ptilosus*	Fluffy-backed tit babbler	NT			
Timaliidae	*Malacocincla malaccensis*	Short-tailed babbler	NT			
Timaliidae	*Malacopteron affine*	Sooty capped babbler	NT			
Timaliidae	*Malacopteron cinereum*	Scaly crowned babbler	LC			
Timaliidae	*Malacopteron magnum*	Rufous crowned babbler	NT			

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
Timaliidae	*Pellorneum capistratum*	Black-capped babbler	LC			
Timaliidae	*Stachyris erythroptera*	Chestnut winged babbler	LC			
Timaliidae	*Stachyris maculata*	Chestnut rumped babbler	NT			
Timaliidae	*Stachyris nigricollis*	Black throated babbler	NT			
Timaliidae	*Trichastoma rostratum*	White-chested babbler	NT			

3. Herpetofauna (reptiles and amphibians)

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
REPTILIA						
SQUAMATA						
Agamidae	*Bronchocela cristatella*	Green-crested lizard				
Agamidae	*Draco quinquefasciatus*	Flying lizard				
Colubridae	*Ahaetulla fasciolata*	Banded vine snake				
Colubridae	*Ahaetulla prasina*	Green vine snake				
Colubridae	*Boiga jaspidea*	Jasper cat snake				
Colubridae	*Chrysopelea paradisi*	Paradise tree snake				
Colubridae	*Dendrelaphis caudolineatus*	Striped bronze-back				
Colubridae	*Dendrelaphis formosus*	Elegant bronze-back				
Colubridae	*Dendrelaphis pictus*	Painted bronze-back				
Colubridae	*Homalopsis buccata*	Puff-faced water snake				
Colubridae	*Oligodon octolineatus*	Striped kukri snake				
Colubridae	*Psammodynastes pictus*	Painted mock viper				
Colubridae	*Rhabdophis chrysargos*	Speckle-bellied Keelback				
Colubridae	*Stegonotus borneensis*	Bornean black snake				Y
Colubridae	*Xenelaphis hexagonotus*	Malayan brown snake				
Crotalinae	*Trimeresurus sumatranus*	Sumatran pit viper				
Crotalinae	*Tropidolaemus wagleri*	Waglers pit viper				
Cylindrophiidae	*Cylindrophis ruffus*	Red tailed pipe snake				
Elapidae	*Bungarus flaviceps*	Yellow-headed Krait				
Elapidae	*Maticora bivirgata/Calliophi bivirgatus*	Blue Malaysian coral snake				
Elapidae	*Naja sumatrana*	Sumatran cobra				
Elapidae	*Ophiophagus hannah*	King Cobra				
Gekkonidae	*Cyrtodactylus pubisulcus*	Inger's bow-fingered gecko				Y

Gekkonidae	*Gekko smithii*	Forest gecko				
Gekkonidae	*Hemidactylus frenatus*	House gecko				
Pythonidae	*Python reticulatus*	Reticulated python		II		
Scincidae	*Dasia vittatum*	Banded tree skink				
Scincidae	*Dasia/Lamprolepis group*	Skink sp.				
Scincidae	*Lygosoma sp. (sens. lat.)*	Skink sp.				
Scincidae	*Mabuya multifasciata / Rubis complex*	Skink sp.				
Scincidae	*Sphenomorphus sp.*	Skink sp.				
Varanidae	*Varanus salvator*	Monitor lizard			Y	
Xenopeltidae	*Xenopeltis unicolor*	Iridescent earth snake				
CROCODILIA						
Crocodylidae	*Crocodylus porosus / raninus*	Estuarine / Bornean crocodile			Y	
Crocodylidae	*Tomistoma schlegelii*	Malayan/False Gharial	EN	I/w	Y	
TESTUDINES						
Bataguridae	*Orlitia borneensis*	Bornean river turtle	EN	II	Y	Y
Geoemydidae	*Cuora amboinensis*	South Asian box turtle	VU	II		
Geoemydidae	*Cyclemys dentata*	Asian Leaf Turtle	NT			
Geoemydidae	*Heosemys spinosa*	Spiny/sunburst turtle	EN	II		
Trionychidae	*Amyda cartilaginea*	South Asian softshell turtle	VU	II		
Trionychidae	*Pelochelys bibroni*	Asian Giant Softshell Turtle	VU	II		
ANURA						
Bufonidae	*Pseudobufo subasper*	Aquatic swamp toad				
Ranidae	*Meristogenys phaeomerus*	Brown torrent frog				Y
Ranidae	*Paramacrodon / Malesianus* sp.	Unknown				
Rhacophoridae	*Polypedates colletti*	Collett's Tree Frog	LC			
Rhacophoridae	*Polypedates leucomystax*	Four-lined Tree Frog	LC			
Rhacophoridae	*Polypedates macrotis*	Darl-eared Tree Frog	LC			
Rhacophoridae	*Racophorus spp.*	Tree frog spp.				

4. Fish

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
RAJIFORMES						
Dasyatidae	*Himantura signifer*					

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
OSTEOGLOSSIFORMES						
Osteoglossidae	*Scleropages formosus*			Y		
Notopteridae	*Noptopterus borneensis*	Pipih				
CYPRINIFORMES						
Cyprinidae	*Barbodes gonionotus*					
Cyprinidae	*Barbodes schwanenfeldii*					
Cyprinidae	*Cyclocheilichthys apogon*					
Cyprinidae	*Cyclocheilichthys armatus*					
Cyprinidae	*Cyclocheilichthys enoplos*					
Cyprinidae	*Cyclocheilichthys janthochir*	Saluang				
Cyprinidae	*Cyclocheilichthys repasson*					
Cyprinidae	*Cyprinus carpio*	Ikan mas				
Cyprinidae	*Epalzeorhynchos kalopterus*					
Cyprinidae	*Hampala bimaculata*					
Cyprinidae	*H. macrolepidota*					
Cyprinidae	*Labiobarbus festivus*					
Cyprinidae	*Labiobarbus ocellatus*					
Cyprinidae	*Lobocheilos falcifer*	Ikan mas				
Cyprinidae	*Luciosoma trinema*					
Cyprinidae	*Osteochilus melanoptera*					
Cyprinidae	*Osteochilus triporos*					
Cyprinidae	*Osteochilus sclegelii*					
Cyprinidae	*Pectenocypris balaena*					
Cyprinidae	*Pectenocypris balaena*					
Cyprinidae	*Puntioplites waandersi*					
Cyprinidae	*Rasbora borneensis*					
Cyprinidae	*Rasbora caudimaculata*					
Cyprinidae	*Rasbora cephalotaenia*	cf. saluang				
Cyprinidae	*Tor tambra*					
Cyprinidae	*Rasbora kalochroma*					
Balitoridae	*Homaloptera ocellata*					
Balitoridae	*Nemacheilus* sp.					
Balitoridae	*Neohomalopter johorensis*	Tjajiu				

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
SILURIFORMES						
Bagridae	*Botia hymenophysa*					
Bagridae	*Botia macrocanthus*					
Bagridae	*Bagrichthys macracanthus*					
Bagridae	*Bagroides melapterus*	Kasak pisang				
Bagridae	*Leiocassis myersi*					
Bagridae	*Leiocassis stenomus*					
Bagridae	*Mystus gulio*					
Bagridae	*Mystus micracanthus*					
Bagridae	*Mystus nemurus*					
Bagridae	*Mystus olyroides*					
Bagridae	*Mystus nigriceps*					
Bagridae	*Mystus wyckii*					
Bagridae	*Mystus olyroides*	Darap				
Bagridae	*Mystus wyckii*	Baung				
Siluridea	*Belodontichthys dinema*	Bamban				
Siluridea	*Hemisilurus heterorhynchus*	Lais				
Siluridea	*Kryptopterus apogon*	Lais				
Siluridea	*Kryptopterus limpok*	Sirang bulu				
Siluridea	*Kryptopterus macrocephalus*	Sirang bulu				
Siluridea	*Kryptopterus parvanalis*					
Siluridea	*Ompok eueneiatus*					
Siluridea	*Silurichthys hasseltii*					
Siluridea	*Wallago leeri*	Tampatnas				
Pangasiidae	*Heliocophagus waandersii*					
Pangasiidae	*Laides hexanema*					
Pangasiidae	*Pangasius lithostoma*	Patin				
Pangasiidae	*Pangasius nasutus*	Rariu				
Clariidae	*Clarias meladerma*	Pentet pendeck				
Clariidae	*Clarias nieuhofii*	Pentet panjang				
Clariidae	*Clarias teijsmanni*					
Clariidae	*Encheloclarias tapeinopterus*	Pentet panjang				
Ariidae	*Hemiarius stormii*					

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
CYPINODONTIFORMES						
Hemiramphidae	*Dermogenys weberi*					
Hemiramphidae	*Hemirhamphodon chrysopunctatus*	Jenjulung				
ANTHERINIFORMES						
Telmatherinidae	*Telmatherina ladigesi*					
SYNGNATHIFORMES						
Syngnathidae	*Doryichthys sp.*					
SYNBRANCHIFORMES						
Synbranchidae	*Monopterus albus*					
PERCIFORMES						
Centropomidae	*Lates calcarifer*					
Chandidae	*Ambassis nalua*					
Lutjanidae	*Coius microlepis*					
Lutjanidae	*Coius quadrifasciatu*					
Toxotidae	*Toxotes jaculatrix*					
Toxotidae	*Toxotes microlepis*					
Nandidae	*Nandus nebulosus*	Tatawun				
Pristolepididae	*Pristolepis grootii*	Pantung				
Pomacentridae	*Pomacentrus taeniometopon*					
Mugiloidae	*Liza macrolepis*					
Mugiloidae	*Liza parmata*					
Polynemidae	*Polynemus borneensis*					
Eleotrididae	*Ophieleotris aporos*					
Eleotrididae	*Oxyeleotris marmorata*					
Eleotrididae	*Oxyeleotris urophthalmoides*					
Gobiidae	*Periophalmodon septemradiatus*					
Luciocephalidae	*Luciocephalus pulcher*	Lanjulung				
Helostomatidae	*Helostoma temminickii*	Tabakan				
Anabantidae	*Anabas testudineus*	Bapuyu				
Belontidae	*Belontia hasselti*	Kakapar				
Belontidae	*Betta akarensis*	Tempala				
Belontidae	*Betta anabatoides*	Tempala				
Belontidae	*Betta edithae*	Tempala				

Order / Family	Latin Name	English name	IUCN	CITES	Protected	Endemic
Belontidae	*Betta foerschi*	Tempala				
Belontidae	*Sphaerichthys vaillanti*	Sapat layang				
Belontidae	*Sphaerichthys selatanensis*	Sapat				
Belontidae	*Trichogaster leerii*	Sapat				
Belontidae	*Trichogaster pectoralis*	Sesapat				
Belontidae	*Trichogaster trichopterus*	Sapat				
Channidae	*Channa bankanensis*	Miyau				
Channidae	*Channa cyanospilos*					
Channidae	*Channa gachua*					
Channidae	*Channa lucius*	Kihung				
Channidae	*Channa maruliodes*					
Channidae	*Channa melasoma*	Peyang				
Channidae	*Channa micropeltes*	Tahuman				
Channidae	*Channa pleurophthalmus*	Karandang				
Channidae	*Channa striata*	Behau				
Mastacembelidae	*Macrognathus maculates*	Telan				
Mastacembelidae	*Mastacembelus unicolor*	Jajili				
TETRAODONTIFORMES						
Tetraodontidae	*Chonerhinos modestrus*					
Tetraodontidae	*Tetraodon biocellatus*					

5. Plants

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Anacardiaceae	*Bouea oppositofolia*	Tamehas				
Anacardiaceae	*Buchanania cf. arborescens*	Kenyem Burung/Sangeh				
Anacardiaceae	*Campnosperma auriculatum*	Hantangan				
Anacardiaceae	*Campnosperma coriaceum*	Terantang				
Anacardiaceae	*Campnosperma squamatum*	Nyating				
Anacardiaceae	*Mangifera* sp.	Binjai	VU			
Anisophyllaceae	*Combretocarpus rotundatus*	Tumih	VU			
Annonaceae	*Artobotrys cf. roseus*	Kalalawit hitam				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Annonaceae	*Artobotrys suaveolins*	Bajakah balayan				
Annonaceae	*Cyathocalyx biovulatus*	Kerandau				
Annonaceae	*Cyathocalyx* sp.	Kerandau				
Annonaceae	*Fissistigma* sp.	Unknown				
Annonaceae	*Polyalthia glauca*	Kayu Bulan				
Anonnaceae	*Polyalthia hypoleuca*	Alulup/Saluang/Banitan				
Anonnaceae	*Polyalthia sumatrana*	Alulup/Saluang/Banitan				
Anonnaceae	*Mezzetia leptopoda / parviflora*	Pisang-pisang besar/Mahabai-mahabai				
Anonnaceae	*Mezzetia umbellata*	Pisang-pisang kecil/Mahabai				
Annonaceae	*Xylopia coriifolia*	Nonang				
Anonnaceae	*Xylopia fusca*	Jangkang kuning/Jangkar/Rahanjang				
Annonaceae	*Xylopia cf. malayana*	Tagula				
Apocynaceae	*Alstonia scholoris*	Pulai/Palawi				
Apocynaceae	*Alyxia* sp.	Bajakah kelanis/Pulas santan				
Apocynaceae	*Dyera lowii / polyphylla*	Jelutung/Pantung	VU			
Apocynaceae	*Parameria* sp.	Unknown				
Apocynaceae	*Willughbea* sp.	Bajakah dango				
Aquifoliaceae	*Ilex cymosa*	Unknown				
Aquifoliaceae	*Ilex hypoglauca / wallichi*	Sumpung/Kambasira				
Aquifoliaceae	*Ilex* sp.	Unknown				
Araceae	*cf. Anthurium* sp.	Lampuyang				
Araceae	*Raphidophora* sp.	Unknown				
Araliaceae	*Schleffera* sp.	Sapahurung				
Arecaceae (*Palmae*)	*Calamus* sp.	Uey liling				
Arecaceae (*Palmae*)	*Calamus* sp. *cf. caesius*	Uey Sigi				
Arecaceae (*Palmae*)	*Calamus* sp. *cf. trachycoleus*	Uey Irit				
Arecaceae (*Palmae*)	*Korthalsia hispida*	Uwei ahaas/Rotan ahas				
Arecaceae (*Palmae*)	*Korthalsia* sp.	Uey paka				
Palmae	*Pinanga* sp.	Pinang Jouy				
Arecaceae (*Palmae*)	*Salacca* sp.	Salak hutan/Lokip				
Asclepiadaraceae	*Astrostemma spartioides*	Anggrek Rangau				
Asclepiadaraceae	*Dischidia cf. latifolia*	Unknown				
Asclepiadaraceae	*Dischidia* sp.	Bajakah Tapuser				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Asclepiadaraceae	*Hoya* sp.	Unknown				
Asparagaceae	*Dracaena* sp.	Akar tewu kaak				
Blechnaceae	*Stenochlaena palustri*	Kalakai				
Burseraceae	*Canarium* sp.	Geronggang Putih	VU			
Burseraceae	*Santiria cf. laevigata*	Irat/ Kayu kacang				
Burseraceae	*Santiria griffithii*	Teras bamban/ Roko-roko	LR/NT			
Burseraceae	*Santiria* spp.	Gerrongang Putih/ Hampuak				
Celastraceae	*Kokoona* sp.	Bunga-bunga/Culokut				
Celesteraceae	*Lophopetalum* sp.	Mahuwi				
Chrysobalanaceae	*Licania splendens*	Bintan				
Clusiaceae (*Guttiferae*)	*Calophyllum hosei*	Jinjit/Bintangor/Nangka-nangka				
Clusiaceae (*Guttiferae*)	*Callophyllum sclerophyllum*	Kapurnaga jangkar				
Clusiaceae (*Guttiferae*)	*Calophyllum soulattri*	Takal				
Clusiaceae (*Guttiferae*)	*Calophyllum* sp.	Kapurnaga Kalakei				
Clusiaceae (*Guttiferae*)	*Calophyllum* sp.	Mahadingan				
Clusiaceae (*Guttiferae*)	*Calophyllum* sp.	Kapurnaga/Kapur naga				
Clusiaceae (*Guttiferae*)	*Calophyllum* sp.	Mahadingan/Parut				
Clusiaceae (*Guttiferae*)	*Calophyllum* sp.	Kapurnaga laut/Meranti putih				
Clusiaceae (*Guttiferae*)	*Garcinia bancana*	Manggis				
Clusiaceae (*Guttiferae*)	*Garcinia* sp.	Aci/ Gandis				
Clusiaceae (*Guttiferae*)	*Garcinia* sp.	Manggis/Gantalang				
Clusiaceae (*Guttiferae*)	*Garcinia* sp.	Aci/Mahalilis				
Clusiaceae (*Guttiferae*)	*Garcinia* sp.	Gantalan				
Clusiaceae (*Guttiferae*)	*Garcinia* sp.	Mahalilis				
Clusiaceae (*Guttiferae*)	*Garcinia* sp. *cf. parvifolia*	Gandis				
Clusiaceae (*Guttiferae*)	*Garcinia* sp. *cf. hombroniana*	Unknown				
Clusiaceae (*Guttiferae*)	*Mesua* sp.	Tabaras akar tinggi/Nangka-nangka				
Combretaceae	*Combretum* sp.	Bajakah Tampelas ?				
Crypteroniaceae	*Dactylocladus stenostachys*	Mertibu				
Cyperaceae	*Thoracostachyum bancanum*	Unknown				
Dipterocarpaceae	*cf. Anisoptera* sp.	Keruing Sabun				
Dipterocarpaceae	*Cotylebium cf. lanceolatum*	Rasak Galeget				
Dipterocarpaceae	*Cotylebium melanoxylon*	Unknown				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Dipterocarpaceae	*Dipterocarpus borneensis*	Keruwing/Nangka-nangka				
Dipterocarpaceae	*Shorea balangeran*	Kahui	CR			
Dipterocarpaceae	*Shorea crassa*	Unknown				
Dipterocarpaceae	*Shorea platycarpa*	Meranti				
Dipterocarpaceae	*Shorea teysmanianna*	Meranti semut/Bunga/Karamunting	EN			
Dipterocarpaceae	*Shorea uliginosa*	Meranti batu/Bijai/Bajang	VU			
Dipterocarpaceae	*Vatica mangachopai*	Rasak Napu				
Ebenaceae	*Diospyros bantamemsis*	Malam-malam/Kacapuri				
Ebenaceae	*Diospyros cf. evena*	Gulung haduk/Ehang/Uwar ehang				
Ebenaceae	*Diospyros confertiflora*	Arang				
Ebenaceae	*Diospyros lanceifolia*	Arang				
Ebenaceae	*Diospyros siamang*	Ehang				
Ebenaceae	*Diospyros* sp.	Kayu Arang Apui				
Ebenaceae	*Diospyros* sp.	Arang				
Elaeocarpaceae	*Elaeocarpus acmocarpus*	Patanak				
Elaeocarpaceae	*Elaeocarpus cf. griffithi*	Rarumpuit				
Elaeocarpaceae	*Elaeocarpus marginatus*	Kejinjing				
Elaeocarpaceae	*Elaeocarpus mastersii*	Mangkinang/ Rimai/Sangeh				
Elaeocarpaceae	*Elaeocarpus* sp.	Patanak galeget/Bangkinang tikus/Hampuak				
Elaeocarpaceae	*Elaeocarpus* sp.	Pasir Payau				
Elaeocarpaceae	*Elaeocarpus* sp.	Ampaning Nyatu				
Euphorbiaceae	*Antidesma coriaceum*	Dawat/Mata undang				
Euphorbiaceae	*Antidesma phanerophe*	Matan undang				
Euphorbiaceae	*Antidesma* sp.	Matan undang/Asam				
Euphorbiaceae	*Baccaurea bracteata*	Rambai hutan daun besar/Hampuak				
Euphorbiaceae	*Baccaurea stipulata*	Kayu Tulang				
Euphorbiaceae	*Blumeodendron elateriospermum*	Kenari/ Kerandau				
Euphorbiaceae	*Cephalomappa* sp.	Karandau putih/Jangkang				
Euphorbiaceae	*Cephalomappa* sp.	Karandau putih/Sarakat/Tempurung				
Euphorbiaceae	*Glochidion cf glomerulatum*	(Buah) Bintang/Gandis				
Euphorbiaceae	*Glochidion* sp.	Rasak				
Euphorbiaceae	*Macaranga* sp.	Mahang Batu				
Euphorbiaceae	*Maccaranga caladiifolia*	Mahang bitik/Sumut				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Euphorbiaceae	*Neoscortechinia forbesii*	Kerandau putih				
Euphorbiaceae	*Neoscortechinia kingii*	Pupu pelanduk/Sarakat				
Euphorbiaceae	*Pimelodendron griffithianum*	Unknown				
Fabaceae (*Leguminosae*)	*Adenanthera pavonina*	Tapanggang/Bure-bure				
Fabaceae (*Leguminosae*)	*Archidendron borneensis*	Kacing Nyaring				
Fabaceae (*Leguminosae*)	*Dalbergia* sp.	Unknown				
Fabaceae (*Leguminosae*)	*Dialium patens*	Kala Pimping Napu				
Fabaceae (*Leguminosae*)	*Dialium* sp.	Roko-roko				
Fabaceae (*Leguminosae*)	*Koompassia malaccensis*	Bangaris	LC			
Fabaceae (*Leguminosae*)	*Leucomphalos callicarpus*	Bajakah tampelas				
Fabaceae (*Leguminosae*)	*Ormosia* sp.	Unknown				
Fabaceae (*Leguminosae*)	*Pithecellobium clypearia*	Tabure/Tapanggang/Sabure				
Fagaceae	*Castanopsis foxworthyii / jaherii*	Takurak				
Fagaceae	*Lithocarpus conocarpus*	Pampaning Bayang				
Fagaceae	*Lithocarpus rassa*	Pampaning				
Fagaceae	*Lithocarpus* sp.	Pampaning Bayang Buah Besar				
Fagaceae	*Lithocarpus* sp.	Pampaning Suling				
Fagaceae	*Lithocarpus* sp. *cf. dasystachys*	Pampaning Bitik/Putar-putar				
Fagaceae	*Lithocarpus spp.*	Pampaning				
Flagellariaceae	*Flagellaria* sp.	Uey Namei				
Gesneraceae	*Aeschynanthus* sp.	Unknown				
Gnetaceae	*Gnetum* sp.	Bajakah Luaa				
Gnetaceae	*Gnetum* sp.	Oto Oto				
Hypericaceae	*Cratoxylon arborescens*	Geronggang				
Hypericaceae	*Cratoxylum glaucum*	Garunggaang merah				
Icacinaceae	*Platea exelsa*	Kambalitan/Jangkar				
Icacinaceae	*Platea* sp.	Lampesu				
Icacinaceae	*Stemonurus scorpiodes /* spp.	Tabaras/Sarakat/Tempurung/Otak udang				
Icasinaceae	*Stemonorus secondiflorus*	Tabaras yang tdk punya akar				
Icasinaceae	*Stemonorus* sp.	Tabaras				
Lauraceae	*Actinodaphne* sp.	Unknown				
Lauraceae	*Alseodaphne coreacea*	Gemor				
Lauraceae	*Cinnamomum* sp. *cf. sintoc*	Sintok				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Lauraceae	*Crypthocarya* sp.	Tampang/Medang				
Lauraceae	*Litsea / Crytocaria* sp.	Tampang/Kayu bulan				
Lauraceae	*Litsea / Crytocaria* sp.	Tampang/Pirawas				
Lauraceae	*Litsea cf. elliptica*	Medang (Species Medang)				
Lauraceae	*Litsea cf. rufo-fusca*	Tampang				
Lauraceae	*Litsea grandis*	Medang /Tabitik/ Katiau				
Lauraceae	*Litsea ochrea*	Unknown				
Lauraceae	*Litsea* sp.	Medang/Gula-gula				
Lauraceae	*Litsea* sp.	Medang				
Lauraceae	*Litsea* sp.	Medang/Katiau				
Lauraceae	*Litsea* sp.	Tampang				
Lauraceae	*Litsea* sp. *cf. resinosa*	Medang Marakuwung				
Lauraceae	*Nothaphoebe* sp.	Medang				
Lauraceae	*Phoebe* sp. *cf. grandis*	Tabitik/Madang				
Lecythidaceae	*Barringtonia longisepala*	Katune/Putat				
Lecythidaceae	*Barringtonia* sp.	Katune/Putat				
Liliaceae	*Hanguana malayana*	Bakong himba/Bakung				
Linaceae	*Ctenolophon parvifolius*	Kayu Cahang/Kalepek				
Loganiaceae	*Fragraea accuminatisma*	Unknown				
Loganiaceae	*Fragraea* sp.	Bajakah kalamuhe				
Loranthaceae	*Dendrophtoe incurvata*	Unknown				
Loranthaceae	*Lepidaria* sp.	Mentawa				
Magnoliaceae	*Magnolia bintulensis*	Medang limo/Asam-asam				
Melastomataceae	*Melastoma malabathricum*	Karamunting				
Melastomataceae	*Melastoma* sp.	Karamunting Danum				
Melastomataceae	*Memecylon* sp.	Tabati/ Nasi-nasi				
Melastomataceae	*Memecylon* sp.	Tabati himba/Bati-bati				
Melastomataceae	*Memecylon* sp.	Milas daun kecil/Galam tikus				
Melastomataceae	*Memecylon* sp.	Tabati himba/Ubar merah				
Melastomataceae	*Pternadra* sp.	Kambusulan				
Melastomataceae	*Pternandra cf. coerulescens*	Kemuning yg bergaris tiga				
Meliaceae	*Aglaia rubiginosa*	Kajalaki	LR/NT			
Meliaceae	*Aglaia* sp.	Bangkuang Napu	LR/NT/VU			

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Meliaceae	*Chisocheton amabilis*	Bunga matahari/Babaka				
Meliaceae	*Chisocheton* sp.	Bunga matahari				
Meliaceae	*Chisocheton* sp.	Mariuh				
Meliaceae	*Chisocheton* sp.	Latak Manuk				
Meliaceae	*Sandoricum beccanarium*	Papong				
Menispermaceae	*Fibraurea tinctoria*	Bajakah kalamuhe				
Moraceae	*Ficus cf. spathulifolia*	Lunuk Punai				
Moraceae	*Ficus cf. stupenda*	Lunuk Tingang				
Moraceae	*Ficus deltoidea*	Lunuk/Tabat barito				
Moraceae	*Ficus* sp.	Lunuk buhis				
Moraceae	*Ficus* sp.	Lunuk tabuan				
Moraceae	*Ficus* sp.	Sasendok				
Moraceae	*Ficus* sp.	Lunuk sasendok				
Moraceae	*Ficus* sp.	Lunuk Bunyer				
Moraceae	*Ficus* sp.	Lunuk Sambon				
Moraceae	*Ficus* sp.	Lunuk				
Moraceae	*Ficus* spp.	Lunuk				
Moraceae	*Parartocarpus venenosus*	Tapakan/lilin-lilin				
Myristicaceae	*Gymnacranthera farquhariania*	Mendarahan daun kecil				
Myristicaceae	*Gymnacranthera* sp.	Mandarahan /Darah-darah				
Myristicaceae	*Horsfieldia crassifolia*	Mendarahan daun besar /Dara-dara	LR/NT			
Myristicaceae	*Knema intermedia*	Karandau merah /Latak manuk / jangkang	LR/NT			
Myristicaceae	*Knema* sp.	Mendarahan daun kecil /Kayu daha	LR/NT/VU			
Myristicaceae	*Myristica lowiana*	Mahadarah Hitam	LR/NT			
Myrsinaceae	*Ardisia cf. sanguinolenta*	Kalanduyung himba				
Myrsinaceae	*Ardisia* sp.	Kamba Sulan				
Myrsinaceae	*cf. Rapanea borneensis*	Mertibu				
Myrtaceae	*Eugenia spicata*	Kayu lalas daun besar /Galam tikus				
Myrtaceae	*Syzygium caladiifolia*	Hampuak /Tatumbu				
Myrtaceae	*Syzygium cf. valevenosum*	Kayu Lalas Daun Besar				
Myrtaceae	*Syzygium clavatum*	Unknown				
Myrtaceae	*Syzygium havilandii*	Tatumbu /Ubar putih				
Myrtaceae	*Syzygium* sp.	Galam tikus				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Myrtaceae	*Syzygium* sp.	Galam tikus/ Jambu-jambu				
Myrtaceae	*Syzygium* sp.	Hampuak galeget /Ubar merah				
Myrtaceae	*Syzygium* sp.	Hampuak galeget/ Ubar putih				
Myrtaceae	*Syzygium* sp.	Milas				
Myrtaceae	*Syzygium* sp.	Kemuning Putih				
Myrtaceae	*Syzygium* sp.	Milas				
Myrtaceae	*Syzygium* sp. *cf. campanulatum*	Tampohot Batang /Ubar merah				
Myrtaceae	*Syzygium* sp. *Elaeocarpus spicata*	Kayu Lalas Daun Kecil				
Myrtaceae	*Syzygium* sp. *cf. lineatum*	Jambu Jambu				
Myrtaceae	*Syzygium* sp. *cf. nigricans*	Jambu Burung Kecil				
Myrtaceae	*Syzygium* sp.	Jambu Burung Kecil				
Myrtaceae	*Syzygium* sp. *cf. garcinifolia*	Jambu burung/ jambuan				
Myrtaceae	*Tristaniopsis obovata*	Blawan				
Myrtaceae	*Tristaniopsis* sp.	Blawan merah				
Myrtaceae	*Tristaniopsis* sp.	Blawan punai				
Myrtaceae	*Tristaniopsis* sp.	Blawan /Plawan				
Myrtaceae	*Tristaniopsis* sp. *cf. bakhuizena*	Blawan Buhis				
Myrtaceae	*Tristaniopsis* sp. *cf. merguensis*	Blawan putih				
Myrtaceae	*Tristaniopsis whiteana*	Blawan				
Nepenthaceae	*Nepenthes ampullaria*	Pusuk kameluh/Ketupat hinut/Kantong semar	LR/NT	II	Y	
Nepenthaceae	*Nepenthes gracilis*	Ketupat hinut/Kantong semar	LR/NT	II	Y	
Nepenthaceae	*Nepenthes rafflesiana*	Ketupat hinut/kantong semar/cepet sangumang	LR/NT	II	Y	
Nephrolepiadaceae	*Nephrolepis* sp.	Paku Jampa				
Ochnaceae	*Euthemis leucarpa*	Unknown				
Ochnaceae	*Euthemis* sp.	Unknown				
Oleaceae	*Chionanthus* sp.	Unknown				
Orchidaceae	*Eria* sp.	Anggrek bawang		II		
Orchidaceae	Unknown	Pahakung		II		
Orchidaceae	Unknown	Pahakung tanduk		II		
Orchidaceae	Unknown	Anggrek garu		II		
Orchidaceae	Unknown	Anggrek hitam		II		
Orchidaceae	Unknown	Anggrek buntut naga				
Pandanaceae	*Freycinetia* sp.	Akar gerising				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Pandanaceae	*Freycinetia* sp.	Katipei Pari				
Pandanaceae	*Pandanus / Freycinetia* sp.	Gerising				
Pandanaceae	*Pandanus* sp.	Pandan				
Pandanaceae	*Pandanus* sp.	Rasau				
Pandanaceae	*Pandanus* sp.	Rasau kelep				
Pandanaceae	*Pandanus* sp.	Sambalaun				
Pandanaceae	Unknown	Lampasau				
Piperaceae	*Piper* sp.	Sirih himba /samuang				
Piperaceae	cf. *Piper* sp.	Sirih sangahau				
Pittosporaceae	*Pittosporum* sp.	Parupuk				
Poaceae (*Palmae*)	*Metroxylon* sp.	Hambiey				
Podacarpaceae	*Dacrydium pectinateum*	Alau	LR/NT			
Polygalaceae	*Xanthophyllum ellipticum*	Kemuning				
Polygalaceae	*Xanthophyllum stipitatum*	Kemuning /Ubar putih				
Rhamnaceae	*Zizyphus angustifolius*	Bajakah karinat				
Rhamnaceae	*Zyzyphus angustifolius*	Karinat				
Rhizophoreaceae	*Cariliia brachiata*	Gandis				
Rhizophoreaceae	*Gynotroches* sp.	Kelumun				
Rubiaceae	*Canthium* sp. *dydimum.*	Kopi-kopi /Kayu kalalawit				
Rubiaceae	*Gardenia tubifera*	Saluang Belum /Rangda				
Rubiaceae	*Ixora havilandii*	Keranji				
Rubiaceae	*Jakiopsis ornata*	Unknown				
Rubiaceae	*Lucinea* sp.	Bajakah Tabari				
Rubiaceae	*Nauclea* sp.	Unknown				
Rubiaceae	*Timonius* sp.	Unknown				
Rubiaceae	*Uncaria* sp.	Kalalawit bahandang/ merah				
Rutaceae	*Evodia glabra*	Sagagulang				
Rutaceae	*Tetractomia tetrandra*	Rambangun /Asam-asam /Sagagulang				
Sapindaceae	*cf. Cubilia cubili*	Kahasuhuy				
Sapindaceae	*Nephellium lappaceum*	Manamun				
Sapindaceae	*Nephellium maingayi*	Kelumun Buhis /Piais / ubar putih				
Sapindaceae	*Nephellium* sp.	Kaaja				
Sapindaceae	*Pometia pinnata*	Rambutan gundul /Takasai				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Sapindaceae	*Xerospermum laevigatum*	Kelumun Bakei				
Sapotaceae	*Isonandra lanceolate*	Nyatoh Palanduk				
Sapotaceae	*Isonandra* sp.	Nyatoh Palanduk				
Sapotaceae	*Madhuca cf. pierri*	Nyatoh Undus				
Sapotaceae	*Madhuca mottleyana*	Katiau /Kanjalaki				
Sapotaceae	*Palaquium cochlearifolium*	Nyatu gagas/ duduk / babi				
Sapotaceae	*Palaquium leiocarpum*	Hangkang				
Sapotaceae	*Palaquium pseudorostratum*	Nyatoh Bawoi				
Sapotaceae	*Palaquium* spp. *Ridleyii*	Nyatu burung				
Sapotaceae	*Planchonella cf. maingayi*	Sangkuak				
Selaginellaceae	*Selaginella* sp.	Jenis pakis /Hawok				
Simaroubaceae	*Quassia borneensis*	Kayu Takang				
Smilacaceae	*Smilax* sp.	Bajakah Tolosong				
Sterculiaceae	*Sterculia rhoiidifolia*	Loting				
Sterculiaceae	*Sterculia* sp.	Muara bungkang				
Sterculiaceae	*Sterculia* sp.	Galaga				
Tetrameristaceae	*Tetramerista glabra*	Ponak /Kayu sabun				
Theaceae	*Ploiarium alternifolium*	Asam Asam				
Theaceae	*Ternstroemia bancanus*	Tabunter				
Theaceae	*Ternstroemia hosei*	Unknown				
Theaceae	*Ternstroemia magnifica*	Tabunter				
Thymeleaeaceae	*Gonystylus bancanus*	Ramin	VU	II		
Tiliaceae	*Microcos (Grewia)* sp.	Brania Himba /Kayu saluang				
Verbenaceae	*Clerodendron* sp.	Supang				
Vitaceae	Unknown	Unknown				
Vitaceae	*Ampelocissus rubiginosa*	Bajakah Panamar Pari				
Vitaceae	*Ampelocissus* sp.	Bajakar oyang / liana anggur				
Vitaceae	Unknown	Anggur hutan				
Vitaceae	*Vitis* sp.	Anggur hutan				
Zingiberaceae	*Alpinia* sp.	Suli Batu				
Zingiberaceae	*Zingiber* sp.	Suli tulang				
Unknown	Unknown	Kalakai palanduk				
Unknown	Unknown	Tagentu				

Order / Family	Latin Name	Local name(s)	IUCN	CITES	Protected	Endemic
Unknown	Unknown	Rampiang				
Unknown	Unknown	Sirih sangumang				
Unknown	Unknown	Bari-bari				
Unknown	Unknown	Takapal				
Unknown	Unknown	Silu kelep				
Unknown	Unknown	Langkabuk				
Unknown	Unknown	Mali-mali				
Unknown	Unknown	Pasak bumi				

APPENDIX 2. VCS AFOLU NON-PERMANENCE RISK ANALYSIS

1. Summary of non-permanence risk

VCS AFOLU non-permanence risk category	Score
Internal Risk	
Project Management (PM) Risk Value	-4
Financial Viability (FV) Risk Value	-1
Opportunity Cost (OC) Risk Value	2
Project Longevity (PL) Risk Value	0
	0
Total External Risk	
Total Land Tenure (LT) Risk Value	0
Total Community Engagement (CE) Risk Value	-5
Total Political (PC) Risk Value	2
	0
Natural Risk	
Fire (F)	2.5
Pest and Disease Outbreaks (PD)	0
Extreme Weather (W)	2
Geological Risk (G)	0
Other natural risk (ON)	0
	4.5
Total Overall Risk Rating	**4.5%**
Non-Permanence Buffer	**10%**

2. Internal risk

2.1. Project Management	Yes/No	Risk Value	Comment
Species planted (where applicable) associated with more than 25% of the stocks on which GHG credits have previously been issued are not native or proven to be adapted to the same or similar agro-ecological zone(s) in which the project is located.	no	0	As decribed in Section 2.2.1 - B) of the PDD, the project only carries out planting of native species, in particular those adapted to wet conditions of rewetted peatland.
Ongoing enforcement to prevent encroachment by outside actors is required to protect more than 50% of stocks on which GHG credits have previously been issued.	no	0	While the project does enforce against possible encroachment, the impact of possible encroachment on carbon stocks is very limited not only because it is limited to small areas but due to the fact that encroachment does not involve commercial drainage of peaatlands and hence does not significantly affect total carbon stocks on which credits are issued.
Management team does not include individuals with significant experience in all skills necessary to successfully undertake all project activities (ie, any area of required experience is not covered by at least one individual with at least 5 years experience in the area).	no	0	As described in Sub-section 1.5.2 of the PDD, the project employs staff with several decades in combined experience covering all areas of expertise required.
Management team does not maintain a presence in the country or is located more than a day of travel from the project site, considering all parcels or polygons in the project area.	no	0	The management team is headquartered in Indonesia with all offices located within one day or travel from the project area. See Section 1.4.
Mitigation: Management team includes individuals with significant experience in AFOLU project design and implementation, carbon accounting and reporting (eg, individuals who have successfully managed projects through validation, verification and issuance of GHG credits) under the VCS Program or other approved GHG programs.	yes	-2	As described in Sub-section 1.5.2 of the PDD, the project and it's partners employ a range of employees who have successfully managed projects, written and managed approval (double validation) of VCS methodologies.
Mitigation: Adaptive management plan in place.	yes	-2	Please refer to Section 6.3 and Chapter 8 of the PDD for a detailed description of the adaptive management plan.
Project Management (PM) Risk Value		**-4**	

2.2. Financial Viability	Yes/No	Risk Value		Comment
Project cash flow breakeven point is greater than 10 years from the current risk assessment	no	0	No Multiple Choice	
Project cash flow breakeven point is between 7 and up to 10 years from the current risk assessment	no	0		
Project cash flow breakeven point between 4 and up to 7 years from the current risk assessment	yes	1		The financial model made available to the validator confirms that the project breaks even between year 4-7 from the project start date
Project cash flow breakeven point is less than 4 years from the current risk assessment	no	0		
Project has secured less than 15% of funding needed to cover the total cash out before the project reaches breakeven	no	0	No Multiple Choice	
Project has secured 15% to less than 40% of funding needed to cover the total cash out required before the project reaches breakeven	no	0		
Project has secured 40% to less than 80% of funding needed to cover the total cash out required before the project reaches breakeven	no	0		
Project has secured 80% or more of funding needed to cover the total cash out before the project reaches breakeven	yes	0		Financial resources to cover funding until break-even have been secured though Permian Global Fund which have set aside a respective amount dedicated to the Katingan Project
Mitigation: Project has available as callable financial resources at least 50% of total cash out before project reaches breakeven	yes	-2		Per the above comment, financial recourses required until breakeven have been secured and set aside.
Financial Viability (FV) Risk Value		**-1**		

2.3. Opportunity Cost	Yes/No	Risk Value		Comment
NPV from the most profitable alternative land use activity is expected to be at least 100% more than that associated with project activities; or where baseline activities are subsistence-driven, net positive community impacts are not demonstrated	no	0	No Multiple Choice	
NPV from the most profitable alternative land use activity is expected to be between 50% and up to100% more than from project activities	no	0		
NPV from the most profitable alternative land use activity is expected to be between 20% and up to 50% more than from project activities	yes	4		The Global Green Growth Institute carried out an extended cost benefit analysis [22], which determined a financial net present value for the business as usual scenario (the most profitable alternative land-use scenario) of USD 182 million compared to USD 139 million in the project scenario which suggests an NPV difference of 30.94%.
NPV from the most profitable alternative land use activity is expected to be between 20% more than and up to 20% less than from project activities; or where baseline activities are subsistence-driven, net positive community impacts are demonstrated	no	0		
NPV from project activities is expected to be between 20% and up to 50% more profitable than the most profitable alternative land use activity	no	0		
NPV from project activities is expected to be at least 50% more profitable than the most profitable alternative land use activity	no	0		
Mitigation: Project proponent is a non-profit organization	no	0		
Mitigation: Project is protected by legally binding commitment (see Section 1.7) to continue management practices that protect the credited carbon stocks over the length of the project crediting period	yes	-2	No Multiple Choice	Terms of the ecosystem restoration concesssion license can be found in Section 1.7. The license includes specific obligations regarding management practices and activities for the concession holder to be carried out over the length of the licencse. The license specifically includes a requirement to restore and enhance carbon stocks.
Mitigation: Project is protected by legally binding commitment (see Section 1.7) to continue management practices that protect the credited carbon stocks over at least 100 years	no	0		
Opportunity Cost (OC) Risk Value		**2**		
	Total may not be less than 0			

2.4. Project Longevity	Enter Project Longevity in Years (min 30)	Risk Value		Comment
Without legal agreement over project longevity or requirement to continue the management practice	0	0	No Multiple Choice	
With legal agreement over project longevity or requirement to continue the management practice	100	-20		Terms of the ecosystem restoration concesssion license can be found in Section 1.7. The license is renewable to a total of 95 years and includes specific obligations regarding management practices and activities for the concession holder to be carried out.
Project Longevity (PL) Risk Value		**0**		
	Total may not be less than 0			

Total Internal Risk (PM+FV+OC+PL)		**0**

3. External risk

3.1. Land Tenure	Yes/No	Risk Value		Comment
Ownership and resource access/use rights are held by same entity(s)	no	0	No Multipl	
Ownership and resource access/use rights are held by different entity(s) (eg, land is government owned and the project proponent holds a lease or concession)	yes	2		As described in Section 1.4, the project proponent holds and ecosystem restoration concession.
In more than 5% of the project area, there exist disputes over land tenure or ownership	no	0		No disputes exist over the project areas. The process of ERC issuance takes into account possible disputes before approving the final boundary. In addition, a Memorandum of Underdstanding has been signed with communities around the project area.
There exist disputes over access/use rights (or overlapping rights)	no	0		No disputes exist over access or use rights.
WRC projects unable to demonstrate that potential upstream and sea impacts that could undermine issued credits in the next 10 years are irrelevant or expected to be insignificant, or that there is a plan in place for effectively mitigating such impacts. Significant impact?	no	0		The project area consists of a domed peatland with higher elevation (upstream) areas at the centre of the project. Hence upstream areas are located at the core of the project which are largely inaccessible and without current population/impact. Therefore there are no upstream impacts on the project. The project is not impacted by sea level.
Mitigation: Project area is protected by legally binding commitment (eg, a conservation easement or protected area) to continue management practices that protect carbon stocks over the length of the project crediting period	yes	-2		The project has been granted an ERC which mandates management for ecosystem restoration beyond the project crediting period and legally prevents destructive forms of land-use.
Mitigation: Where disputes over land tenure, ownership or access/use rights exist, documented evidence is provided that projects have implemented activities to resolve the disputes or clarify overlapping claims	no	0		
Total Land Tenure (LT) Risk Value		**0**		
	Total may not be less than 0			

3.2. Community Engagement	Yes/No	Risk Value	Comment
Less than 50 percent of households living within the project area who are reliant on the project area, have been consulted	no	0	As described in Sub-section 2.7.3 of the PDD, the project has conducted extensive stakeholder/community consultation and development programs in all communities around the project area.
Less than 20 percent of households living within 20 km of the project boundary outside the project area, and who are reliant on the project area, have been consulted	no	0	
Mitigation: The project generates net positive impacts on the social and economic well-being of the local communities who derive livelihoods from the project area	yes	-5	As described in Section 2.2 of the PDD, the project is actively driving community development both in social and economic terms.
Total Community Engagement (CE) Risk Value		**-5**	

3.3. Political Risk	Yes/No	Risk Value	Comment
Governance score of less than -0.79	no	0	
Governance score of -0.79 to less than -0.32	yes	4	
Governance score of -0.32 to less than 0.19	no	0	
Governance score of 0.19 to less than 0.82	no	0	
Governance score of 0.82 or higher	no	0	
Mitigation: Country is implementing REDD+ Readiness or other activities, as set out in this Section 2.3.3.	yes	-2	
Total Political (PC) Risk Value		**2**	
	Total may not be less than 0		

Total External Risk (LT,CE,PC)	**0**

4. Natural risk

4.1. Natural Risk Likelihood Score (LS)

Significance of Natural Disturbance	Likelihood: Less than every 10 years	Every 10 to less than 25 years	Every 25 to less than 50 years	Every 10 to less than 100 years	Once every 100 years or more, or resik is not applicable to the project area	Comment
Catastrophic (70% or more loss of carbon stocks)	FAIL	30	20	5	0	
Devastating (50% to less than 70% loss of carbon stocks)	30	20	5	2	0	
Major (25% to less than 50% loss of carbon stocks)	20	5	2	1	0	
Minor (5% to less than 25% loss of carbon stocks)	5	2	1	1	0	
Insignificant (less than 5% loss of carbon stocks) or transient (full recovery of lost carbon stocks expected within 10 years of any event)	2	1	1	0	0	
No Loss	0	0	0	0	0	

4.2. Mitigation Score (MS)

Prevention measures applicable to the risk factor are implemented	0.5	
Project proponent has proven history of effectively containing natural risk	0.5	
Both of the above	0.25	
None of the above	1	

4.3. Total score for each natural risk applicable to the project (determined by (LS × MS)

	Chose Risk Likelihood Score as applicable	Chose Mitigation Score as applicable	Risk Value	Comment
Fire (F)	5	0.5	2.5	Fires around the project area and on the project's borders have occurred more frequently than every 10 years but have affected far less than 25% of carbon stocks. As detailed in Sub-section 2.2.1 - D), extensive fire prevention activities are being carried out by the project.
Pest and Disease Outbreaks (PD)	0	1	0	No historic records of pest and disease could be found.
Extreme Weather (W)	2	1	2	Extreme weather may occur but does significantly affect carbon stock due to the fact that the vast majority of stocks occur below ground.
Geological Risk (G)	0	1	0	No historic records of detrimental geological events could be found.
Other natural risk (ON) (salt water intrusion)	0	1	0	No historic records of other natural risk could be found.
Total Natural Risk (F + PD + W + G + ON)			**4.5**	

APPENDIX 3. COPY OF THE ECOSYSTEM RESTORATION CONCESSION LISENCE GRANTED TO PT. RMU

The copy of the concession license is available to the validator upon request.

APPENDIX 4. STRATA CHANGES IN THE BASELINE SCENARIO FOR WRC ACTIVITIES

1. Strata changes in the baseline scenario for WRC activities

From Strata	To		To		Area (ha)	Remarks
	Strata	Year	Strata	Year		
P1L0D0	P1L0D1	2011	P1L0D1AC	2011	122.94	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2023	4.81	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2025	57.99	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2026	8.99	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2028	8.20	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2029	26.69	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2030	21.47	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2031	20.83	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2017	6.38	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2018	34.86	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1AC	2019	7.97	Acacia zone
P1L0D0	P1L0D1	2023	P1L0D1AC	2025	37.28	Acacia zone
P1L0D0	P1L0D1	2023	P1L0D1AC	2026	8.54	Acacia zone
P1L0D0	P1L0D1	2025	P1L0D1AC	2026	5.98	Acacia zone
P1L0D0	P1L0D1	2029	P1L0D1AC	2031	39.06	Acacia zone
P1L0D0	P1L0D1	2013	P1L0D1AC	2026	4.57	Acacia zone
P1L0D0	P1L0D1	2013	P1L0D1AC	2031	14.47	Acacia zone
P1L0D0	P1L0D1	2013	P1L0D1AC	2032	4.31	Acacia zone
P1L0D0	P1L0D1	2013	P1L0D1AC	2016	24.51	Acacia zone
P1L0D0	P1L0D1	2013	P1L0D1AC	2017	0.42	Acacia zone
P1L0D1	P1L0D1	2011	P1L0D1AC	2032	0.11	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2011	1,566.40	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2020	947.69	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2021	298.20	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2022	745.90	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2023	1,103.90	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2024	1,014.19	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2025	608.18	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2026	1,311.44	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2027	1,636.34	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2028	2,211.90	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2029	1,708.80	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2012	1,640.12	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2030	1,958.26	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2031	832.57	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2013	1,646.38	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2014	1,635.56	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2015	1,498.39	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2016	1,155.94	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2017	578.93	Acacia zone

From Strata	To		To		Area (ha)	Remarks
	Strata	Year	Strata	Year		
P1L1D0	P1L1D1	2011	P1L0D1AC	2018	1,543.15	Acacia zone
P1L1D0	P1L1D1	2011	P1L0D1AC	2019	488.22	Acacia zone
P1L1D0	P1L1D1	2021	P1L0D1AC	2021	351.19	Acacia zone
P1L1D0	P1L1D1	2021	P1L0D1AC	2022	1,955.17	Acacia zone
P1L1D0	P1L1D1	2021	P1L0D1AC	2023	1,217.96	Acacia zone
P1L1D0	P1L1D1	2021	P1L0D1AC	2024	1,268.83	Acacia zone
P1L1D0	P1L1D1	2023	P1L0D1AC	2023	680.57	Acacia zone
P1L1D0	P1L1D1	2023	P1L0D1AC	2024	899.77	Acacia zone
P1L1D0	P1L1D1	2023	P1L0D1AC	2025	920.90	Acacia zone
P1L1D0	P1L1D1	2023	P1L0D1AC	2026	426.81	Acacia zone
P1L1D0	P1L1D1	2023	P1L0D1AC	2029	0.11	Acacia zone
P1L1D0	P1L1D1	2025	P1L0D1AC	2025	1,406.59	Acacia zone
P1L1D0	P1L1D1	2025	P1L0D1AC	2026	1,828.17	Acacia zone
P1L1D0	P1L1D1	2025	P1L0D1AC	2027	1,242.80	Acacia zone
P1L1D0	P1L1D1	2025	P1L0D1AC	2028	993.97	Acacia zone
P1L1D0	P1L1D1	2025	P1L0D1AC	2029	124.01	Acacia zone
P1L1D0	P1L1D1	2025	P1L0D1AC	2030	153.76	Acacia zone
P1L1D0	P1L1D1	2027	P1L0D1AC	2027	503.26	Acacia zone
P1L1D0	P1L1D1	2027	P1L0D1AC	2028	536.80	Acacia zone
P1L1D0	P1L1D1	2027	P1L0D1AC	2029	474.04	Acacia zone
P1L1D0	P1L1D1	2027	P1L0D1AC	2030	119.72	Acacia zone
P1L1D0	P1L1D1	2029	P1L0D1AC	2029	1,558.59	Acacia zone
P1L1D0	P1L1D1	2029	P1L0D1AC	2030	2,551.98	Acacia zone
P1L1D0	P1L1D1	2029	P1L0D1AC	2031	1,381.15	Acacia zone
P1L1D0	P1L1D1	2029	P1L0D1AC	2032	1,469.43	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2020	1,991.04	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2021	3,102.16	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2022	1,385.10	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2023	2,385.16	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2024	1,908.39	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2025	1,737.80	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2026	1,368.41	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2027	1,774.45	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2028	1,347.12	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2029	1,285.51	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2030	290.44	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2031	1,170.52	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2032	2,324.70	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2013	3,562.39	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2014	3,535.33	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2015	3,298.92	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2016	3,392.92	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2017	1,914.90	Acacia zone
P1L1D0	P1L1D1	2013	P1L0D1AC	2018	2,019.63	Acacia zone

From Strata	To		To		Area (ha)	Remarks
	Strata	Year	Strata	Year		
P1L1D0	P1L1D1	2013	P1L0D1AC	2019	1,307.35	Acacia zone
P1L1D0	P1L1D1	2015	P1L0D1AC	2015	156.23	Acacia zone
P1L1D0	P1L1D1	2015	P1L0D1AC	2016	490.23	Acacia zone
P1L1D0	P1L1D1	2015	P1L0D1AC	2017	973.57	Acacia zone
P1L1D0	P1L1D1	2015	P1L0D1AC	2018	105.01	Acacia zone
P1L1D0	P1L1D1	2015	P1L0D1AC	2019	379.14	Acacia zone
P1L1D0	P1L1D1	2017	P1L0D1AC	2020	1,125.33	Acacia zone
P1L1D0	P1L1D1	2017	P1L0D1AC	2021	31.73	Acacia zone
P1L1D0	P1L1D1	2017	P1L0D1AC	2022	138.65	Acacia zone
P1L1D0	P1L1D1	2017	P1L0D1AC	2017	1,523.63	Acacia zone
P1L1D0	P1L1D1	2017	P1L0D1AC	2018	1,554.72	Acacia zone
P1L1D0	P1L1D1	2017	P1L0D1AC	2019	2,160.18	Acacia zone
P1L1D0	P1L1D1	2019	P1L0D1AC	2020	747.42	Acacia zone
P1L1D0	P1L1D1	2019	P1L0D1AC	2021	1,351.50	Acacia zone
P1L1D0	P1L1D1	2019	P1L0D1AC	2022	903.25	Acacia zone
P1L1D0	P1L1D1	2019	P1L0D1AC	2019	844.17	Acacia zone
P1L1D1	P1L1D1	2011	P1L0D1AC	2032	13.26	Acacia zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2011	48.09	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2020	3.22	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2021	31.42	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2022	74.44	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2023	119.68	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2024	163.20	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2025	154.51	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2026	43.03	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2027	50.07	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2028	22.79	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2029	76.89	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2012	93.84	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2030	22.31	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2013	6.79	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2014	89.96	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2015	74.86	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2016	66.07	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2018	68.86	Community Crops zone
P1L0D0	P1L0D1	2011	P1L0D1CA	2019	17.68	Community Crops zone
P1L0D0	P1L0D1	2029	P1L0D1CA	2030	9.68	Community Crops zone
P1L0D0	P1L0D1	2029	P1L0D1CA	2032	0.01	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2020	41.87	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2021	14.13	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2025	26.23	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2026	5.69	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2027	53.56	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2028	49.49	Community Crops zone

From Strata	To		To		Area (ha)	Remarks
	Strata	Year	Strata	Year		
P1L0D0	P1L0D1	2013	P1L0D1CA	2029	162.77	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2030	119.06	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2031	52.02	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2032	21.88	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2013	118.81	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2014	113.35	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2015	0.16	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2016	172.47	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2017	211.78	Community Crops zone
P1L0D0	P1L0D1	2013	P1L0D1CA	2019	103.25	Community Crops zone
P1L0D0	P1L0D1	2015	P1L0D1CA	2018	1.57	Community Crops zone
P1L0D0	P1L0D1	2017	P1L0D1CA	2017	7.53	Community Crops zone
P1L0D0	P1L0D1	2017	P1L0D1CA	2018	0.00	Community Crops zone
P1L0D1	P1L0D1	2011	P1L0D1CA	2021	130.68	Community Crops zone
P1L0D1	P1L0D1	2011	P1L0D1CA	2022	102.23	Community Crops zone
P1L0D1	P1L0D1	2011	P1L0D1CA	2023	140.87	Community Crops zone
P1L0D1	P1L0D1	2011	P1L0D1CA	2024	130.04	Community Crops zone
P1L0D1	P1L0D1	2011	P1L0D1CA	2025	143.96	Community Crops zone
P1L0D1	P1L0D1	2011	P1L0D1CA	2026	82.13	Community Crops zone
P1L0D1	P1L0D1	2011	P1L0D1CA	2027	93.54	Community Crops zone
P1L0D1	P1L0D1	2011	P1L0D1CA	2028	137.57	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2011	124.65	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2020	173.57	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2021	193.13	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2022	131.90	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2023	55.47	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2024	15.40	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2025	18.50	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2026	103.00	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2027	90.02	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2028	120.31	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2029	82.73	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2012	109.93	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2030	115.90	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2013	173.97	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2014	92.17	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2015	103.96	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2016	104.20	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2017	174.45	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2018	110.07	Community Crops zone
P1L1D0	P1L1D1	2011	P1L0D1CA	2019	176.18	Community Crops zone
P1L1D0	P1L1D1	2021	P1L0D1CA	2021	0.05	Community Crops zone
P1L1D0	P1L1D1	2021	P1L0D1CA	2022	1.00	Community Crops zone
P1L1D0	P1L1D1	2021	P1L0D1CA	2023	1.00	Community Crops zone

From Strata	To		To		Area (ha)	Remarks
	Strata	Year	Strata	Year		
P1L1D0	P1L1D1	2021	P1L0D1CA	2024	0.23	Community Crops zone
P1L1D0	P1L1D1	2029	P1L0D1CA	2030	0.21	Community Crops zone
P1L1D0	P1L1D1	2029	P1L0D1CA	2032	0.17	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2020	281.33	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2021	222.77	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2022	254.32	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2023	234.77	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2024	258.98	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2025	158.03	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2026	143.26	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2027	236.09	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2028	171.23	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2029	156.21	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2030	152.00	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2031	160.64	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2032	167.79	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2013	327.39	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2014	282.10	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2015	226.67	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2016	321.38	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2017	193.27	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2018	392.43	Community Crops zone
P1L1D0	P1L1D1	2013	P1L0D1CA	2019	242.40	Community Crops zone
P1L1D0	P1L1D1	2015	P1L0D1CA	2016	1.49	Community Crops zone
P1L1D0	P1L1D1	2015	P1L0D1CA	2017	0.25	Community Crops zone
P1L1D0	P1L1D1	2015	P1L0D1CA	2018	4.51	Community Crops zone
P1L1D0	P1L1D1	2017	P1L0D1CA	2020	123.37	Community Crops zone
P1L1D0	P1L1D1	2017	P1L0D1CA	2024	0.93	Community Crops zone
P1L1D0	P1L1D1	2017	P1L0D1CA	2017	9.17	Community Crops zone
P1L1D0	P1L1D1	2017	P1L0D1CA	2018	89.13	Community Crops zone
P1L1D0	P1L1D1	2017	P1L0D1CA	2019	138.10	Community Crops zone
P1L1D1	P1L1D1	2011	P1L0D1CA	2021	10.10	Community Crops zone
P1L1D1	P1L1D1	2011	P1L0D1CA	2022	59.27	Community Crops zone
P1L1D1	P1L1D1	2011	P1L0D1CA	2023	45.72	Community Crops zone
P1L1D1	P1L1D1	2011	P1L0D1CA	2024	55.59	Community Crops zone
P1L1D1	P1L1D1	2011	P1L0D1CA	2025	64.16	Community Crops zone
P1L1D1	P1L1D1	2011	P1L0D1CA	2026	79.28	Community Crops zone
P1L1D1	P1L1D1	2011	P1L0D1CA	2027	17.85	Community Crops zone
P1L1D0	P1L1D0CF	2011	N/A	N/A	13,424.70	Conservation Forest zone
P1L0D0	P1L0D1IS	2011	N/A	N/A	34.62	equal to P1L0D1
P1L0D0	P1L0D1IS	2025	N/A	N/A	0.16	equal to P1L0D1
P1L0D0	P1L0D1IS	2029	N/A	N/A	5.72	equal to P1L0D1
P1L0D0	P1L0D1IS	2013	N/A	N/A	14.11	equal to P1L0D1
P1L1D0	P1L1D0IS	2011	N/A	N/A	1,993.90	equal to P1L1D0CF

From Strata	To		To		Area (ha)	Remarks
	Strata	Year	Strata	Year		
P1L1D0	P1L1D1CF	2011	N/A	N/A	15.55	equal to P1L1D1IS
P1L1D0	P1L1D1CF	2013	N/A	N/A	10.48	equal to P1L1D1IS
P1L0D0	P1L0D1	2011	P1L0D1IF	2011	18.98	Ground Fascility zone
P1L0D0	P1L0D1	2011	P1L0D1IF	2027	2.68	Ground Fascility zone
P1L0D0	P1L0D1	2013	P1L0D1IF	2017	0.25	Ground Fascility zone
P1L1D0	P1L1D1	2011	P1L0D1IF	2011	25.20	Ground Fascility zone
P1L1D0	P1L1D1	2011	P1L0D1IF	2023	9.80	Ground Fascility zone
P1L1D0	P1L1D1	2011	P1L0D1IF	2025	9.72	Ground Fascility zone
P1L1D0	P1L1D1	2011	P1L0D1IF	2027	18.15	Ground Fascility zone
P1L1D0	P1L1D1	2011	P1L0D1IF	2015	30.05	Ground Fascility zone
P1L1D0	P1L1D1	2011	P1L0D1IF	2019	20.51	Ground Fascility zone
P1L1D0	P1L1D1	2027	P1L0D1IF	2027	7.90	Ground Fascility zone
P1L1D0	P1L1D1	2013	P1L0D1IF	2021	3.77	Ground Fascility zone
P1L1D0	P1L1D1	2013	P1L0D1IF	2025	21.63	Ground Fascility zone
P1L1D0	P1L1D1	2013	P1L0D1IF	2029	17.14	Ground Fascility zone
P1L1D0	P1L1D1	2013	P1L0D1IF	2013	93.03	Ground Fascility zone
P1L1D0	P1L1D1	2013	P1L0D1IF	2017	11.64	Ground Fascility zone
P1L0D0	P1L0D0IS	2011	N/A	N/A	13.88	Indigeneous Species zone
P1L1D0	P1L1D1IS	2011	N/A	N/A	8,363.18	Indigeneous Species zone
P1L1D0	P1L1D1IS	2021	N/A	N/A	25.61	Indigeneous Species zone
P1L1D0	P1L1D1IS	2025	N/A	N/A	52.44	Indigeneous Species zone
P1L1D0	P1L1D1IS	2027	N/A	N/A	8.46	Indigeneous Species zone
P1L1D0	P1L1D1IS	2029	N/A	N/A	0.16	Indigeneous Species zone
P1L1D0	P1L1D1IS	2013	N/A	N/A	5,658.75	Indigeneous Species zone
P1L1D0	P1L1D1IS	2015	N/A	N/A	48.50	Indigeneous Species zone
P1L1D0	P1L1D1IS	2017	N/A	N/A	66.17	Indigeneous Species zone
P1L0D0	Canal	2011	N/A	N/A	57.60	Water Body zone
P1L0D0	Canal	2023	N/A	N/A	1.34	Water Body zone
P1L0D0	Canal	2025	N/A	N/A	0.13	Water Body zone
P1L0D0	Canal	2029	N/A	N/A	1.53	Water Body zone
P1L0D0	Canal	2013	N/A	N/A	47.20	Water Body zone
P1L0D0	Canal	2015	N/A	N/A	0.09	Water Body zone
P1L0D0	Canal	2017	N/A	N/A	0.02	Water Body zone
P1L0D1	Canal	2011	N/A	N/A	32.42	Water Body zone
P1L1D0	Canal	2011	N/A	N/A	838.26	Water Body zone
P1L1D0	Canal	2021	N/A	N/A	131.15	Water Body zone
P1L1D0	Canal	2023	N/A	N/A	75.76	Water Body zone
P1L1D0	Canal	2025	N/A	N/A	146.13	Water Body zone
P1L1D0	Canal	2027	N/A	N/A	43.87	Water Body zone
P1L1D0	Canal	2029	N/A	N/A	175.79	Water Body zone
P1L1D0	Canal	2013	N/A	N/A	1,225.65	Water Body zone
P1L1D0	Canal	2015	N/A	N/A	55.29	Water Body zone
P1L1D0	Canal	2017	N/A	N/A	179.75	Water Body zone
P1L1D0	Canal	2019	N/A	N/A	96.39	Water Body zone

From Strata	To		To		Area (ha)	Remarks
	Strata	Year	Strata	Year		
P1L1D1	Canal	2011	N/A	N/A	9.20	Water Body zone
River	River	N/A	N/A	N/A	208.94	Water Body zone, No Changes
NP	NP	N/A	N/A	N/A	3,161.84	Non Peatland, No Changes

Note: N/A = Not available, indicates no changes in the corresponding sequence
Strata with the same symbol in a consecutive change indicates no changes

APPENDIX 5. BASELINE STRATIFICATION BASED ON EMISSION CHARACTERISTICS

1. For ARR activities

Activity	LC pre (LC0)	LC post (LC1)	Area (ha)	Planting/harvesting year	Description
Planting	Non forest	Rubber tree plantation	-	2010	GHG removal
Planting	Non forest	Rubber tree plantation	44	2011	GHG removal
Planting	Non forest	Rubber tree plantation	49	2012	GHG removal
Planting	Non forest	Rubber tree plantation	156	2013	GHG removal
Planting	Non forest	Rubber tree plantation	140	2014	GHG removal
Planting	Non forest	Rubber tree plantation	43	2015	GHG removal
Planting	Non forest	Rubber tree plantation	271	2016	GHG removal
Planting	Non forest	Rubber tree plantation	215	2017	GHG removal
Planting	Non forest	Rubber tree plantation	67	2018	GHG removal
Planting	Non forest	Rubber tree plantation	243	2019	GHG removal
Planting	Non forest	Rubber tree plantation	45	2020	GHG removal
Planting	Non forest	Rubber tree plantation	190	2021	GHG removal
Planting	Non forest	Rubber tree plantation	308	2022	GHG removal
Planting	Non forest	Rubber tree plantation	424	2023	GHG removal
Planting	Non forest	Rubber tree plantation	349	2024	GHG removal
Planting	Non forest	Rubber tree plantation	315	2025	GHG removal
Planting	Non forest	Rubber tree plantation	113	2026	GHG removal
Planting	Non forest	Rubber tree plantation	300	2027	GHG removal
Planting	Non forest	Rubber tree plantation	241	2028	GHG removal
Planting	Non forest	Rubber tree plantation	239	2029	GHG removal
Planting	Non forest	Rubber tree plantation	143	2030	GHG removal
Planting	Non forest	Rubber tree plantation	107	2031	GHG removal
Planting	Non forest	Rubber tree plantation	227	2032	GHG removal
Planting	Non forest	Rubber tree plantation	44	2036	GHG removal
Planting	Non forest	Rubber tree plantation	49	2037	GHG removal
Planting	Non forest	Rubber tree plantation	156	2038	GHG removal
Planting	Non forest	Rubber tree plantation	140	2039	GHG removal
Planting	Non forest	Rubber tree plantation	43	2040	GHG removal
Planting	Non forest	Rubber tree plantation	271	2041	GHG removal
Planting	Non forest	Rubber tree plantation	215	2042	GHG removal
Planting	Non forest	Rubber tree plantation	67	2043	GHG removal
Planting	Non forest	Rubber tree plantation	243	2044	GHG removal
Planting	Non forest	Rubber tree plantation	45	2045	GHG removal
Planting	Non forest	Rubber tree plantation	190	2046	GHG removal
Planting	Non forest	Rubber tree plantation	308	2047	GHG removal
Planting	Non forest	Rubber tree plantation	424	2048	GHG removal
Planting	Non forest	Rubber tree plantation	349	2049	GHG removal
Planting	Non forest	Rubber tree plantation	315	2050	GHG removal
Planting	Non forest	Rubber tree plantation	113	2051	GHG removal
Planting	Non forest	Rubber tree plantation	300	2052	GHG removal
Planting	Non forest	Rubber tree plantation	241	2053	GHG removal
Planting	Non forest	Rubber tree plantation	239	2054	GHG removal
Planting	Non forest	Rubber tree plantation	143	2055	GHG removal
Planting	Non forest	Rubber tree plantation	107	2056	GHG removal
Planting	Non forest	Rubber tree plantation	227	2057	GHG removal
Planting	Non forest	Rubber tree plantation	44	2061	GHG removal
Planting	Non forest	Rubber tree plantation	49	2062	GHG removal
Planting	Non forest	Rubber tree plantation	156	2063	GHG removal

Activity	LC pre (LC0)	LC post (LC1)	Area (ha)	Planting/harvesting year	Description
Planting	Non forest	Rubber tree plantation	140	2064	GHG removal
Planting	Non forest	Rubber tree plantation	43	2065	GHG removal
Planting	Non forest	Rubber tree plantation	271	2066	GHG removal
Planting	Non forest	Rubber tree plantation	215	2067	GHG removal
Planting	Non forest	Rubber tree plantation	67	2068	GHG removal
Planting	Non forest	Rubber tree plantation	243	2069	GHG removal
Harvesting	Rubber tree plantation	Non forest	44	2036	GHG emission
Harvesting	Rubber tree plantation	Non forest	49	2037	GHG emission
Harvesting	Rubber tree plantation	Non forest	156	2038	GHG emission
Harvesting	Rubber tree plantation	Non forest	140	2039	GHG emission
Harvesting	Rubber tree plantation	Non forest	43	2040	GHG emission
Harvesting	Rubber tree plantation	Non forest	271	2041	GHG emission
Harvesting	Rubber tree plantation	Non forest	215	2042	GHG emission
Harvesting	Rubber tree plantation	Non forest	67	2043	GHG emission
Harvesting	Rubber tree plantation	Non forest	243	2044	GHG emission
Harvesting	Rubber tree plantation	Non forest	45	2045	GHG emission
Harvesting	Rubber tree plantation	Non forest	190	2046	GHG emission
Harvesting	Rubber tree plantation	Non forest	308	2047	GHG emission
Harvesting	Rubber tree plantation	Non forest	424	2048	GHG emission
Harvesting	Rubber tree plantation	Non forest	349	2049	GHG emission
Harvesting	Rubber tree plantation	Non forest	315	2050	GHG emission
Harvesting	Rubber tree plantation	Non forest	113	2051	GHG emission
Harvesting	Rubber tree plantation	Non forest	300	2052	GHG emission
Harvesting	Rubber tree plantation	Non forest	241	2053	GHG emission
Harvesting	Rubber tree plantation	Non forest	239	2054	GHG emission
Harvesting	Rubber tree plantation	Non forest	143	2055	GHG emission
Harvesting	Rubber tree plantation	Non forest	107	2056	GHG emission
Harvesting	Rubber tree plantation	Non forest	227	2057	GHG emission
Harvesting	Rubber tree plantation	Non forest	44	2061	GHG emission
Harvesting	Rubber tree plantation	Non forest	49	2062	GHG emission
Harvesting	Rubber tree plantation	Non forest	156	2063	GHG emission
Harvesting	Rubber tree plantation	Non forest	140	2064	GHG emission
Harvesting	Rubber tree plantation	Non forest	43	2065	GHG emission
Harvesting	Rubber tree	Non forest	271	2066	GHG emission

Activity	LC pre (LC0)	LC post (LC1)	Area (ha)	Planting/harvesting year	Description
	plantation				
Harvesting	Rubber tree plantation	Non forest	215	2067	GHG emission
Harvesting	Rubber tree plantation	Non forest	67	2068	GHG emission
Harvesting	Rubber tree plantation	Non forest	243	2069	GHG emission

2. Appendix. Baseline stratification based on emission characteristic for REDD

LC pre def (LC0)	LC post def (LC1)	Area (ha)	Year of deforestation	Description
Forest	Acacia plantation	-	2010	Acacia plantation area
Forest	Acacia plantation	1,589	2011	Acacia plantation area
Forest	Acacia plantation	1,640	2012	Acacia plantation area
Forest	Acacia plantation	5,225	2013	Acacia plantation area
Forest	Acacia plantation	5,203	2014	Acacia plantation area
Forest	Acacia plantation	5,194	2015	Acacia plantation area
Forest	Acacia plantation	5,196	2016	Acacia plantation area
Forest	Acacia plantation	5,248	2017	Acacia plantation area
Forest	Acacia plantation	5,257	2018	Acacia plantation area
Forest	Acacia plantation	5,187	2019	Acacia plantation area
Forest	Acacia plantation	5,231	2020	Acacia plantation area
Forest	Acacia plantation	5,164	2021	Acacia plantation area
Forest	Acacia plantation	5,141	2022	Acacia plantation area
Forest	Acacia plantation	5,392	2023	Acacia plantation area
Forest	Acacia plantation	5,184	2024	Acacia plantation area
Forest	Acacia plantation	4,966	2025	Acacia plantation area
Forest	Acacia plantation	4,954	2026	Acacia plantation area
Forest	Acacia plantation	5,157	2027	Acacia plantation area
Forest	Acacia plantation	5,098	2028	Acacia plantation area
Forest	Acacia plantation	5,169	2029	Acacia plantation area
Forest	Acacia plantation	5,074	2030	Acacia plantation area
Forest	Acacia plantation	3,286	2031	Acacia plantation area
Forest	Acacia plantation	3,809	2032	Acacia plantation area
Forest	Non-Forest	423	2011	Infrastructure
Forest	Non-Forest	780	2013	Infrastructure
Forest	Non-Forest	189	2015	Infrastructure
Forest	Non-Forest	365	2017	Infrastructure
Forest	Non-Forest	189	2019	Infrastructure
Forest	Non-Forest	336	2021	Infrastructure
Forest	Non-Forest	161	2023	Infrastructure
Forest	Non-Forest	359	2025	Infrastructure
Forest	Non-Forest	182	2027	Infrastructure
Forest	Non-Forest	361	2029	Infrastructure
Forest	Rubber tree plantation	133	2011	Community crops
Forest	Rubber tree plantation	155	2012	Community crops
Forest	Rubber tree plantation	523	2013	Community crops
Forest	Rubber tree plantation	502	2014	Community crops

LC pre def (LC0)	LC post def (LC1)	Area (ha)	Year of deforestation	Description
Forest	Rubber tree plantation	579	2015	Community crops
Forest	Rubber tree plantation	398	2016	Community crops
Forest	Rubber tree plantation	463	2017	Community crops
Forest	Rubber tree plantation	600	2018	Community crops
Forest	Rubber tree plantation	435	2019	Community crops
Forest	Rubber tree plantation	588	2020	Community crops
Forest	Rubber tree plantation	431	2021	Community crops
Forest	Rubber tree plantation	316	2022	Community crops
Forest	Rubber tree plantation	174	2023	Community crops
Forest	Rubber tree plantation	275	2024	Community crops
Forest	Rubber tree plantation	260	2025	Community crops
Forest	Rubber tree plantation	461	2026	Community crops
Forest	Rubber tree plantation	259	2027	Community crops
Forest	Rubber tree plantation	269	2028	Community crops
Forest	Rubber tree plantation	307	2029	Community crops
Forest	Rubber tree plantation	382	2030	Community crops
Forest	Rubber tree plantation	282	2031	Community crops
Forest	Rubber tree plantation	191	2032	Community crops

APPENDIX 6. DEFAULT VALUES USED IN QUANTIFICATION OF GHG EMISSIONS

1. Default Emission Factors for Quantification of GHG Emissions from Peat Microbial Decomposition and Dissolved Organic Carbon in Baseline (BSL) and Project Scenario (WPS) (ton CO2e.ha-1.y-1). Numbers in bracket signify half with 95% confidence interval.

Strata	Description	CO_2	CH_4	DOC	Reference	Scenario
P1L1D0	Peat, Forest, Not Drained	0 (0)	0.72 (0.22)	-	IPCC Wetlands Supplement 2013, Chapter 3, Tables 3.1 and 3.3 and 3A.3*	BSL Initial Stratum and WPS
P1L1D1	Peat, Forest, Drained	19.43 (5.74)	0.14 (0.03)	-	IPCC Wetlands Supplement 2013, Chapter 2, Tables 2.1 and 2.3	BSL Initial Stratum and WPS
P1L0D0	Peat, Non Forest, not Drained	1.50 (2.39)	0.20 (0.12)	-	IPCC, Wetlands Supplement 2013, Dariah et al 2013, Hairiah et al 1999; Ishida et al 2001; Lamade & Bouillet 2005; Matthews et al 2000; Melling et al 2005a, 2007a; Watanabe et al 2009	BSL Initial Stratum and WPS
P1L0D1	Peat, non Forest, Drained	19.43 (5.74)	0.14 (0.03)	-	IPCC Wetlands Supplement 2013, Chapter 2, Tables 2.1 and 2.3	BSL Initial Stratum and WPS
P1L0D1AC	Peat, Non Forest, Drained, Acacia	73.33 (5.64)	0.08 (0.06)	-	IPCC Wetlands Supplement 2013, Chapter 2, Tables 2.1 and 2.3	BSL
P1L1D0CF	Peat, Forest, Not Drained, Conservation	0 (0)	0.72 (0.22)	-	IPCC Wetlands Supplement 2013, Chapter 3, Tables 3.1 and 3.3*	BSL, unchanged stratum during the project course, equal to P1L1D0
P1L0D1IF	Peat, Non Forest, Drained, Infrastructure	19.43 (5.74)	0.14 (0.03)	-	IPCC Wetlands Supplement 2013, Chapter 2, Tables 2.1 and 2.3	BSL
P1L1D1IS	Peat, Forest, Drained,	19.43 (5.74)	0.14 (0.03)	-	IPCC Wetlands Supplement	BSL, equal to P1L1D1

Strata	Description	CO_2	CH_4	DOC	Reference	Scenario
	Indigeneous Species+River Buffer				2013, Chapter 2, Tables 2.1 and 2.3	
P1L0D1CA	Peat, Non Forest, Drained, Community Crops	51.33 (16.02)	0.20 (0.12)	-	IPCC Wetlands Supplement 2013, Chapter 2, Tables 2.1 and 2.3	BSL
WB	Natural	-	-	2.1 (0.27)	IPCC Wetlands Supplement 2013, Chapter 2, Tables 2.2	WPS
WB	Drained	-		3.0 (1.22)	IPCC Wetlands Supplement 2013, Chapter 2, Tables 2.2	BSL

2. Default Burn Scar Depths for Quantification of GHG Emissions from Peat Burning in Baseline and With-Project Scenario

Repeated Burning Order	Average burn scar depth (cm)	Reference
1st	18	Page, et. al., 2014 [28]
2nd	11	Page, et. al., 2014 [28]
3rd onward	4	Wösten

3. IPCC default values for Combustion Factors and Global Warming Potential used in Quantification of GHG Emissions from Peat and Biomass Burning

Gas	Global Warming Potential (GWP_g)	Combustion Factor (G_g) ($g.kg^{-1}$ dry mass)	Reference
CH_4	28	6.8	IPCC Table 2.5
CO_2	1	1,580	IPCC Table 2.5

APPENDIX 7.THE SIZE AND POPULATION OF THE PROJECT-ZONE VILLAGES [6][7]

Sub-district	NO	Village	Area (ha)	Population			No of HH	Dominant Ethnicity	Dominant Religion	Avg. Monthly Income IDR/HH	Main livelihoods/source of income, and proportion of each	Highest Education Level	No of clinic and health care services	Electricity (hours/day)
				Male	Female	Total								
KATINGAN DISTRICT														
Mendawai	1	Mendawai	31,300	525	485	1,010	283	Dayak, Banjar	Muslim	1M	Farmer (30%), Fishermen (10%), Logging and timber processing mill (10%), Water taxi (8%), Civil servants (2%), Middlemen and traders (8%), Day labourers (32%)	Vocational high school (30 People)	1 Community health center, 1 Pre- and postnatal health center	100 % (12 hours)
	2	Kampung Melayu	8,295	455	435	890	232	Dayak, Banjar, Melayu	Muslim	900K-1M	Farmer (70%), Fishermen (5%), Loggers and timber processing mill (5%), Water taxi (3%), Other employment (1%), Middlemen and traders (8%), Day labourers (8%)	High school (23 People)	1 Branch community health center, 1 Pre- and postnatal health center	0%
	3	Tewang Kampung	59,038	303	284	587	149	Dayak, Banjar	Muslim	500-750K	Farmer (90%), Middlemen and traders (5%), Day labourers (5%)	High school (14 People)	1 Branch community health center, 1 Pre- and postnatal health center	0%
	4	Parigi	29,700	282	245	527	137	Dayak, Banjar	Muslim	500K-1M	Farmer (70%), Fishermen (20%), other employment (5 %) Day labourers (5%)	Bachelor's degree (19 People)	1 Branch community health center, 1 Pre- and postnatal health center	0%
	5	Tumbang Bulan	35,300	579	225	800	186	Dayak, Banjar	Muslim	1-1.5M	Fishermen (60%), Farmer (30%), Day labourers (10%)	Bachelor's degree (1 Person)	1 Branch community health center, 1 Pre- and	0%

Sub-district	NO	Village	Area (ha)	Population			No of HH	Dominant Ethnicity	Dominant Religion	Avg. Monthly Income IDR/HH	Main livelihoods/source of income, and proportion of each	Highest Education Level	No of clinic and health care services	Electricity (hours/day)
				Male	Female	Total								
													postnatal health center	
Kamipang	6	Galinggang	12,100	744	742	1,486	412	Dayak, Banjar	Muslim	1M	Fishermen (80%), Day labourers (15%), Middlemen and traders (3%), Other employment (2%)	High school (30 People)	1 Branch community health center, 1 Pre- and postnatal health center	0%
	7	Tampelas	1,100	244	262	506	142	Dayak, Banjar	Muslim	1M	Fishermen (75%), Day labourers (15%), Middlemen and traders (5%), Other employment (5%)	Bachelor's degree (1 Person)	1 Branch community health center, 1 Pre- and postnatal health center	0%
	8	Telaga	34,200	723	652	1,375	439	Dayak	Muslim	1-1.5M	Fishermen (70%), Miners (20%), Day labourers (10%)	High school (30 People)	1 Branch community health center, 1 Pre- and postnatal health center	0%
	9	Parupuk	49,000	69	67	136	40	Dayak, Banjar	Muslim	1M	Fishermen (95%), Middlemen and traders (3%), Other employment (2%)	Bachelor's degree (4 People)	1 Branch community health center, 1 Pre- and postnatal health center	0%

Sub-district	NO	Village	Area (ha)	Population			No of HH	Dominant Ethnicity	Dominant Religion	Avg. Monthly Income IDR/HH	Main livelihoods/source of income, and proportion of each	Highest Education Level	No of clinic and health care services	Electricity (hours/day)
				Male	Female	Total								
	10	Karuing	21,600	295	258	553	134	Dayak, Banjar	Muslim	1M	Fishermen (90%), Day labourers (10%)	Bachelor's degree (2 People)	1 Branch community health center, 1 Pre- and postnatal health center	0%
	11	Jahanjang	19,800	328	282	610	183	Dayak, Banjar	Muslim	1M	Fishermen (75%), Day labourers (15%), Middlemen and traders (5%), Other employment (5%)	Bachelor's degree (5 People)	1 Branch community health center, 1 Pre- and postnatal health center	100 % (12 hours/day)
	12	Tumbang Runen	11,400	193	206	399	107	Dayak	Muslim	1M	Farmer (90%), Day labourers (10%)	Bachelor's degree (4 People)	1 Branch community health center, 1 Pre- and postnatal health center	100 %(12 hours/day)
	13	Baun Bango	62,500	423	446	869	241	Dayak, Banjar	Muslim,	1M	Fishermen (80%), Day labourers (10%), Middlemen and traders (5%), Other employment (5%)	Bachelor's degree (20 People)	1 Community health center, 1 Pre- and postnatal health center	100 % (12 hours/day)
	14	Asem Kumbang	22,200	702	671	1,373	397	Dayak	Muslim	1M	Fishermen (70%), Day labourers (20%), Traders (5%), Other employment (5%)	Bachelor's degree (13 People)	1 Branch community health center, 1 Pre- and postnatal health care center	100 %(12 hours/day)

Sub-district	NO	Village	Area (ha)	Population			No of HH	Dominant Ethnicity	Dominant Religion	Avg. Monthly Income IDR/HH	Main livelihoods/source of income, and proportion of each	Highest Education Level	No of clinic and health care services	Electricity (hours/day)
				Male	Female	Total								
KOTAWARINGIN TIMUR DISTRICT														
Seranau	15	Ganepo	26,000	858	765	1,623	461	Dayak, Jawa, Madura	Muslim	400K	Farmers (90%), Business owners (5%), Civil servants (2%), Day labourers (2%), Driver (1%)	Master's degree (1 Person)	1 Branch community health center, 1 Pre- and postnatal health center	100%
	16	Mentaya Seberang	22,309	1,664	1,522	3,186	871	Dayak, Banjar, Maduru, Jawa	Muslim 99.9%. 0.1 % Christian	1.5M	Civil serventns (9%), Company workers (19%), Business owners/middlemen and traders (12%), Farmers (23%), Engineers/specialist (10%), Farm day labourers (24%)	Master's degree (1 Person)	1 Community health center, 1 Pre- and postnatal health center	100%
	17	Seragam Jaya[20]	1,501	397	368	765	184	Dayak, Banjar, Madura	Muslim	1.5M	Farmers (70%), Business owners/middlemen and traders (30%)	Bachelor's degree	1 Pre- and postnatal health center	100%
	18	Batuah	9,100	973	912	1885	518	Dayak, Banjar, Maduru	Muslim	1.5M	Farmers (80%), Middlemen and traders (7%), Civil servants (2%), Day labourers (10%)	High school (10 People)	1 Branch community health center, 1 Pre- and postnatal health center, 1 Village birth center	100%
	19	Terantang Hilir	9,400	1,031	836	1,867	507	Dayak, Banjar, Madura, Jawa	Muslim	1M	Farmers: 70%, Middlemen and traders: 10%, Day labourers: 15%, Civil servants: 2%, Loggers: 3%	Bachelor's degree (7 People)	1 Branch community health center, 1 Pre- and	100%

[20] Seragam Jaya village was separated from Mentaya Seberang and established in 2015.

Sub-district	NO	Village	Area (ha)	Population			No of HH	Dominant Ethnicity	Dominant Religion	Avg. Monthly Income IDR/HH	Main livelihoods/source of income, and proportion of each	Highest Education Level	No of clinic and health care services	Electricity (hours/day)
				Male	Female	Total								
													postnatal health center	
	20	Terantang	10,000	769	741	1,510	402	Dayak, Banjar, Madura, Jawa	Muslim	1M	Farmers: 80%, Middlemen and traders: 10%, Day labourers: 8%, Civil servants: 2%	Bachelor's degree (10 People)	1 Branch community health center, 1 Village birth center, 1 Pre- and postnatal health center	100%
Pulau Hanaut	21	Rawa Sari	1,700	389	345	734	184	Jawa, Dayak	Muslim	1M	Farmers: 97%, Civil servants: 3%	Bachelor's degree (8 People)	1 Branch community health center, 1 Pre- and postnatal health center	100%
	22	Makarti Jaya	1,200	556	628	1,184	247	Jawa, Madura, Dayak	Muslim	700K	Farmers: 95%, Civil servants: 5%	High school (100 People)	1 Village birth center, 1 Village health center	100%
	23	Hanaut	6,600	990	931	1,921	515	Madura, Banjar, Jawa, Dayak	Muslim	500K	Farmers: 98%, Civil servants: 2%	Bachelor's degree (8 People)	1 Branch community health center, 1 Pre- and postnatal health center	100%
	24	Bapinang Hulu	4,250	655	580	1,235	344	Dayak, Banjar, Madura	Muslim	750K	Farmers: 50%, Civil servants: 10%, Day labourers: 30%, Transportation: 10%	Bachelor's degree (27 People)	Community health center, 1 Pre and postnatal health	100%

Sub-district	NO	Village	Area (ha)	Population			No of HH	Dominant Ethnicity	Dominant Religion	Avg. Monthly Income IDR/HH	Main livelihoods/source of income, and proportion of each	Highest Education Level	No of clinic and health care services	Electricity (hours/day)
				Male	Female	Total								
													center	
	25	Bamadu[21]	2,712	304	272	576	175	Banjar, Madura	Muslim	900K	Farmers: 90%, Day labourers: 10%	N/A	No clinic	100%
	26	Penyaguan[22]	2,221	338	345	683	245	Banjar, Madura	Muslim	900K	Farmer (90%), Day labourers (10%)	Bachelor's degree (20 People)	1 Branch community health center	100%
	27	Babaung	4,200	1509	1291	2800	703	Banjar, Madura	Muslim	1.2M	Farmers: 70%, Day labourers: 20%, Transportation service providers: 10%	Bachelor's degree (10 People)	1 Branch community health center, 1 Village birth center, 1 Pre- and postnatal health center	100%
	28	Bapinang Hilir	5.183	1,098	1,224	2,322	644	Dayak, Banjar, Madura	Muslim	750K	Farmers (70%), Day labourers (20%), Transportation service providers (10%)	N/A	1 Branch community health center, 1 Village birth center, 1 Pre- and postnatal health center	100%

[21] Bamadu village was separated from Bapinang Hulu village and established in 2012.
22 Penyaguan village was separated from Bapinang Hulu village and established in 2012.

Sub-district	NO	Village	Area (ha)	Population			No of HH	Dominant Ethnicity	Dominant Religion	Avg. Monthly Income IDR/HH	Main livelihoods/source of income, and proportion of each	Highest Education Level	No of clinic and health care services	Electricity (hours/day)
				Male	Female	Total								
	29	Babirah	8,100	893	889	1,782	462	Dayak, Banjar, Madura	Muslim	1.5M	Farmers: 90%, Civil servants: 3%, Fishermen: 7%	Bachelor's degree (17 People)	1 Branch community health center, 1 Village birth center, 1 Pre- and postnatal health center	100%
	30	Hantipan	2,745	362	344	706	230	Dayak, Banjar, Madura	Muslim	750K	Farmers (70%), Day labourers (20%), Transportation service providers (10%)	N/A	1 Branch community health center, 1 Pre- and postnatal health center	100%
	31	Bapinang Hilir Laut	4,200	1,332	1,334	2,666	400	Banjar, Dayak, Madura	Muslim	1.5M	Farmers: 70%, Fishermen: 23%, Day labourers: 5%, Civil servants: 2%	Bachelor's degree (10 People)	1 Branch community health center	100%
	32	Bantian	3,950	562	525	1,087	307	Dayak, Banjar, Madura	Muslim	1M	Farmers: 80%, Fishermen: 10%, Day labourers: 10%	High school (25 People)	No clinic	100%
	33	Serambut	7,200	649	598	1,238	365	Dayak, Banjar, Madura	Muslim	1M	Farmers: 80%, Fishermen: 15%, Civil servants: 2%, Day labourers: 3%	Bachelor's degree (5 People)	1 Branch community health center	0%
	34	Satiruk	6,655	1,047	1,106	2,153	462	Banjar, Jawa, Madura	Muslim	1.5M	Fishermen: 65%, Farmers: 30%, Day labourers: 3%, Civil servants: 2%	Bachelor's degree (10 People)	1 Branch community health center, 1 Village birth center	0%

Sub-district	NO	Village	Area (ha)	Population			No of HH	Dominant Ethnicity	Dominant Religion	Avg. Monthly Income IDR/HH	Main livelihoods/source of income, and proportion of each	Highest Education Level	No of clinic and health care services	Electricity (hours/day)
				Male	Female	Total								
KATINGAN TOTAL			397,533	-	-	11,463	3,078							
KOTAWARINGIN TOTAL			134,043	-	-	32,577	8,397							
PROJECT ZONE TOTAL			531,576	-	-	44,040	11,475							

APPENDIX 8. LIST OF STANDARD OPERATION PROCEDURES (SOP)

Some of the SOPs are presented in Annexes, and other complete ones are also available to validators upon request.

SOP (Standard Operation Procedure)		Status		
		Complete	Draft	Planned
A. Carbon Stock Measurement and monitoring				
1	Aboveground Biomass Stock Assessment	V		
2	Belowground Biomass Stock Assesment			V
3	Field monitoring of deforestation			V
4	Field monitoring of forest degradation			V
B. Peat Survey Measurement, Analysis and Monitoring				
1	Peat thickness measurement and sampling	V		
2	Peat Analysis	V		
3	Elevation measurement	V		
4	Peat Subsidence Monitoring (Consolidation and Compaction)	V		
C. GHGs Emission Estimation				
1	GHGs Emission Measurement from peat decomposition		V	
2	GHGs Emission Estimation from Burning/fires			V
3	GHGs Emission Estimation from Dicths and open water Body			V
D. Hydrology Survey Measurement and Monitoring				
1	Water table depth monitoring	V		
2	Canal/dicth survey	V		
3	Water Quality (pH, COD, BOD)	V		
E. Meteorological Monitoring (weather Station)				
1	Precipitation data collection/monitoring	V		
2	Soil and Air temperature	V		
3	Wind measurement (anemometer)	V		
F. Biodiversity Survey and monitoring				
1	Biodiversity Survey/Monitoring		V	
2	Flora survey		V	
3	Fauna survey			V
G. Community Development				
1	Community Meeting	V		
2	Community Mapping	V		
3	Village Planning and Monitoring (CD)	V		
4	Livelihood Assessment	V		
5	Social baseline Survey	V		
6	Complaint and grievance response mechanism	V		
H. Fire Prevention and Control				
1	Fire Prevention SOP and Manuals	V		
2	Fire suppression SOP and Manuals	V		
3	Post Fire SOP and Manuals	V		
I. Restoration and Rehabilitation-RE				
1	Hydrology Restoration			V
2	Forest Restoration	V		
J. Administration				
1	Licensing (*Dolapkeu*)		V	
2	Payroll	V		
3	Employment	V		
4	Recruitment	V		

SOP (Standard Operation Procedure)		Status		
		Complete	Draft	Planned
5	Employee training	V		
6	Internal supervision/control	V		
7	Health and worker safety	V		
J. Others				
1	Use of Efficient Technology			V
2	Knowledge management			V
3	Forest protection	V		
4	Research and development			V
5	Field visit			V
6	Data management and reporting system			V
7	Internship program			V

APPENDIX 9. CLIMATE MRV TRACKER

The Climate MRV tracker lists all parameters available at validation and/or to be monitored and their monitoring frequency as required by the VCS methodology VM0007. They are presented in an Excel format and available to validators upon request.

APPENDIX 10. COMMUNITY MRV TRACKER

The Community MRV tracker lists all parameters (i.e., monitoring indicators) to be monitored by the Katingan Project and their monitoring frequency. They are presented in an Excel format and available to validators upon request.

APPENDIX 11. BIODIVERSITY MRV TRACKER

The Biodiversity MRV tracker lists all parameters (i.e., monitoring indicators) to be monitored by the Katingan Project and their monitoring frequency. They are presented in an Excel format and available to validators upon request.

LIST OF ANNEXES

Annexes are provided in separate documents and available upon request.

ANNEX 1. CLIMATE AND HYDROLOGY OF THE PROJECT AREA

Annex 1 explains basic climate and hydrology of the project area including: precipitation and evapotranspiration, aquifer, and drainage pattern. A short description of local alteration of topography (minidome) caused by drainage, and its relevance with rewetting activities is also included.

ANNEX 2. COMMUNITIES IN THE PROJECT ZONE

Annex 2 describes the socioeconomic conditions of the project-zone communities.

ANNEX 3. HCV ASSESSMENT AND BIODIVERSITY IN THE PROJECT ZONE

Annex 3 provides the result of HCV and biodiversity assessment in the project zone.

ANNEX 4. CLIMATE PARAMETERS MONITORING DESIGN

This annex describes methods for measuring CO2 and CH4 fluxes and emissions, water table depth, subsidence, soil moisture content, soil and water temperatures, precipitation, air temperature, relative humidity, barometric pressure, wind speed, wind direction, evapotranspiration, channel flow, channel slope, and channel dimension.

ANNEX 5. METHOD AND RESULT OF 1D STEADY STATE WATER TABLE MODELLING ALONG CROSS SECTION PERPENDICULAR TO HANTIPAN CANAL

Annex 5 describes method and result of modelling water table depth along cross sections perpendicular to Hantipan canal with 60 days without rainfall scenario using 4 hydraulic conducitivy values. The modelling result was used in estimating significant drainage impact dinstance from canal.

ANNEX 6. HYDROLOGICAL MODELLING METHOD

Annex 6 describes model schematization, methods for ground water flow simulation, channel flow simulation, and model calibration. A short description on the importance of hydrological modelling for refining project stratification is also included.

ANNEX 7. METHODS FOR MEASURING PEAT THICKNESS AND MAPPING PEAT DISTRIBUTIONS

Annex 7 describes methods for peat thickness measurement in field as well as auger used is described in detail. Based on measured peat thickness the generation of peat thickness map, by using supporting data and geomorphological correlation analysis is described.

ANNEX 8. LEVELLING AND DEM CREATION METHOD

Annex 8 describes levelling measurements in the field, correlating relative elevation to mean sea level datum, as well as method for creating digital elevation model by using geomorphological correlation analysis is described .

ANNEX 9. DRAINABILITY ELEVATION LIMIT MAPPING METHOD

Annex 9 provides drainability elevation limit concept and generation of drainability elevation limit map based on water level elevations of the nearest water body.

ANNEX 10. PEAT BULK DENSITY MEASUREMENT AND STATISTICAL ANALYSIS METHOD

Annex 10 describes detailed method of peat bulk density measurement in field as well as instrumentation. Analisis results based on field surveys in 2010 – 2011 are also presented along with statistical analysis method and summary statistics of bulk density.

ANNEX 11. SPECIFIC PROXY DEVELOPMENT METHOD

The Site-specific proxy development method in general includes processes of correlation of GHG emissions versus water table depth, soil moisture content, and soil temperature at different land cover types. Correlation between subsidence versus measured CO2 and CH4 emissions is also treated. Validation of landuse-hydrologically-based CHG emissions by subsidence-based emissions is described. Connetion of proxied GHG emissions with hydrological modelling is also presented

ANNEX 12. UNCONTROLLED BURNING ANALYSIS METHOD

This annex describes measurement of burn scar boundaries and determination of burning repetition in project scenario. Estimation of peat and above ground biomass burnt are also treated. Modelling high risk areas in baseline scenario based on a stochastic model of burning frequency in relation to distance to human access is given.

ANNEX 13. SUBSIDENCE CALCULATION METHOD

The basic concept of Initial subsidence due to compaction and consolidation is explained. Consolidation. Compaction and compression equations are given. Subsidence due to mass loss in microbial decomposition of peat is also presented. Total subsidence is treated as the summation of all subsidence component.

ANNEX 14. COMBINATION-ELIMINATION PROCESS FOR IDENTIFYING RELEVANT WRC STRATA

This covers combination-elimination process of identifying, combining and eliminating irrelevant and impossible strata. By this process intial strata for baseline and project scenario as well subsequent strata for baseline scenario are treated.

ANNEX 15. MONITORING METHODS OF ABOVEGROUND BIOMASS

This annex describes the overview of plot types established in project area, parameter to be monitored, field team arrangement, equipment needed for measurement, monitoring schedule, and procedures for field measurement.

ANNEX 16. NASA MODIS FIRE HOT SPOT LOCATIONS IN PROXY AREAS

This annex describes hot spot locations in seven proxy areas for determining the frequency and percentage of burnt areas per year for simulating annual area burnt in the baseline scenario.

ANNEX 17. UNCERTAINTY ANALYSIS

Annex 17 provides a detailed calculation of uncertainty in excel spreadsheet.

REFERENCES

[1] Carlson, K. M., L. M. Curran, G. P. Asner, et al. (2013). Carbon emissions from forest conversion by Kalimantan oil palm plantations. Nature Climate Change. 3: pp. 283-287.

[2] Ludang, Y. and H. Jaya (2007). Biomass and Carbon Content in Tropical Forest of Central Kalimantan. Journal of Applied Sciences in Environmental Sanitation. 2(1): pp.7-12.

[3] Nila, E.S., E. Rustandi & R. Heryanto (1995). Peta Geologi Lembar Palangkaraya, Kalimantan 1:250,000. Pusat Penelitian dan Pengembangan Geologi, Bandung, Indones

[4] Siran S. A., Naito R., Dharmawan I. W. S., Subarudi, and Setyawati T. (2012). Methodology Design Document for Reducing Emissions from Deforestation and Degradation of Undrained Peat Swamp Forests in Central Kalimantan, Indonesia. Forestry Research and Development Agency (FORDA). Bogor, Indonesia.

[5] Sulistiyanto, Y (2004). Nutrient dynamics in different sub-types of peat swamp forest in Central Kalimantan, Indonesia. PhD Thesis. University of Nottingham. Nottingham. P.388.

[6] Badan Pusat Statistik (BPS) Kabupaten Kotawaringin Timur. (2010). Statistik Daerah Kecamatan

[7] Badan Pusat Statistik (BPS) Kabupaten Katingan. (2009). Katingan District Village Monograph 2009.

[8] Harrison M. E., Hendri, Dragiewicz M. L., Krisno, Cheyne S. M. and Husson S. J. (2010). Baseline Biodiversity and Ape Population Assessment and Preliminary Monitoring Protocol in the Katingan Peat Swamp, Central Kalimantan, Indonesia. Report produced by the Orangutan Tropical Peatland Project for PT. Rimba Makmur Utama / PT. Starling Asia, Palangka Raya, Indonesia.

[9] Harrison M. E., Kursani, Santiano, Hendri, Purwanto A. and Husson S. J. (2011). Baseline Flora Assessment and Preliminary Monitoring Protocol in the Katingan Peat Swamp, Central Kalimantan, Indonesia. Report produced by the Orangutan Tropical Peatland Project for PT. Rimba Makmur Utama / PT. Starling Asia, Palangka Raya, Indonesia.

[10] IUCN. (2009). Pseudibis davisoni. In: (Eds). IUCN 2010. IUCN Red List of Threatened Species. Version 2010. 1. URL:www.iucnredlist.org.

[11] Tropenbos. (2008). Panduan Identifikasi Kawasan Bernilai Konservasi Tinggi di Indonesia. Konsorsium Revisi HCV Toolkit Indonesia. Tropenbos International Indonesia Programme.

[12] IUCN/SSC. (2013). Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

[13] VCS Methodology VM0007. (2015). REDD Methodology Framework (REDD-MF). Version 1.5. URL: http://www.v-c-s.org/sites/v-c-s.org/files/VM0007%20REDD-MF%20v1.5.pdf

[14] Kasischke, E.S, Melack, J.M. and Dobson, M.C. (1997). The use of imaging radars for ecological applications-a review. Remote Sensing of Environment, vol. 59, issue 2, 141-156.

[15] IPCC. (2003). Good Practice Guidance for Land Use, Land-Use Change and Forestry. J., Penman, M. Gytarsky, T. Hiraishi, T. Krug, D. Kruger, R. Pipatti, L. Buendia, K. Miwa, T. Ngara, K. Tanabe, and F. Wagner. (eds). IGES, Japan.

[16] IPCC. (2014). 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland

[17] UNFCCC. (2007). Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities: Version 1. URL: https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf.

[18] Ambar, T. R., Hamidy, R., and Thamrin. (2008). Pendugaan Kandungan Karbon pada Acacia crassicarpa di Hutan Rawa Gambut. Journal of Environmental Science, University of Riau, 26-32.

[19] Hooijer, A., Page, S., Jauhiainen, J., Lee, W. A., Lu, X. X., Idris, A., et al. (2012). Subsidence and carbon loss in drained tropical peatlands. Biogeosciences, 9 , 1053–1071.

[20] Kehutanan, K. (2010). Rencana Strategis Kementerian Kehutanan Tahun 2010-2014. Jakarta: Kementerian Kehutanan Republik Indonesia.

[21] Verchot, L. V., Petkova, E., Obidzinski, K., Atmadja, S., Yuliani, E. L., Dermawan, A., et al. (2010). Reducing Forestry Emission in Indonesia. Bogor, Indonesia: CIFOR.

[22] Purba, C. P., Nanggara, S. G., Ratriyono, M., Apriani, I., Rosalina, L., Sari, N. A., et al. (2014). Potret Keadaan Hutan Indonesia 2009-2013. Bogor: Forest Watch Indonesia.

[23] BPS. (2014). Kalimantan Tengah in Figures 2014. Palangkaraya: BPS Provinsi Kalimantan Tengah.

[24] Afriyanti, D., Rais, D. S., Sari, N. M., & Suryadiputra, I. N. (2015). Inventarisasi Sebaran Perkebunan Kelapa Sawit di Lahan Gambut Sumatra Selatan, Jambi dan Kalimantan Tengah. Bogor: Wetlands International.

[25] GGGI. (2005). Costs and Benefits of Investing in Ecoystem Restoration and Conservation: Green Growth Opportunities in Katingan Peatlands. Seoul: GGGI.

[26] Ministry of Forestry. (2014). Perkembangan IUPHHK-HTI S/D MEI 2014. URL: http://www.hutan-aceh.com/system/publications/documents/000/000/060/original/Daftar_IUPHHK-HTI_Definitif_Mei_2014.pdf?1416937554.

[27] Wahyunto, S. Ritung dan H. Subagjo (2004). Peta Sebaran Lahan Gambut, Luas dan Kandungan Karbon di Kalimantan / Map of Peatland Distribution Area and Carbon Content in Kalimantan, 2000 – 2002. Wetlands International - Indonesia Programme & Wildlife Habitat Canada (WHC).

[28] Ministry of Environemnt and Forestry. (1995). Keputusan Mentri Kehutanan Nomor: 70/Kpts-II/95 tentang pengaturan tata ruang hutan tanaman industri.

[29] Page, S., K. Tansey, P. Navratil, A. Hooijer, and N. Mawdsley. 2014. Measuring emissions from peat fire: Commentary on a proposed methodology for Indonesia. Report for the Indonesia-Australia Forest Carbon Partnership, IACP, Jakarta.

[30] Couwenberg, J. Thiele, A. Tanneberger, F. Augustin, J. Barisch, S. Dubovik, D. Liashchynskaya, N. Michaelis, D. Minke, M. Skuratovich, A. and H. Joosten. (2011). Assessing greenshouse gas emissions from peatlands using vegetation as a proxy. 674 (1), pp 67-89. Springer. Netherlands.

[31] Haruni, K. and R. Imanuddin. 2012.Carbon stock estimation of aboveground pool based on forest inventory(permanent sample plot) data: a case study in peat swamp forest in Jambi

[32] UNFCC. (2013). A/R methodological tool 15. Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity: Version 02.0. URL: http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-15-v2.0.pdf.

[33] DFID (1999). Sustainable Livelihood Guidance Sheets. United Kingdom Department for International Development: London.

[34] Margoulis, R. and N. Salafsky (1998). Measures of success: designing, managing, and monitoring conservation and development project. Island press, Washington DC.

[35] Henry, C., M. Sharma, C. Lapenu, and M. Zeller (2003). Microfinance poverty assessment tool. Washington DC: The World Bank.

[36] UNDP (2010). The Human Development Report 2010: The Real Wealth of Nations: Pathways to Human Development. 20th Anniversary Edition. United Nations Development Programme, New York.

[37] Badan Pusat Statistik. 2010. URL: http://www.bps.go.id/linkTabelStatis/view/id/1489.

[38] Earth Observing System Data and Information System (EOSDIS). (2009). Earth Observing System Clearing House (ECHO) / Reverb, Version 10.X [online application]. Greenbelt, MD: EOSDIS, Goddard Space Flight Center (GSFC) National Aeronautics and Space Administration (NASA). URL: http://reverb.earthdata.nasa.gov

[39] S.Manuri,et.al. Tree biomass equations for tropical peat swamp forest ecosystems in Indonesia. Forest Ecology and Management 334 (2014) 241–253

[40] UNFCCC (2010). A/R Methodological Tool: Calculation of the number of sample plots for measurements within A/R CDM project. Version 2.1. Available online at:
activitiesî https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf

PHOTO CREDIT

Cover photo.
© Dihim – Photovoices Katingan Doc

Page 20.
Left: © M. Zainuddin – Photovoices Katingan Doc
Right: © Rumi Naito

Page 21.
Above: © Malik Ar-Rahiem
Bottom: © Rumi Naito

Page 22.
Left: © Karyadie – Photovoices Katingan.doc
Right: © Bambang Susanto – Photovoices Katingan.doc

Page 23. © Ruslan – Photovoices Katingan.doc

Page 32. © Rumi Naito

Page 36.
Left: © Ningkui Kambran – Photovoices Katingan Doc
Right: © Suharman – Photovoices Katingan Doc