ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PROCESS OF THE MOZAMBICAN INTEGRATED TRANSMISSION BACKBONE SYSTEM (STE PROJECT) – PHASE 1: VILANCULOS - MAPUTO

ENVIRONMENTAL IMPACT STUDY

FINAL REPORT

VOLUME I – INTRODUCTION, PROJECT DESCRIPTION AND BASELINE ASSESSMENT

ELECTRICIDADE DE MOÇAMBIQUE, E.P.

Illuminating the Transformation of Mozambique

February 2019

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February 2019

LIST OF VOLUMES

NON TECHNICAL SUMMARY

Introduction

Electricidade de Moçambique, E.P. (EDM) is planning the implementation of the Mozambican Integrated Transmission Backbone System – the STE Project. The STE Project is a major power transmission project linking the Provinces of Tete and Maputo, through extra high voltage transmission lines. The goals of this Project are to connect and integrate the current two isolated power systems in Mozambique and to allow the evacuation to the southern region of surplus power generated in the north.

Due to its complexity, EDM plans to develop the STE Project in phases. Currently, EDM is proposing the implementation of Phase 1 of the STE Project: Vilanculos – Maputo, which includes a 561 km long 400 kV line connecting these two cities, the construction of three new substations (in Vilanculos, Chibuto and Matalane) and the upgrade of the Maputo substation.

In order to obtain the Environmental License required in terms of the Environmental Law (Law No. 20/1997, of 1 October) for the development described above (hereafter the "Project"), EDM developed an Environmental and Social Impact Assessment (ESIA) Process.

This ESIA was prepared in accordance with national legislation, particularly the ESIA Regulation (Decree No. 54/2015, of 31 December) and associated decrees, as well as with the Southern African Power Pool and World Bank environmental and social policies, and international best practice ESIA standards, namely the IFC Performance Standards.

Project Description

The STE Project Phase 1 includes a new 561 km long 400 kV HVAC transmission line between Vilanculos and Maputo, the construction of three new substations - Vilanculos, Chibuto and Matalane (in Marracuene) and the upgrade of the Maputo substation (in Boane) (see **Figure 1**). The proposed alignment crosses three Provinces (Inhambane, Gaza and Maputo) and thirteen districts.

The Vilanculos – Maputo power line alignment under assessment in this ESIA is the result of a long iterative design process that has been developed during the last 10 years, through multiple engineering and environmental studies. The proposed alignment was initially evaluated in 2008, in a pre-feasibility study. The alignment was the further optimized in 2009, to which was followed a full ESIA, conducted between 2009 and 2011. As the Project didn't move forward at the time, for several reasons, the alignment was again optimized in 2015, through a Feasibility Study.

The proposed transmission line will start in the new Vilanculos substation and will end in Maputo substation (in Boane District), which wil be upgraded. The main characteristics of the proposed 400 kV transmission line are presented in **Table 1**.

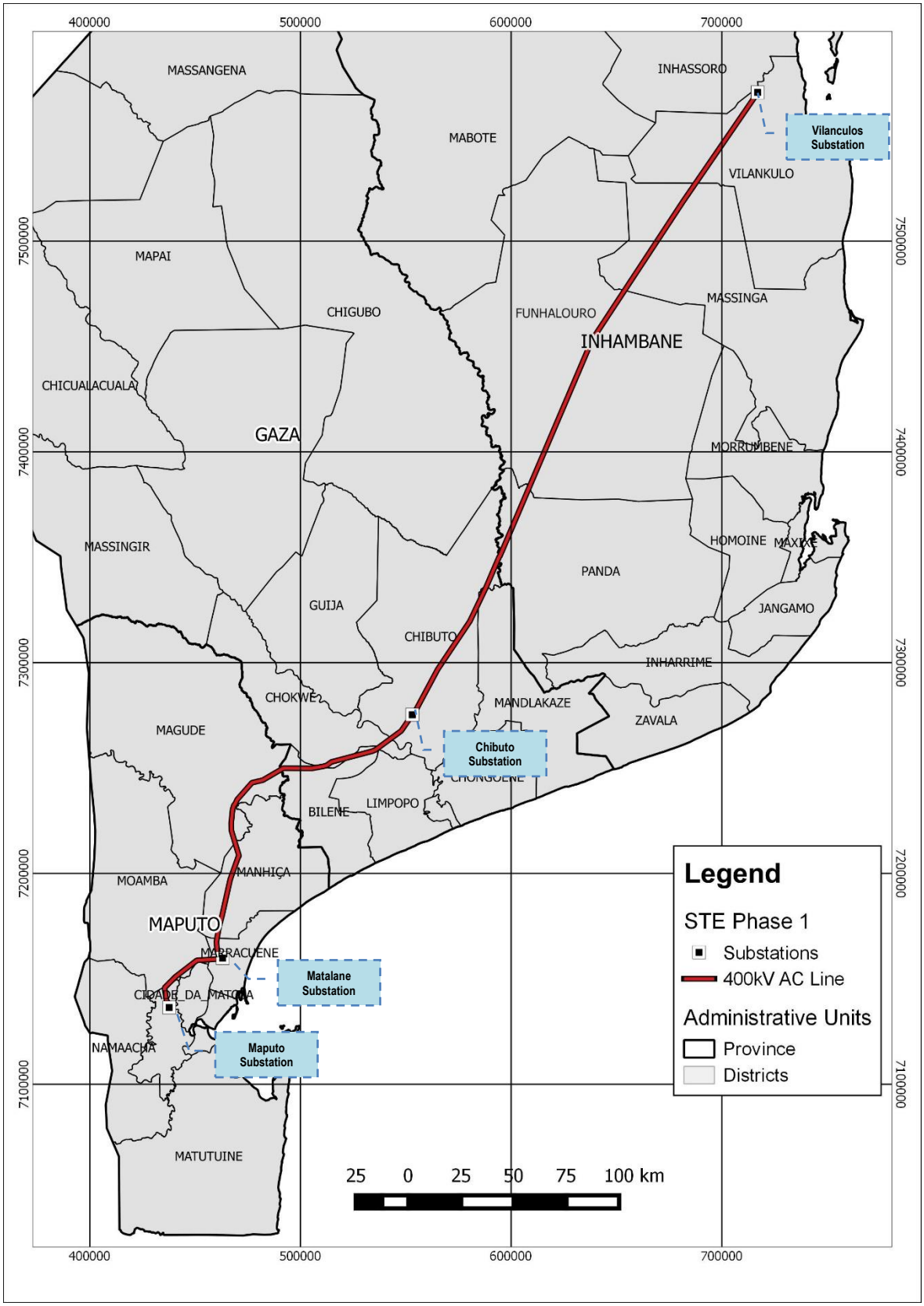


Figure 1 – Project Location

Table 1 – Main characteristics of the new 400 kV transmission line

Technical Aspect	400 kV Line
Total length	561 km
Right-of-Way (RoW) width	100 m
Type of Towers	Self-supporting and guyed V-towers
Tower spacing average	450 m
Height of the Towers	20 to 35 m
Average tower base footprint	10 m x 10 m (100 m^2)

Further to the project components described above, the implementation of the Project will require some support components and activities, namely:

- Development and maintenance of right-of-way (RoW) - a 100 m corridor (50 m to each side of the center line) will be established as the line RoW. Clearance of vegetation, as well as removal of built structures, from the RoW will be required, so as to protect the system from windfall, contact with trees and braches and other potential hazards that may result in damage to the system, power failures or forest fires. The RoW will also be utilized to access, service and inspect the overhead line (OHL);
- Construction of access roads, for line construction and maintenance purposes;
- Exploration of borrow pits to provide aggregates and inert materials;
- Establishment of construction camps, including temporary workers' accommodation and temporary storage sites for equipment and materials.

The location of temporary access roads, borrow pits and construction camps is not known at this stage. The location of these support infra-structures will be the responsibility of the construction Contractor, under the supervision of EDM. The Environmental and Social Management Plan (ESMP – Volume III of the EIS report) provides some guidance for these auxiliary infrastructures, so as to minimize their potential impacts.

The global project cost for the STE Project Phase I is estimated at 600 million USD (American dollars). Please note that this figure is an estimate and may change during detailed engineering.

Project's Areas of Influence

The baseline description and the impact assessment of the Project is based on the delineation of two study areas that cover all physical, biological and social elements that may be directly or indirectly affected by the Project or that could affect its implementation, in all of its phases. These study areas are the Project's areas of influence, including an area of direct influence (ADI) and an area of indirect influence (AII).

When defining these areas, it is useful to consider biophysical and socioeconomic impacts separetly. The Project's Area of Direct Influence (ADI) is delineated as follows:

- **Biophysical environment**: a 300 m wide corridor, centered on the Project's alignment, as most of the direct biophysical impacts are expected to be felt in the immediate surroundings of the footprint area;
- **Socioeconomic environment**: the communities crossed by the proposed RoW. A 2 km wide corridor centered on the line's route was assumed to encompass all crossed communities.

The Project's Area of Indirect Influence (AII) is defined as follows:

- **Biophysical environment**: a 2 km wide corridor, centered on the Project's alignment;
- **Socioeconomic environment**: the boundaries of the districts crossed by the overhead line, as benefits and impacts from Project-induced changes in the ADI are likely to extend to other communities within these territories.

Baseline Characterization

Physical Environment

The proposed route develops along the Great Coastal Plains geomorphological zone, with elevations of less than 200 m. This zone is dominated by soft sediments and covers the region south of the Save River and the coastal strip. The relief is mostly flat.

The geology of the Project area is mostly built up by sedimentary rocks, composed, from top to bottom in the stratigraphic sequence, of Cenozoic and Cretaceous rocks, overlying Karoo basalts. The Cretaceous and Tertiary units are exposed underneath a Quaternary cover, made up mostly of sandy formations.

Although central Mozambique is under the influence of the Great Rift Valley, with earthquake activity (generally of low magnitude), seismic activity in southern Mozambique, where the Project is located, is very low, as the influence of the rift doesn't reach this region.

The geologic framework (parent materials) strongly influences the pedogenetic processes, so the main soil units in the study area are alluvial soils (occurring in the floodplains of the main rivers) and sandy soils, including Mananga soils (colluvial sandy soils) and sandy soils from cover sands and interior dunes.

The proposed line is within a region with a low erosion risk. However, at local level, there may be areas where erosion may constitute an important risk, due to specific local conditions.

The proposed alignment crosses four major hydrographic basins, North to South: Govuro, Limpopo, Incomáti and Matola. The main rivers crossed include the Changane, Limpopo, Incomati and Matola rivers. Also, the Project alignment crosses Limpopo and Incomati floodplains, in large extension, in areas with cycle flood problems in the wet season.

In the Project´s area of influence, few atmospheric pollution emission sources were identified. The more significant air pollutant emission sources are biomass burning, including wild fires, slash-and-

burn agricultural practices and residential fuel burning. The ambient air quality is expected to be relatively good as the study area mainly falls in mostly undeveloped and rural areas.

The baseline ambient noise of the area of interest is in general terms mainly determined by natural noise sources (such as rain, wind, insects, etc.), low intensity road traffic and normal human activity on the settlements located along the proposed alignment. The ambient noise of the study area is expected to be typical of natural and rural areas, with low ambient noise levels complying with the adopted noise guidelines.

Biotic Environment

According to WWF; the study area encompasses three biomes: the Tropical and Subtropical Moist Broadleaf Forests biome, the Tropical and Subtropical Grasslands, Savannas, Shrublands and Woodlands biome and the Flooded Grasslands and Savannas biome. The main vegetation types found inside the study area include: miombo forest, miombo woodland, undifferentiated woodland, savannah and agricultural areas (see **Figure 2**).

Figure 2 – Illustration of vegegation types in the study area: miombo forest (up, left), miombo woodland (up, right), savannah (down, left) and agricultural area (down, right)

A total of 233 species of flora has been identified during the flora surveys. None of the species confirmed in the study area are classified as threatened, according to IUCN, but three species are classified as Near Threatened: *Dalbergia melanoxylon, Pterocarpus angolensis* and *Encephalartos ferox.* Four species are endemic: *Carissa praetermissa, Dolichandrone alba*, *Bauhinia burrowsii* and *Croton inhambanensis*.

A total of 112 mammal's species are potential in the study area, of which 18 were recorded during the field surveys. Three of the confirmed species have a global threatened status of Vulnerable, namely: leopard (*Panthera pardus*), hippopotamus (*Hippopotamus amphibious*) and African elephant (*Loxodonta africana*).

In total, 38 amphibian species have the potential to occur in the study area, according to bibliographic sources. During field work a total of 9 species of amphibians were confirmed as present in the study area. None of the listed species are globally threatened. There are also no endemic, restricted range, migratory or congregatory amphibian species in the study area.

A total of 23 reptile species are potential in the study area. During field work, it was possible to confirm the presence of 18 species, including the Nile crocodile and two vipers: puff adder (*Bitis arietans*) and lowland swamp viper (*Proatheris superciliaris*). None of the listed species for the study area are threatened, according to IUCN. There are also no endemic, restricted range, migratory or congregatory reptile species in the study area.

Overall, in the study area a total of 457 bird species can occur, according to bibliographic sources. During field work a total of 119 species were confirmed as present. Rivers, wetlands and waterbodies were the places where a high concentration of birds was observed. Of the 457 potentially occurring bird species, 150 are migratory birds, mostly Paleartic migrants that follow set migration patterns between Europe and Southern Africa in a broad North-South direction. However, no specific migratory routes are known for the Project region.

None of the confirmed species are threatened at global level. However, eight of the species listed for the study area are threatened. Four species are classified as Vulnerable: martial eagle (*Polemaetus bellicosus*), secretarybird (*Sagittarius serpentarius*), Southern ground-hornbill (*Bucorvus cafer*) and wattled crane (*Grus carunculatus*); two as Endangered: steppe eagle (*Aquila nipalensis*) and Cape vulture (*Gyps coprotheres*); and two as critically endangered: white-backed vulture (*Gyps africanus*) and hooded vulture (*Necrosyrtes monachus*).

No conservation or protected areas are interfered by the proposed alignment.

Socio-Economic Environment

The STE Project will cross the provinces of Maputo, Gaza and Inhambane and 13 Districts, namely:

- Inhambane Province: Vilanculos, Massinga, Funhalouro and Panda;
- Gaza Province: Chibuto, Mandlakaze, Chokwe and Bilene;
- Maputo Province: Magude, Manhiça, Marracuene, Moamba, Boane.

According to projections of the National Institute of Statistics (INE), in 2016 the population of the interested provinces was estimated to comprise 1,523,635 habitants (Inhambane), 1,467,951 habitants (Gaza) and 1,782,380 habitants (Maputo). Maputo Province has the highest population density of the three provinces of interest. The more densely populated district is Boane. In terms of the population age structure, all three provinces and 13 districts follow a typical age pyramid structure for developing countries, with a large young population and low elderly population.

Within the Project RoW (100 m corridor centered on the alignment), a total of 415 affected households (HH) were identified (i.e. people with houses or other buildings within the Project's RoW). The age distribution is similar to that of the encompassing districts, with a large number of young people, and low number of elders.

The three main ethnic groups in Inhambane Province are the Bitongas, Chopi and Chitsuas. The four main ethnic groups in Gaza Province are the Changane, Tsonga, Chopi and Ronga. The main ethnic group in the Maputo Province is the Tsonga. However, due to the fact that Maputo Province is the main economic and financial centre of Mozambique, it has become an attractive centre for people seeking employment and better opportunities. As a result, there is a great diversity of ethnic groups in Maputo Province.

This multi-ethnicity is also manifested in the great diversity of religious affiliations in the three Provinces. Christianity (including several different traditions) and Islam are the two major religions, representing, respectively, 86.5% and 9.8 % of the population of these three Provinces.

In what regards the HHs within the RoW, most belong to the Changane ethno-linguistic group (67%). This reflects the fact that the majority of these HHs are located in Maputo Province. In terms of religion, the HHs living within the Project RoW differ from the pattern described for the rest of the districts and provinces, with a greater number of evangelic practitioners (32%), followed by Zionist (32%) and Catholics (15.8%). Five churches are located within the RoW (**Figure 3**). No sacred places are located within the RoW, but 18 cemeteries are within or very near the RoW.

Figure 3 – Zion churches located within the Project RoW

The education system in the provinces of Inhambane, Gaza and Maputo and the 13 districts of interest follows the same trend as the rest of the country, with a focus on Primary Education as illustrated by the significantly larger number of primary education facilities in comparison with secondary. All the localities crossed by the Project have at least one primary school. Only the locality of Tenga in Moamba District mentioned been equipped with a secondary school. No school is located within the Project RoW.

The health sector in Mozambique focuses on primary healthcare services. According to INE (2013). in 2012 Inhambane Province had a total of 125 sanitary facilities, of which one was a Provincial Hospital, four were Rural Hospitals, 10 were health posts and 110 were health centers. The province of Gaza had 128 health facilities in 2012 (INE, 2013), namely one provincial Hospital, four Rural Hospitals, 29 health posts and 94 health centers. Maputo Province has a total of 85 health facilities,

namely one provincial hospital, one general hospital, one rural hospital, one district hospital and 73 health centers.

When looking at the health facilities near the Project RoW, eight localities (out of eighteen) stated having a health centre, meaning that population do not have to walk long distances to access health services. No health centre is located within the RoW. The most common diseases among the HH living within the RoW in the last 12 months were: malaria, tuberculosis, asthma, diarrhoea, cholera, STD, HIV/AID. 23% of HH stated having a HH member with a chronic illness.

In urban and peri-urban areas in the Provinces of Inhambane, Gaza and Maputo and the Districts of interest, electricity is the main source of energy and is supplied by *Electricidade de Moçambique, E.P.* (EDM), whilst water is supplied by *Águas de Moçambique* (AdeM). In the rural areas, the main source of water is usually from public taps/standpipes (*fontanários*) that are connected to the general water supply network, as well as boreholes, open wells and rivers and lagoons. With regards to sanitation, the urban and peri-urban areas have a system of individual family septic tanks. In more rural areas, the majority of the population uses latrines or open air defecation.

Among the HHs within the Project RoW, 31% of the HHs get their water from boreholes (**Figure 4**). All localities crossed by the Project have boreholes, but many of them are not in working conditions. Three boreholes were identified within the Project RoW. In what regards to water quality, 75% of the HHs do not treat water prior to using it, 18% boil water, 7% use chlorine (*certeza*). 26% of the HH within the RoW do not have any type of sanitation facilities, 52% have traditional latrines and 17% have improved latrines within their plot.

Figure 4 – Protected borehole (left) and public tap (right) in the study area

With regards to electricity, the census survey showed that only 7% of the population living within the RoW are connected to electricity from EDM. Energy sources used by the HH to illuminate the house include candles (17%), kerosene (20%) and torches (19%). For cooking, the main sources of energy are fire wood (72%) and charcoal (15%).

In the provinces and districts of interest, as in the rest of the country, the most important economic activity is agriculture (**Figure 5**). Most of the Mozambican population is dependent on subsistence farming for their survival. Other economic sectors in the provinces include fishing, tourism and industry, and in the last years the natural resources sector has being increasing substantially with

the natural gas exploration in Vilanculos district, in Inhambane Province and the heavy sands prospection in Chibuto District, Gaza Province.

Figure 5 – Agriculture and livestock keeping is the most important economic activity in the study area

Regarding the economic activities practiced by the population living within the Project RoW, the census survey showed that a large number of the heads of HH are farmers (33.3%). Other occupations such as construction worker, housekeeper, guard, commerce were also mentioned. When the head of the HH were asked what their main income source is, 26% mentioned from the sale of the crops cultivated in their fields, 13% mentioned that they're employed in formal sector and 7% said from sales of goods in the informal sector.

Cultivation methods used by the HH are, in general, rudimentary and manual. Most HH (87.5%) do not use inputs such as improved seeds, fertilizers or pesticides. Agriculture in the survey area is predominantly rainfed and developed in semi-arid lowlands and occasionally at the bottom of small slopes. During the fieldwork, a total of 88 farms were identified, of which four were considered as commercial and are dedicated to sugar cane plantation.

When looking at the income level of the surveyed HH, it was found that most of them have a low income, with the majority of the HH stating a monthly income lower than 5,000.00 Meticais (roughly 83 USD/month). With an average of 4.2 members per HHH, this income is below the poverty line of 120 meticais, per day, per person (2 USD/day) stipulated by the United Nations.

Public Participation Process

A Public Participation Process (PPP) was implemented to support the development of the Project's ESIA. General objectives of this process were to:

- Ensure the early and informed consultation of stakeholders at key stages of the ESIA, in order to improve their results and increase the credibility of the process.
- Ensure compliance with national and international requirements for stakeholder engagement and public consultation during ESIA studies for major projects.
- Ensure the ESIA helps to consolidate the efforts made by EDM in order to establish lasting relationships with affected communities and other stakeholders.

In accordance with legal requirements, the PPP included consultation in two phases: early in the ESIA process (in the scoping phase; Environmental Pre-Feasibility and Scope Definition Study - EPDA Phase) and again in the Environmental Impact Study (EIS) Phase. The overall PPP strategy includes:

- The disclosure and availability of documentation for a 30 day period (15 days prior to and post public meetings);
- Public meetings and other stakeholder engagement activities; and
- Inclusion of issues raised in the public meetings on the reports drafted as part of the ESIA process.

The EPDA phase PPP for the STE Project was undertaken in May 2017. During the EPDA PPP activities, the main issues, suggestions and comments raised by stakeholders were related to the following issues:

- Criteria used to define the transmission line alignment and the locations for the substations;
- Rural electrification of communities along the Project's alignment;
- Desirability of the Project and ways in which the transmission line will improve the ease of access to energy and the quality of that access;
- Criteria used to define the transmission line right-of-way (RoW), socioeconomic impacts resulting from the clearing of the RoW and methodologies to be used to compensate the persons affected by the RoW clearing;
- Interferences between the transmission line and existing infrastructure;
- Biodiversity impacts associated with the RoW clearing;
- Use of local workers and suppliers in the construction works.

The EIS phase PPP was undertaken in November 2018. The main issues, suggestions and comments raised by stakeholders were related to the following issues:

- Criteria used to define the transmission line alignment. Consideration of the risks of natural disasters (cyclones and earthquakes) in the project design;
- Rural electrification of communities along the Project's alignment;
- Line maintenance and RoW inspection procedures, including planned response to RoW encroachment;
- Desirability of the Project and ways in which the transmission line will improve the ease of access to energy and the quality of that access;
- Interferences between the transmission line and existing infrastructure (gas pipelines);
- Biodiversity impacts associated with the RoW clearing and opening of new access roads;
- Potential impacts on sacred sites, including graves and cemeteries;
- Potential impacts on irrigated lands;
- Use of local manpower in the construction works;
- Resettlement impacts and the resettlement process.

Chapter 8 of this EIS (**Volume II**) includes a comment / response register that details all comments and suggestions received during the PPP and the way they were considered and/or addressed in the EIA process. **Volume V** of this EIS presents the PPP report.

Impact Assessment and Mitigation Measures

The tables below summarize the assessment of the Project's main impacts. Negative impacts are coded in shades of yellow or red, while positive impacts are coded with shades of green. Further to the impacts listed in the table below, several other impacts were identified and assessed in the EIS, but were deemed to be of very low or insignificant significance, prior to mitigation. Those impacts were not included in the table below, but their assessment is provided in the main report (see **Volume II** of the EIS).

Table 1 – Summary of Project Impacts in Construction Phase

Impact Description	Significance Rating		Main Mitigation Measures
	Pre-mitigation	Post-mitigation	
Noise impact from construction activities.	**LOW**	**VERY LOW**	- Speed limits for construction heavy vehicles should not exceed 30 km/h near residential areas; - Construction activities should be limited to the daytime period of working week days, whenever possible.
Impacts on irrigation lands and on soils with suitability for irrigation	**MEDIUM**	**LOW**	- The sitting of transmission facilities must seek to avoid to the maximum extent possible areas of high irrigation suitability; - Learning about individual farm field activities, such as planting, tillage, and crop rotations so that construction methods and timing can be adapted to the timing of crop work.
Increased soil erosion and compactation	**LOW**	**VERY LOW**	- Restrict vegetation clearing and topsoil removal to the areas strictly required for construction; - Strip and store topsoil prior to earth moving activities for later reuse in rehabilitation works.
Potential pollution of surface waters during the construction phase.	**LOW**	**VERY LOW**	- Avoid the movement of machinery on river beds and floodplain areas, as much as possible; - Implement adequate management and treatment of wastewater; - Develop and implement a Waste Management Plan for the construction phase.
Temporary degradation of landscape at worksites.	**LOW**	**VERY LOW**	- Promote the selection of areas with less of a need for tree cutting for temporary work and storage areas; - Rehabilitate and revegetate temporary access road and work areas as soon as possible.
Direct loss of vegetation units and habitats.	**HIGH**	**MEDIUM**	- Realign the line route, to avoid the area of critical habitat (miombo forest patch located in Massinga District – please see the impact assessment on section 7.9.1.2 of Volume II for more information on the line reroute to be implemented); - Strictly limit the clearing of vegetation to the required areas, particularly in areas of natural habitats.

Impact Description	Significance Rating		Main Mitigation Measures
	Pre-mitigation	Post-mitigation	
Degradation of nearby vegetation units during construction.	**LOW**	**VERY LOW**	- Limit disturbance outside site boundaries; - Limit non-Project vehicles entrance in the construction area to avoid invasive and ruderal species dispersion and entrance of people that can exploit illegally natural resources.
Impacts on wetlands and riverine areas.	**LOW**	**VERY LOW**	- Design tower structures to minimize impacts / areas of disturbance in wetlands, river banks, river beds and waterbodies; - Avoid movement of heavy machinery in wetlands, river banks, river beds and waterbodies; - Delimitate the perimeter of rivers, wetlands and waterbodies close to construction areas with construction tape.
Reduction of feeding, breeding and roosting areas for regional fauna.	**LOW**	**LOW**	- Vegetation clearance activities should be accompanied by an ecology/biology specialist; so as to detect any bird roosting and/or nesting sites close to the clearance areas and implement cautionary measures.
Increased fauna mortality and decreased species diversity	**LOW**	**VERY LOW**	- During induction sessions inform workers of biodiversity importance and commitment of the Project to it, in order to avoid run over animal on purpose; - Vegetation removal activities should be accompanied by an ecology/biology specialist, to minimize as much as possible the death of tree roosting animals.
Possible introduction or spread of invasive species in the Project area	**MEDIUM**	**LOW**	- Forbid people and vehicle movements outside Project accesses; - Whenever possible new and temporary accesses should be created based in existent accesses; - Monitor and control the presence and expansion of invasive flora species along the RoW.
Loss of dwellings and other built infrastructure in the RoW	**HIGH**	**MEDIUM**	- Before the start of activities, put into effect an encroachment control program, in articulation with local authorities, to avoid the construction of new dwellings in the Project area; - Develop and implement a comprehensive RAP compliant with Mozambican Legislation and WB OP 4.12.
Disturbance to farming areas due to powerline construction and establishment of right-of-way	**MEDIUM**	**LOW**	- Optimize the STE alignment during the final engineering design phase, in order to minimize as much as possible the interference with farming areas; - Develop and implement a compensation plan, to adequately compensate for any losses of crops due to powerline construction.
Transfer of skills to local communities due to mobilization of construction workforce	**MEDIUM**	**MEDIUM**	- The construction contractor should provide technical training programs for unskilled workers, with the objective of improving their job performance and giving them the skills to compete for other positions; - The construction contractor should provide environmental, health and safety training to all workers.
Local and regional economic stimulation due to construction expenditure and increased workforce income	**LOW**	**LOW**	- The procurement of goods and services by the construction contractor should give priority to sourcing from the local and provincial markets, whenever possible.

Impact Description	Significance Rating		Main Mitigation Measures
	Pre-mitigation	Post-mitigation	
Loss of cultural heritage sites	HIGH	LOW	- Affected religious temples will be relocated or compensated for, as part of the Project RAP; - Affected cemeteries will be relocated to a new location, as part of the Project RAP, in agreement with local communities, and following all required cerimonies and traditional practices; - The Contractor will implement a Chance Find Procedure, to safeguard any archaeological finding that may be uncovered during construction.
Security concerns increase due to the traffic volume increase	LOW	VERY LOW	- Construction heavy vehicles must abide by a 30 km/h speed limit near residential areas; - Install temporary official traffic signs on local roads around the work fronts before and during the execution of the works together with local transit authorities.
Potential increase of community conflicts due to the influx of migrant workers	MEDIUM	LOW	- The contractor should implement a Local Recruitment Plan, to ensure that procurement processes are conducted in a transparent and fair manner, in coordination with local authorities and community leaders; - EDM will develop a Communication Plan, to be able to interact with the communities, informing them of the nature and timing of the activities, and establishing communication channels to manage any social conflicts that may arise.
Increased risk of transmission of STDs due to workforce mobilization and population influx	MEDIUM	LOW	- The Contractor should develop a management plan for the prevention of HIV / AIDS and STD and implement awareness campaigns for counseling, testing, care, treatment and prevention (condom distribution) among the workforce; - EDM will interact with the Provincial and District Directorates of Health and local NGOs specialized in the subject, to support similar campaigns among local communities in general.
Potential impacts on workers' health and safety during the construction phase.	MEDIUM	VERY LOW	- The Contractor will develop and implement an Emergency Response Plan - The Contractor will develop and implement a Health and Safety Management Plan to protect every worker involved in construction activities, even temporary workers. This plan should comply with national legislation and WBG General EHS Guidelines and WBG Industry Sector Guideline for Electric Power Transmission.

Table 2 – Summary of Project Impacts in Operational Phase

Impact Description	Significance Rating		Mitigation / Enhancement Measures
	Pre-mitigation	Post-mitigation	
Wind-generated noise emissions.	LOW	VERY LOW	- Regular maintenance of the transmission line components.
Noise emissions from corona discharge.	LOW	LOW	- Regular maintenance of the transmission line components, such as insulators.

Impact Description	Significance Rating		Mitigation / Enhancement Measures
	Pre-mitigation	Post-mitigation	
Noise emissions from substation operations.	LOW	LOW	- Within the substation projected area, locate noisy equipment's away, as much as possible, from the identified nearby residential areas; - Conduct regular maintenance of the substation transformers in order to minimize noise emissions as much as possible.
Potential pollution of surface waters during the operational phase.	LOW	VERY LOW	- Maintain substation equipment in good running condition, free of leaks, excess oil and grease; - Regularly inspect all equipment at the substations that may contain contaminants, such as transformers; - Develop and implement a Waste Management Plan.
Permanent alteration to the landscape	MEDIUM	LOW	- Minimize the number of permanent access roads to and in the RoW, when possible, proceed to early closing and rehabilitation of access roads near sensitive scenic areas; - Allow tree and shrub species whose height is limited to 3 m to grow within the RoW; - If complaints are received, from local communities or other stakeholders, regarding a negative visual impact created by the transmission line, create visual barriers to reduce line visibility in sensitive areas, if feasible.
Indirect degradation of vegetation units and habitats along the RoW	HIGH	MEDIUM	- Limit non-Project vehicle entrance and circulation along the RoW, as much as possible, through the placement of signalization; - Coordinated intervention by relevant Government Departments to enforce restrictions on uncontrolled settlement and agricultural expansion, clearance of woodland, and enforcement on controls on hunting, charcoal and timber cutting.
Increased mortality of bird and bat species due to collisions and electrocution	HIGH	MEDIUM	- Adopt control measures in the design of line and towers, including: o Signal lines with 35cm diameter BFD near rivers and wetlands and along large undisturbed forest or woodland areas; o Isolation of all conductors, to avoid electrocution; o Install anti-landing devices in tower close to wetlands, river and waterbodies.
Habitat fragmentation due to the presence of the RoW	MEDIUM	LOW	- Limit disturbance outside maintenance area boundaries; - Limit vegetation clearance to the area required. Complete vegetation clearance should be restricted to the 30 m corridor; - Outside of the 30 m full clearance corridor, allow tree and shrub species whose height is limited to 3 m to grow. Apply selective removal of tall-growing tree species only; - Avoid clearing in riparian areas, thus allowing rivers to maintain their function as ecological corridors.
Local and regional economic stimulation, due to increase in power supply	HIGH	HIGH	- EDM should ensure the standard maintenance program for the STE Project.
Risks to community health and safety due to encroachement into the RoW	MEDIUM	VERY LOW	- Monitor encroachment of infrastructure into the RoW and strictly enforce the RoW restrictions.
Potential impacts on workers' health and safety during the operational phase.	HIGH	LOW	- Implement EDM's existing health and safety policies and procedures for the operation of substations and transmission lines.

As shown in the previous tables, the main ***negative impacts*** of the Project are mostly associated with the clearance and establishment of the RoW. The Project's negative impacts with medium residual significance or greater include:

- The direct loss, degradation and fragmentation of important habitats and vegetation (mostly woodland habitats) caused by vegetation clearance in the RoW, particularly in the northern half of the alignment, closer to Vilanculos, where unfragmented large areas of woodland habitats still exist;
- The indirect additional degradation of natural habitats (mostly woodland habitats), along the RoW during the operational phase, in particular due to the expanse of agriculture and natural resources exploitation along the RoW, given the increased ease of access to presently inaccessible areas. This is again more relevant to the northern half of the alignment, as currently these areas are mostly inaccessible by local populations; and
- The direct ressetlement impacts caused by the establishment of the RoW, generating the need to relocate 415 families and compensate for affected built structures, farm lands and fruit trees;
- Increased mortality of birds (particularly birds with large wing spans), due to collisions and electrocution with the line and towers.

Mitigation measures were defined to avoid or minimize the predicted impacts, of which the more relevant include a minor realignment of the line, in order to avoid a patch of critical habitat (miombo forest), the development of a RAP and the adoption of control measures in the design of line and towers, to minimize bird collisions. The mitigation of the indirect impact (expansion of population along the RoW during the operational phase) will require coordinated effort by several government agencies, to avoid the establishment of settlements in more sensitive areas and to control human activities with the potential to impact on biodiversity, such as hunting, harvesting, farming, etc.

In what regards ***positive impacts***, two significant impacts were identified, both regarding the socioeconomic environment, which can be essentially summarized as follows:

- The transfer of know-how and skills to the unskilled local workers that will be employed by the Project will result in a long-term benefit for these families, and for the local workforce in general. This was assessed as a medium significance residual positive impact;
- The increased power supply created by the STE Project will have a positive impact on the local and regional economy. On current conditions, the power supply in some areas is weak or nonexistent. The STE Project will allow for the increase of power supply in the southern region of Mozambique and will enable a better distribution of power in areas which are currently not electrified. The development of the STE Project could also create business opportunities in the industrial sector, as developers will know that the STE Project will both increase the quantity and robustness of power supply, enabling a larger number of viable industrial projects. All these vectors of economic stimulation will in turn result in the creation of jobs. This indirect effect, which is indeed the main goal of the Project, was assessed as a high significance residual positive impact.

Cumulative Impacts

Known existing and future projects, as well as known vectors of human development, could have a cumulative effect with those associated with the STE Project. The main potentially affected valued environmental components (VECs) include flora and vegetation, local communities and avifauna.

The potential effects of the present and future projects and vectors of development on the VECs were determined and their potential cumulative effect with those of the STE Project was evaluated.

The only relevant cumulative effect will be the synergistic effect of loss and degradation of natural habitats due to the expansion of urban areas, and of agriculture and natural resources exploitation, as the establishment of the RoW will enable population access to woodland areas which currently are very hard to access (as no roads exist within these large unfragmented areas of woodland). This is applicable to the northern part of the STE Project's alignment, between Chibuto and Vilanculos. In this case, as the STE Project enables and potentiates the expansion of the population, the cumulative effect is significant, in particular in the long term.

Environmental and Social Management Plan

Environmental management of a proposed activity is a crucial tool to ensure any project's environmental performance. This ESMP aims to establish the guidelines for best practice environmental management of the STE Project, through a clear definition of the environmental actions and management procedures to be implemented in each phase of Project development, as defined in the EIS.

The ESMP aims at defining and structuring the measures to be implemented in order to mitigate or enchance the Project's potential impacts. For each measure, responsibilities are presented. The environmental management plan also comprises specific management programs, which are:

- Air Quality Management Program;
- Water Resources Management Program;
- Waste Management Program;
- Biodiversity Management Program;
- Communication Plan Framework;
- Community Awareness Program;
- Project Grievance Redress Mechanism (GRM);
- Community Health and Safety Management Plan;
- Cultural Heritage Chance Finds Procedure;
- Emergency Response Plan.

Further to the programs listed above, the Contractor will be required to develop and implement a number of additional management plans for the construction phase, including:

- Camp and Housing Management Plan;
- Security Management Plan;
- Borrow Pit and Quarry Management Plan;

- Access Roads Location and Management Plan;
- Soil and Erosion Management Plan;
- Traffic Management Plan;
- Local Recruitment Plan;
- Local Procurement Plan;
- Training and Skill Transfer Program;
- Health and Safety Management Plan;
- Rehabilitation and Revegetation Plan;
- Contractors' GRM for Communities and Workers.
- Method Statements, including, but not limited to: erosion control, water crossing, work in heights, and others that may be required by the Environmental, Social and Communication Control Manager (ESCMM).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

LIST OF ACRONYMS AND ABBREVIATIONS

ADI	Area of Direct Influence
AII	Area of Indirect Influence
ANAC	National Administration of Conservation Areas
ANE	National Administration of Roads
AoI	Area of Influence
ARENE	Energy Regulatory Authority
BIP	Beluluane Industrial Park
AQUA	National Agency for the Control of Environmental Quality
CITES	Convention on the International Trade of Flora and Fauna Species
CFC	Chlorofluorocarbons
CH_4	Methane
CMS	Convention on Migratory Species
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DINAB	National Directorate of Environment
DINOTER	National Directorate of Land Planning and Resettlement
DNE	National Directorate of Electricity
DNG	National Directorate of Geology
DPTADER	Provincial Directorates of Land, Environment and Rural Development
DUAT	Land Use and Development Right
EBA	Endemic Bird Area
EDM	*Electricidade de Moçambique, E.P.*
EHS	Environmental Health and Safety
EHV	Extra High Voltage
EIS	Environmental Impact Study
EPDA	Environmental Pre-Feasibility and Scope Definition Study
EP1	Primary Education Stage 1
EP2	Primary Education Stage 2
ES	Ecosystem Service

ESIA	Environmental and Social Impact Assessment
ESG1	Secondary Education Level 1
ESG2	Secondary Education Level 2
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FAO	Food and Agriculture Organization
FS	Feasibility Study
GHG	Greenhouse Gases
GIS	Geographic Information System
GoM	Government of Mozambique
GWP	Global Warming Potential
HH	Household
HVAC	High-Voltage Alternating Current
HVDC	High-Voltage Direct Current
HWC	Human-Wildlife Conflict
I&APs	Interested and Affected Parties
IBA	Important Bird Area
IFC	International Finance Corporation
INE	National Institute of Statistics
INIA	National Institute for Research into Food and Agricultural Technology
INIR	National Irrigation Institution
IUCN	International Union for the Conservation of Nature
MGtP	Mozambique Gas-to-Power Project
MIREME	Ministry of Mineral Resources and Energy
MITADER	Ministry of Land, Environment and Rural Development
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
NTS	Non-Technical Summary
O_3	Ozone
OECD	Organisation for Economic Co-operation and Development

OHL	Overhead Transmission Line
PAP	Project Affected People
PES	Economic and Social Plan
PM10	Particulate Matter (with diameter smaller than 10 µm)
PM2.5	Particulate Matter (with diameter smaller than 2.5 µm)
PNI	National Irrigation Program
PPP	Public Participation Process
PS	Performance Standard
RoW	Right-of-way
SADC	Southern African Development Community
SAFARI	Southern African Regional Science Initiative
SAPP	Southern African Power Pool
SES	Simplified Environmental Study
SGK	Karoo Supergroup
SO_2	Sulfur Dioxide
SREA	East African Rift System
STE Project	Mozambican Integrated Transmission Backbone System
ToR	Terms of Reference
TSP	Total Suspended Particles
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WB	World Bank
WHO	World Health Organization

1 Introduction

1.1 General Considerations

Electricidade de Moçambique, E.P. (EDM) is planning the implementation of the Mozambican Integrated Transmission Backbone System – the STE Project. The STE Project is a major power transmission project linking the Provinces of Tete and Maputo, through extra high voltage transmission lines. The goals of this project are to connect and integrate the current two isolated power systems in Mozambique and to allow the evacuation to the southern region of surplus power generated in the north.

Due to its complexity, EDM plans to develop the STE Project in phases. Currently, EDM is proposing the implementation of Phase 1 of the STE Project: Vilanculos – Maputo, which includes a 561 km long 400 kV line connecting these two cities, the construction of three new substations (in Vilanculos, Chibuto and Matalane) and the upgrade of the Maputo substation.

In order to obtain the Environmental License required in terms of the Environmental Law (Law No. 20/1997, of 1 October) for the development described above (hereafter the "Project"), EDM has developed an Environmental and Social Impact Assessment (ESIA) Process.

The ESIA Process was initiated through the submission of a Screening Report to the Ministry of Land, Environment and Rural Development (MITADER) on 29 March 2017, to allow Project categorization. Following MITADER's pre-assessment, the Project was classified as Category A on 31 March 2017 (letter ref. 570/MITADER/DINAB/GDN/183/17), thus requiring a full ESIA Process.

The following step in the ESIA Process is the submission of an Environmental Pre-Feasibility and Scope Definition Study (EPDA) to MITADER. The EPDA's main goals are to *(i)* determine potential fatal flaws associated with the proposed Project and *(ii)* define the scope of the environmental assessment to be undertaken in the following ESIA phase - the Environmental Impact Study (EIS).

The EPDA report was submitted to MITADER on 8 June 2017. Following MITADER's review, the EPDA Report was approved on 15 September 2017 (letter ref. 448/MITADER/GM/183/17). Following the EPDA's approval, the next step in the ESIA process is the development of the EIS, in compliance with the approved Terms of Reference (ToR).

This document presents the EIS Final Report, which was compiled following the Public Participation Process (PPP) of the EIS phase and integrates the findings of that PPP.

1.2 Project Proponent

The Project Proponent is **Electricidade de Moçambique, E.P.** (EDM), a public enterprise, under the tutelage of the Ministry of Mineral Resources and Energy, tasked with the establishment and operation of the public service of generation, transmission, distribution and commercialization of electricity in Mozambique. EDM's relevant contact details for this assignment are provided below.

Table 1.1 – Proponent's contact details

Project Proponent	Electricidade de Moçambique, E.P. (EDM)		
Address	Av. Zedequias Manganhela, No. 267 Prédio Jat IV – 1st Floor Maputo, Mozambique		
Contact Person	Cirilo Fabião		
Contact Number	+258 21308946	**Fax Number**	+258 21431029
Contact e-mail	Cirilo.Fabiao@edm.co.mz		

1.3 Purpose of the Report

The EIS's main goal is to assess project risks and impacts, define mitigation to minimize negative impacts and enhance positive impacts and to inform the environmental authority's decision process, regarding the issuance of the environmental license for the proposed activity. The EIS Report must include the following information, as per Article 11 of the EIA Regulation (Decree No. 54/2015, of 31 December):

- A legal framework pertaining to the proposed activity;
- A description of the proposed activity, considering all phases of its life cycle;
- A description and detailed comparison of Project alternatives, when applicable;
- The definition of the activity areas of influence;
- A description of the environmental and social baseline conditions of those areas of influence;
- The identification and assessment of the activity's impacts;
- The definition of the required mitigation measures, in order to avoid, reduce or compensate the negative impacts and optimize the positive ones; and
- An Environmental and Social Management Plan (ESMP) for the activity, including monitoring programs, if relevant.

The main tasks in an EIS thus include: assessment of baseline conditions in the Project's areas of influence through the specialist studies defined in the EPDA ToR, impact assessment, definition of required mitigation measures and their compilation into an ESMP, including monitoring actions.

Further to the tasks described above, the EIS phase also includes a PPP, in order to provide the opportunity for Interested and Affected Parties (I&APs) to review and comment on the Project and the EIS. A Draft EIS Report was compiled in order to support the public consultation activities of the EIS phase. The results of the EIS PPP were then integrated in this EIS Final Report, which will be submitted to MITADER for review and approval.

1.4 Report Structure

The EIS Report is structured in four Volumes, the content of which is listed in **Table 1.2** below.

Table 1.2 – EIS report structure

Volume	Chapter	Content
Volume I	Chapter 1	**Introduction** Provides a background to the proposed Project and the ESIA and provides information about the Proponent, the ESIA consultant team and the report's main goals and structure.
	Chapter 2	**Legal and Regulatory Framework** Outlines the legal framework within which the ESIA will be undertaken and identifies other environmental legislation, standards and guidelines applicable to the Project.
	Chapter 3	**ESIA Approach and Methodology** Presents the approach and methodology for the ESIA process.
	Chapter 4	**Project Description** Discusses the desirability of the Project and provides a description of the Project.
	Chapter 5	**Area of Influence** Defines the areas of direct and indirect influence of the Project.
	Chapter 6	**Baseline Assessment** Describes the biophysical and socio-economic baseline of the Project's areas of influence.
Volume II	Chapter 7	**Impact Assessment and Mitigation Measures** Identifies and assesses potential Project impacts (biophysical and socioeconomic impacts) and defines relevant mitigation measures to avoid, reduce, compensate or enhance Project impacts (as applicable).
	Chapter 8	**Public Participation Process** Provides a summary of the PPP activities undertaken in the ESIA process.
	Chapter 9	**Conclusions and Recommendations** Presents the main findings of the EIS report and recommendations for the following phases of the Project.
Volume III – ESMP	**Environmental and Social Management Plan** Presents the Project ESMP, organizing all mitigation, management and monitoring requirements set out in the EIS into thematic management programs.	
Volume IV – Annexes	**Annexes** Provides support information to the EIS, in the form of annexes.	
Volume V	**Public Participation Process Report** Describes and documents the public consultation activities developed for the EIS.	

2 Legal and Regulatory Framework

2.1 Introduction

The ESIA Process is being developed in compliance with Mozambique's national legislative requirements and with applicable international standards. This Chapter presents the national and international development and environmental legal frameworks applicable to the proposed Project, including:

- National Development Framework: national development and strategic plans with relevance to the proposed Project (see section 2.2);
- Institutional Framework: relevant governmental institutions and authorities with jurisdiction over the Project or over relevant environmental aspects (see section 2.3);
- Legislative Framework: legal requirements that are relevant for the Project's environmental assessment (see section 2.4);
- Relevant International Conventions (see section 2.5);
- International Guidelines and Policies, including the World Bank (WB) Operational Policies, and International Finance Corporation (IFC) Performance Standards (see section 2.6).

2.2 National Development Framework

2.2.1 National Development Strategy (2015-2035)

The National Development Strategy (2015-2035), approved in July 2014 (GoM, 2014), defines the Government of Mozambique's (GoM) main development strategies to achieve the goal of "*raising its people quality of life through the structural transformation of the economy and the expansion and diversification of the production base*".

The National Development Strategy believes that industrialization, grounded in an inclusive and sustainable growth model, is the main way to achieve Mozambique's vision of prosperity and competitiveness. To materialize industrialization, the strategy defines four main development pillars, namely:

- Human capital development;
- Infrastructure development;
- Research, innovation and technological development; and
- Institutional coordination and articulation.

With regards to infrastructure development, the strategy considers that massive investment in the infrastructure sector is required and is a determinant factor for economic growth. As such, the strategy lists the main infrastructure that should be the focus of investment, including:

- Logistics, namely transport and storage infrastructure (the latter with a focus on storage of agricultural, fisheries, mineral and hydrocarbon products);
- Maritime cabotage for cargo transport at long distances;

- Power generation, including alternative energy sources;
- Natural gas supply systems;
- Sustainable management of water resources;
- Social infrastructure; and
- Tourism infrastructure.

The Project under assessment proposes the development of the first phase of the STE Project, the main goal of which is to link the Mozambican central-northern and southern electricity transmission systems. This will enable the development of Hydro, Gas and Coal medium and large scale power generation projects, currently planned for the Zambezi river and other sources (estimated at more than 3 100 MW total), by providing the power transmission infra-structure required to evacuate the generated power.

The STE Project is thus essential for the development of Mozambique's vast energy resources, both for domestic consumption and development and for export to neighbouring countries, and in full alignment with the infrastructure development strategic goals, as defined in the National Development Strategy for the 2015-2035 period.

2.2.2 Governmental Five-Year Plan (2015-2019)

The Government's Five-Year Plan for the current period (2015-2019), approved in February 2015 (GoM, 2015), states that the improvement of the Mozambican people's quality of life is its main objective, through the increased creation of jobs, productivity and competitiveness. To achieve this, the five-year plan defines strategic areas of development on which the GoM should focus its action, and on which private and public investment should be incentivized.

The development of infrastructure is one of these strategic areas, for which the five-year plan sets a number of strategic goals, including the following related to electric power infrastructure: "*to increase quality access to, and availability off, electricity, liquid fuels and natural gas, to enable the development of socio-economic activities, domestic consumption and exportation.*"

The STE Project aims to integrate Mozambique's central-northern and southern electricity transmission systems, thus substantially improving the quality of the national power transmission and distribution systems, enabling the future development of new power generation projects and subsequent increase in availability and quality of access to electric power for both domestic and industrial consumers. As such, the goals of the proposed Project are fully aligned with the strategic goals of the GoM's Five-Year Plan (2015-2019).

2.2.3 Economic and Social Plan for 2018

The Economic and Social Plan (PES) for 2018 is an instrument for the implementation of the economic and social objectives defined in the 5 Year Government Program for the 2015-2019 period.

It defines objectives regarding economic growth, inflation, export, net international reserves, public good production, basic social services assistance and public finances.

The PES 2018 (approved by the Assembly of the Republic on 14 December 2017) includes a number of programs for human, social and economic development, which translate the GoM's main strategic objectives. With regards to economic development, one of the subprograms pertains to infrastructure development, including the energy sector. In terms of the energy sector, the PES 2018 mentions a predicted growth of 7.0% due to increased production predicted for 2018 (from hydropower, gas and solar energy projects).

The PES 2018 also plans a continued effort for expansion of the power production, transmission and distribution infrastructure, including the construction of new substations, the electrification of four district headquarters in Zambézia and Tete, the construction of 240 km of new 110 kV transmission lines, the conclusion of the construction of a new 100 MW gas-fed power plant in Maputo and the construction of two solar power plants in Mocuba and Metoro.

Although not specifically mentioned in this plan, the STE Project is in line with the overall strategic goals of development of Mozambique's power infrastructure, reflected in the PES 2018.

2.2.4 Energy Sector Strategy

The Energy Sector Strategy was approved by Resolution No. 10/2009, of 4 June, and establishes strategic guidelines for the implementation of the Energy Policy (approved by Resolution No. 5/98, of 3 March).

This strategy recognizes that energy is one of the main factors contributing to national economic growth and poverty relief, and believes that Mozambique has a significant potential, in terms of energy resources, sufficient to respond both to national and regional demands, in the context of Southern Africa.

The strategy sets forth some principles for the energy sector, which include:

- Sustainable increase of access to electricity;
- Sustainable development and preservation of the environment;
- Institutional coordination and consultation with all stakeholders;
- Exploration of the regional market, enabling large power projects; and
- Efficient use of energy.

The STE Project will contribute to the increase of access to electricity and will enable the development of large power projects, by establishing the required infrastructure to evacuate the generated power, as well as facilitating the export of power to the regional market. As such, the proposed Project is fully in line with the goals of the Energy Sector Strategy.

2.3 Institutional Framework

2.3.1 Energy Sector

The **Ministry of Mineral Resources and Energy** (MIREME) was created by Presidential Decree No. 1/2015, of 16 January. The Ministry's attributions are defined by Resolution No. 14/2015, of 8 July, and include, among others, promoting the improved knowledge of national energy resources and their development and usage and the development of energy production to satisfy national needs and to seize the opportunities of the regional market.

The **Energy Regulatory Authority** (ARENE) was recently created by Law No. 11/2017, of 8 September, replacing the former National Electricity Council. ARENE possesses supervision, regulamentation, inspection and sanctioning powers over the energy sector.

The **National Directorate of Electricity** (DNE), created by Ministerial Decree No. 195/2005, of 14 September, is the department of MIREME responsible for the conception, promotion, assessment, execution, and monitoring of the electricity sector policies. Licensing of electric installations falls under the DNE jurisdiction, as defined in its Internal Regulations (Ministerial Decree No. 24/2010, of 29 January).

Electricidade de Moçambique, E.P. (EDM) was created in 1977 (Decree-Law No. 38/77, of 27 August) as the state-owned national electricity utility. It became a public enterprise, expected to operate on commercial terms, in 1995 (Decree No. 28/95, of 17 July). EDM is under the tutelage of MIREME and is tasked with the establishment and operation of the public service of production, transmission, distribution and commercialization of electricity in Mozambique, and as such manages the national electrical grid (Decree No. 43/2005, of 29 November).

2.3.2 Environmental Authorities

The **Ministry of Land, Environment and Rural Development** (MITADER), created by Presidential Decree No. 1/2015, of 16 January, is the central authority that plans, coordinates, controls and ensures the execution of policies related to the management of land, forests, environment, conservation areas and wildlife management and rural development. Presidential Decree No. 13/2015, of 16 March, defines MITADER's role and scope of intervention, while Resolution No. 6/2015 of 26 June approves its statures. MITADER is organized into different areas of activities, through national directorates, of which the following are relevant for the ESIA process:

- National Directorate of Environment (DINAB) – whose tasks include the proposal of environmental policies and regulations, the promotion of sustainable development, the control and protection of environmental quality and the monitoring of ESIA processes;
- National Directorate of Land Planning and Resettlement (DINOTER) – whose tasks include the establishment of rules, regulations and guidelines for land planning and resettlement and the promotion and monitoring of the execution of land planning instruments and resettlement processes, among other tasks;

- Land, Environment and Rural Development Inspection – those tasks include the inspection of the compliance with laws, rules and regulations associated with land, environment, conservation areas and forests and wildlife.

MITADER further includes the National Directorates of Rural Development, Forests, and Land. Additionally, MITADER oversees the following institutions: National Administration of Conservation Areas (ANAC), National Agency for the Control of Environmental Quality (AQUA) and the National Fund for Sustainable Development.

The management of conservation areas is done by ANAC. The management and monitoring of environmental quality, including such aspects as pollution control, water, soils and air quality, noise emissions and waste management, are tasks allocated to AQUA.

At the provincial level, MITADER is represented by **Provincial Directorates of Land, Environment and Rural Development** (DPTADERs). At district level, MITADER is represented by the Planning and Infrastructure District Services.

ESIA applications are monitored by MITADER through DINAB at the national level, and through the DPTADERs at the provincial level.

2.4 Legislative Framework

The Constitution of the Republic of Mozambique defines the right of all citizens to a balanced environment and the duty to protect it (Article 90º). Additionally, the State is required to ensure: *(i)* the promotion of initiatives to ensure ecological balance and environmental preservation, and *(ii)* the implementation of policies to prevent and control pollution and integrate environmental concerns in all sectorial policies so as to guarantee the citizen the right to live in a balanced environment supported by sustainable development (Article 117º).

The proposed Project must comply with the legal requirements for environmental licensing, taking into consideration not only the specific ESIA regulations but also all the applicable environmental regulation (biophysical and social) that may be relevant to the Project throughout its life cycle (construction, operation and decommissioning). The environmental instruments and regulations relevant to the proposed Project ESIA Process include:

- National Environmental Policy, Resolution No. 5/95, of 6 December;
- Environmental Law, Law No. 20/97, of 1 October;
- Regulation for Environmental Impact Assessment Process, Decree No. 54/2015, of 31 December;
- Regulation for the Environmental Audit Process, Decree No. 25/2011, of 15 June;
- Regulation for the Environmental Inspection Process, Decree No. 11/2006, of 15 June;
- General Guidelines for the preparation of Environmental Impact Studies, Ministerial Decree No. 129/2006, of 19 July; and
- General Guidelines for Public Participation Process (PPP) in the ESIA Process, Ministerial Decree No. 130/2006, of 19 July.

Further to the ESIA specific regulation, additional legislation which may be relevant considering the nature of the Project and its location includes:

- Water Law, Law No. 16/91;
- Regulation for Environmental Quality Standards and Effluent Emission, Decree No. 18/2004, of 2 June (as amended by Decree No. 67/2010, of 31 October);
- Regulation for Urban Solid Waste Management, Decree No. 94/2014, of 31 December, and Regulation for Hazardous Waste Management, Decree No. 83/2014, of 31 December;
- Land National Policy, Resolution No. 10/95;
- Land Law, Law No. 19/1997, and its Regulation, Decree No. 66/98, of 8 December;
- Law for Territorial Planning, Law No. 19/2007, and its Regulation, Decree No. 23/2008, of 1 July;
- Guidelines for the Expropriation Process resulting from Territorial Planning, Ministerial Decree No. 181/2010;
- Regulation for the Resettlement Process Resulting from Economic Activities, Decree No. 31/2012, of 8 August;
- Cultural Heritage Law, Law No. 10/88, of 22 December;
- Labour Law, Law No. 23/2007, and subordinate labor, health and safety regulations;
- Forest and Wild Life Law, Law No. 10/99, of 7 July, and its Regulation, Decree No. 12/2002, of 7 June; and
- Law No. 16/2014, of 20 June, regulates the National System of Conservation Areas.

As the proposed development is a power transmission project, it should also take into account the relevant legal framework in place for the Energy Sector, namely:

- Electric Energy Law, Law No. 21/97, of 1 October;
- Decree No. 8/2000, of 20 April – establishing procedures for the granting of concessions for the production, transmission, distribution and sale of electric energy;
- Decree No. 42/2005, of 29 November – establishing rules pertaining to the national electric energy grid;
- Decree No. 57/2011, of 11 November – establishing safety standards and guidelines pertaining to the design of power lines.

The relevance and applicability of these legal requirements for the Project are briefly discussed in **Table 2.1** below. Please note that a given decree may be relevant to different matters, e.g. the Environmental Law must be considered for both biodiversity conservation and waste management.

Table 2.1 – Key environmental legislation

Legislation	Description	Relevance
ENVIRONMENTAL ASSESSMENT		
Resolution No. 5/95 - National Environmental Policy	Establishes the basis for all environmental legislation. According to clause 2.1, its main goal is to ensure sustainable development in order to maintain an acceptable balance between socio-economic development and environmental protection. To reach the aforementioned goal, this Policy requires, among other requirements, the integration of environmental considerations in the socioeconomic planning, the management of the country's natural resources and the protection of ecosystems and of the essential ecological processes.	The Project should strive to meet the policy's goals, integrating environmental considerations in its design, thus minimizing impacts on natural resources and ecosystems.
Law No. 20/97 - Environmental Law	Defines the legal basis for the sound use and management of the environment towards the sustainable development of the country. The Environmental Law applies to all public and private activities that may directly or indirectly affect the environment.	The Project should strive to meet the sustainable development principle defined by the Environmental Law, throughout its life cycle.
Decree No. 54/2015 - Regulation for Environmental Impact Assessment	Establishes the ESIA Process as one of the fundamental instruments for environmental management, aiming at mitigating the negative impacts that public or private projects may cause to the natural and socio-economic environment, through the undertaking of environmental studies prior to commencement of the projects. Defines the ESIA Process, the required environmental studies, PPP, studies review process, project environmental feasibility decision process and environmental license issuance. Applies to all public or private activities with direct or indirect influence in environmental components.	The Project should be submitted to a formal ESIA Process, in accordance with this regulation. An environmental license needs to be obtained from MITADER, and the issuance of the environmental license precedes any other license or permit required for the Project.
Decrees No. 25/2011 - Regulation on the Environmental Audit Process	Defines an environmental audit as a documented and objective instrument for management and systematic assessment of the management system and relevant documentation implemented to ensure protection of the environment. Its objective is to assess compliance of work and operational processes with the environmental management plan, including the environmental legal requirements in force, as approved for a particular project.	Throughout the Project's lifecycle, the Proponent should conduct independent environmental audits at least once a year, without prejudice to the public environmental audit that may be requested under this decree.
Decree No. 11/2006 - Regulation for Environmental Inspections	Regulates the supervision, control and verification of compliance with environmental protection rules at a national level.	During the construction or operational phases of the Project, MITADER may undertake inspections in order to ascertain compliance with environmental legislation and the ESMP. The Proponent must allow for and facilitate such inspections.
Ministerial Decree No. 129/2006 - General Guidelines for Environmental Impact Studies	Provides details on environmental licensing procedures, as well as the format, general structure and contents of the environmental impact assessment report. The objective is to standardize procedures followed by various role-players in the environmental impact assessment process.	The EIS report must conform to the guidelines outlined in this Ministerial Decree.
Ministerial Decree No. 130/2006 guides the PPP of the ESIA Process	Defines the basic principles, methodologies and procedures for the ESIA consultation process. Considers public participation as an iterative process that initiates at the design stage and continues throughout the life time of the project.	The PPP for the ESIA Process must conform to the guidelines provided in this Ministerial Decree.

Legislation	Description	Relevance
ATMOSPHERIC EMISSIONS AND AIR QUALITY		
Law No. 20/97 - Environmental Law	Article 9 forbids the discharge of any toxic substances to the atmosphere if exceeding the legal standards. The emission standards are defined by Decree No. 18/2004 (see below).	The Project must comply with the air quality emissions limits, as defined in this regulation, so as not to harm the environment.
Decree No. 18/2004 (as amended by Decree No. 67/2010) - Regulation for Environmental Standards and Effluent Emissions	Establishes parameters for the maintenance of air quality (Article 7º); patterns of emission of gaseous pollutants for various industries (Article 8º); and standards for emission of gaseous pollutants from mobile sources (Article 9º) - including light and heavy vehicles.	
WATER RESOURCES AND WATER QUALITY		
Law No. 16/91 - Water Law	This law is based on the principles of public water use, basin scale management, and user-pays and polluter-pays. Intends to safeguard the ecological balance and environment. Water uses require either a water concession (permanent or long term water uses) or a water license (short term water uses). Licenses are given for a period of 5 renewable years, while concessions are valid for a period of 50 renewable years. Article 54 of this Law stipulates that any activity with the potential of contaminating or degrading public waters, in particular the discharge of effluents, is subject to a special authorization to be issued by the Regional Water Administration and payment of a fee.	If the Project requires the abstraction of water from natural sources (such as for concrete batching), a water license must be obtained from the competent authority (Regional Administrations of Water). If the Project requires the discharge of effluents into water bodies (such as in any construction camp), a discharge license must be obtained.
Decree No. 18/2004 – Regulations for Environmental Quality Standards and Effluent Emissions	Determines that when industrial effluent is discharged into the environment, the final effluent discharged must comply with discharge standards established in Annex III of the decree. The discharge of domestic effluent must comply with the discharge standards in Annex IV.	The Project must comply with the effluent emission limits established by this regulation, so as not to harm the environment.
POLLUTION AND WASTE MANAGEMENT		
Law No. 20/97 - Environmental Law	Limits the production and / or disposal into the soil or subsoil and the disposal into water or the atmosphere of any toxic or polluting substances, as well as the practice of activities that accelerate erosion, desertification, deforestation or any other form of environmental degradation to those limits established by the law (Article 9).	The Project needs to include measures to prevent pollution during and after implementation. Any project must conform to the requirements outlined in this regulation.
Decree No. 94/2014 - Regulation for Urban Solid Waste Management	Establishes the legal framework for urban solid waste management. The key objective is to establish rules for the generation, collection and disposal of urban solid wastes, so as to minimize their impacts on public health and the environment. Urban solid wastes, according to this decree, are to be classified in accordance with the Mozambican Norm NM339 – Solid Wastes – Classification. Waste management is a responsibility of Municipal Councils and District Governments, in their respective areas of jurisdiction.	Any project should implement suitable waste management practices throughout its life cycle. The Project must conform to the requirements outlined in this regulation.
Decree No. 83/2014 - Regulation for Hazardous Waste Management	Establishes the legal framework for hazardous waste management. The key objective is to establish rules for the generation, collection and disposal of hazardous wastes, so as to minimize their impacts on public health and the environment. Annex IX of this decree provides waste classifications. MITADER is the competent entity to manage hazardous wastes, namely by licensing waste management units. Only entities which are registered with and licensed by MITADER can collect and transport hazardous wastes, beyond the limit of the facilities where they were generated.	Any project should implement suitable waste management practices throughout its life cycle. The Project must conform to the requirements outlined in this regulation.

Legislation	Description	Relevance
ELECTRIC ENERGY		
Law No. 21/97 – Electricity Law	Article 9 states that the transmission of electricity, by either private or public entities, requires the issuance of a concession for the effect. Article 14 states that the management of the national transmission grid is attributed to a public entity, and that private capital may participate in the development of the national power transmission grid.	EDM has been designated as the managing entity of the national power transmission grid, as per Decree No. 42/2005.
Decree No. 42/2005 – Regulation establishing rules for the national electric grid	Article 3 reinforces that the construction and operation of power transmission infrastructure requires the issuance of a concession, as required by Law No. 21/97.	
Decree No. 57/2011 – Safety Regulation for High Voltage Power Lines	This Decree establishes several standards and guidelines for the design of power lines, to ensure their safety. Article 28 (clause 3) states that in order to ensure a safe operation of high voltage power lines, the protection zone (RoW) should have the maximum width of: (i) 30 m, for lines under 66 kV, and (ii) 50 m, for lines over 66 kV.	According to this decree, the width of the RoW should be 50 m (25 m to each side). However, this contradicts the Land Law, which sets the width of the RoW as 100 m (50 m to each side). As such, a 100 m RoW was adopted, in compliance of the Land Law.
LAND OWNERSHIP AND RESETTLEMENT		
Resolution No. 10/95 – Land National Policy	Establishes that the State must provide the land for each family to build or possess their own habitation, and is responsible for land use and physical planning, although plans can be made by the private sector.	The Project must conform to the principles of this policy, as per the regulations defined in the implementing laws, below.
Law No. 19/1997 – Land Law	Defines land use rights (DUAT), including details on customary rights and procedures for acquisition and use of land titles by communities and individuals. This law recognizes and protects the rights acquired through inheritance and occupation (customary rights and duties of good faith), except for legally defined reserves or areas where land has been legally transferred to another person or institution.	The Land Law and its regulation define total and partial protection zones. In these zones, land use is restricted. According to this regulation, the corridor of 50 m to each side of a transmission line is considered to be a partial protected zone (the line's RoW). The approval of power transmission lines projects by the Council of Ministers or by the relevant competent authorities automatically implies the creation of the accompanying partial protected zones. The creation of this partial protected zone will extinguish existing DUATs in the RoW and prevent the issuance of new ones. This creates the need to compensate existing assets and resettle existing settlements within the RoW. Some uses may continue to be allowed within the RoW (such as annual crops) but legal assurances and other measures will need to be implemented to protect the rights of PAPs that elect to continue permissible activities in the RoW, where this is technically viable and allowed by EDM. This will be addressed in the Resettlement Action Plan (RAP) or through other specific instruments.
Decree No. 66/98 – Regulation for Land Law	Defines total protection areas, set aside for nature conservation and State defense, as well as partial protection areas, where land use titles may not be granted, and where activities cannot be implemented without a license. Partial protection areas, which include, amongst others, the 50 m strip of land along lakes and rivers, 100 m strip of land along the seafront and estuaries, 50 m along aerial, surface or underground pipelines/cables for electricity, telecommunications, oil, gas and water, 30 m along primary roads and 15 m along secondary and tertiary roads.	

Legislation	Description	Relevance
Decree No 31/2012 – Regulation for the Resettlement Process Resulting from Economic Activities	Defines rules and basic principles for resettlement processes from the implementation of public or private economic activities. Article 15 states that the Resettlement Action Plan is part of the ESIA Process and that its approval precedes the issuance of the environmental license.	If physical displacement results from the Project, this regulation is applicable, and a RAP will be required. Any potential economic displacement (such as the loss of farming plots or other assets) will also need to be assessed in the ESIA and, if present, duly compensated for, in abidance with the Land Law. Note that for electricity projects, expropriation procedures may apply (please see below).
Decree No. 21/97 – Electric Energy Law	Article 29 states that the issuance of a concession for power supply projects implies the authorization for access and use of land, following the payment of due compensation, in accordance with the Land Law and its Regulation. Article 30 states that when the transmission of electricity implies the use of land or land rights, the issuance of the concession is preceded by expropriation and payment of appropriate compensation. Article 30 also states that the expropriation procedures should only be followed after the concessioner follows through the normal procedures to try to obtain the DUAT, through an agreement with the current holders of that right. Expropriation requires the issuance of a declaration of public interest, by the Council of Ministers.	According to this Decree, expropriation procedures (as defined in the land planning regulation – see below) may be applicable to power transmission projects.
Decree No 23/2008 – Regulation for Land Planning	Aims to establish regulatory territorial planning measures and procedures to ensure the rational and sustainable use of natural resources, regional potentials, infrastructure and urban centers, and to promote national cohesion and safety of the people. Articles 68 to 71 deal with expropriation procedures for private property for national public interest reasons. Article 70 states that expropriation should be preceded by fair compensation.	If expropriation of land rights is required for Project implementation, the requirements of this regulation should be complied with. Expropriation requires the issuance of a declaration of public interest for the Project, as defined in the Electric Energy Law.
Ministerial Decree No. 181/2010 – Guidelines for the Expropriation Process Resulting from Territorial Planning	Establishes procedures for expropriation processes resulting from territorial planning, including procedures for the issuance of a declaration of public interest, compensations for expropriation (including calculation methods) and the expropriation process itself.	If expropriation of land and land rights within the Project area is required, the procedures established in these guidelines should be followed.
CULTURAL HERITAGE		
Law No. 10/88 - Cultural Heritage Law	Aims to legally protect material and non-material assets of the Mozambican cultural heritage. Under this law, cultural heritage is defined as a "group of material and non-material assets created or integrated by the Mozambican people through history, with relevance to the definition of the Mozambican cultural identity". Material cultural assets include: monuments, groups of buildings with historic, artistic or scientific importance, places or locations (with archaeological, historic, aesthetic, ethnologic or anthropologic interest) and natural elements (physical and biological formations with particular interest from an aesthetic or scientific point of view).	The potential presence of cultural heritage on the Project area must be assessed in the EIS. Archaeological objects may also be found during the construction phase of the Project. In such cases, the Proponent must immediately communicate the finding to the relevant cultural heritage agency.
BIODIVERSITY		
Law 20/97 – Environmental Law	Articles 12 and 13 state that the planning, implementation and operation of projects should guarantee the protection of biological resources, particularly of plant or animal species threatened with extinction or that, by their genetic value, ecological, cultural or scientific, require special attention and this issue is to extend their habitats, especially those within areas of environmental protection.	The Project must consider protected biodiversity and the presence of potential relevant biodiversity values in the Project area will need to be assessed in the ESIA.

Legislation	Description	Relevance
Law No. 10/99 - Forest and Wildlife Law	Establishes the principles and basic rules on protection, conservation and sustainable use of forest and wildlife resources. Article 10 defines protection areas as territorial delimited areas, representative of the national natural heritage, designated for their biodiversity and fragile ecosystems or the conservation of animal and plant species.	The Proponent must notify MITADER if a species listed in this regulation is captured or disturbed.
Decree No. 12/2002 – Regulation on the Forest and Wildlife Law	Applies to protection, conservation, use, exploration and production activities of fauna and flora resources. Includes the commerce, transport, storage and primary artisanal or industrial transformation of these resources. Includes a list of protected fauna species, Annex II, for which hunting is prohibited.	
Law 16/2014 (as amended by Law 5/2017) – Protection, Conservation and Sustainable Use of Biodiversity Law and its Regulation	This law establishes basic principles and norms for the protection, conservation, restoration and sustainable use of biological diversity in national territory, in particular within conservation areas. Article 16 states that all activities that could result in changes to land and vegetation cover, or that could disturb flora, fauna and ecological processes up to the point of compromising their maintenance, are interdicted within national parks, except if required for scientific reasons or management needs. Article 11 of the Regulation states that cultural and natural monuments should be conserved. These include areas with one or more natural, aesthetic, geological, religious, historical or culturally unique values that, due to their rarity, must be conserved. Natural monuments can include trees of ecological, aesthetic, historical and cultural value.	No protected areas, as per this law's definitions, are interfered by the proposed Project.
WORK AND SAFETY		
Law No. 23/2007 - Labor Law	This law applies to legal relations of subordinate work established between employers and domestic and foreign workers in all industries, operating in the country. Chapter VI provides the principles of safety, hygiene and health of workers.	The Proponent must provide to its employees, good physical condition, environmental and moral work, inform them about the risks of their work and instruct them about compliance with the standards for hygiene and safety at work.
Law nº 19/2014 - Law of Protection of People, Workers and Job Applicants Living with HIV/AIDS (revokes Law nº 5/2002)	This law establishes the general principles that aim to ensure that all employees and job applicants are not discriminated against in the workplace or when applying for jobs, for being suspected of having or having HIV / AIDS. Article 47 states that workers and job applicants should not discriminated in their rights regarding labour, training, promotions and career advancement, on account of being HIV positive. Article 52 forbids requiring HIV tests for job applications, job maintenance, to access training or to quality for promotion or any other job activity.	It is prohibited testing of HIV / AIDS for job applicants. It's also prohibited testing to workers, without the employee's consent. The proponent must train and reorient all workers infected with HIV / AIDS, who are able to fulfill their duties at work, taking him to a job compatible with his capacities.
Decree nº 45/2009 - Regulation on the General Labour Inspectorate	This Regulation lays down the rules on inspections, under the control of the legality of work. Paragraph 2 of Article 4 provides for the employer's responsibility for the prevention of occupational health and safety risks for the employee.	The Proponent shall comply with the requirements. In the case of an inspection, the proponent must help to provide all necessary information to the inspectors.

2.5 Relevant International Conventions

2.5.1 Energy International Conventions

Mozambique is part of the Southern African Power Pool (SAPP), a cooperation of national electricity companies in Southern Africa, founded in 1995 under the auspices of the Southern African

Development Community (SADC). SAPP is comprised of twelve SADC member countries represented by their Electric Power Utilities, including Mozambique, represented by EDM.

The members of the SAPP have created a common power grid between their countries and a common market for electricity in the SADC region. SAPP aims to meet the electricity needs of its member countries, ensuring that their production is based on renewable natural resources, without unsustainable effects on the environment.

The Administrative and Technical Unit of the Energy Sector of the SAPP's Environmental Management Commission produced several directives for the energy sector of member countries. These directives have, as guiding principles, the appropriate adoption of environmental policy in development projects, transparency in licensing procedures, the equitable energy distribution to the population and the fight against poverty.

2.5.2 Environmental and Social International Conventions

Relevant international conventions for the Project under assessment are provided in **Table 2.2** below. Where relevant these will be discussed in further detail within relevant chapters

Table 2.2 – Relevant international conventions

Convention	Description
BIODIVERSITY	
African Convention on the Conservation of Nature and Natural Resources	The fundamental principle of this Convention consists in the Contracting States undertaking of adopting the measures to ensure conservation, utilization and development of soil, water, flora and fauna resources in accordance with scientific principles and with due regard to the best interests of the people. Pursuant to Resolution No. 18/81, of 30 December 1981, the Republic of Mozambique acceded to the African Convention on the Conservation of Nature and Natural Resources.
United Nations Convention on Biological Diversity 1993	This convention is an international legally-binding treaty with three main goals: conservation of biodiversity; sustainable use of biodiversity; and the fair and equitable sharing of the benefits arising from the use of genetic resources. Its overall objective is to encourage actions which will lead to a sustainable future. Mozambique ratified this convention in 1994, by Resolution No. 2/94.
Convention on Wetlands of International Importance, Especially as Waterfowl Habitat (Ramsar Convention), 1971	Sustainable use and conservation of wetlands. Ratified by Mozambique in 2003.
Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES), 1973	Ensure that international trade in specimens of wild animals and plants does not threaten their survival. It accords varying degrees of protection to more than 33,000 species of animals and plants. Convention ratified by Mozambique through Resolution No. 20/81.
Convention on the Conservation of Migratory Species of Wild Animals (Bonn / CMS Convention), 1979	Aims to foster protection measures for migratory species of wild animals throughout their natural range, a conservation strategy of wildlife and habitats on a global scale. Ratified by Mozambique in 2008.
SADC Protocol on Wildlife Conservation and Law Enforcement, 1999	Ensure the conservation and sustainable use of wildlife resources. Ratified by Mozambique in 2002.

Convention	Description
FISHERIES	
SADC Protocol on Fisheries	Mozambique ratified the SADC Protocol on Fisheries by Resolution No. 39/2002 of 30 April, which is aimed at promoting the responsible utilization of living aquatic resources and their ecosystems. Article 14 refers to the protection of the marine environment and requires member states to apply the precautionary principle to ensure that activities within their jurisdiction do not cause major adverse impacts. In addition, legislative and administrative measures necessary for the prevention of water pollution caused by activities in interior, coastal and marine waters must be implemented.
HAZARDOUS AND NON HAZARDOUS WASTE	
Basel Convention on the control of Trans-boundary Movements of Hazardous Wastes and their Disposal, 1989	This convention regulates the import, export and trans-boundary movement of hazardous waste. The Basel Convention was superseded by the Bamako Convention (see below). The Republic of Mozambique ratified the Basel Convention on the control of Trans-boundary Movements of Hazardous Wastes and their Disposal by way of Resolution No. 18/96, of 26 November.
Convention on the Ban of the Import into Africa and the Control of Transboundary Movements and Management of Hazardous Wastes within Africa, Bamako, 1991	During the negotiation of the Basel Convention, the African states represented by the Organization for African Unity adopted the Bamako Convention believing that the Basel Convention was not strict enough. The Bamako Convention totally prohibits the import of hazardous waste into Africa. The Convention came into force on April 22, 1998. The Republic of Mozambique ratified the Bamako Convention by way of Resolution No. 19/96, of 26 November.
AIR QUALITY/CLIMATE CHANGE	
The United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, 1992 & 1997	UNFCCC is an international environmental treaty produced with the objective of achieving stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system. The Kyoto Protocol to the UNFCCC was adopted in December 1997, whereby most industrialized nations and some central European economies in transition agreed to legally binding reductions in greenhouse gas emissions of an average of 6 to 8% below 1990 levels between the years 2008-2012, defined as the first emissions budget period. The UNFCCC was ratified by way of Resolution No. 1/94, of 24 August and the Kyoto Protocol acceded to by the Republic of Mozambique by way of Resolution No. 10/2004, of 28 July.
Vienna Convention for the Protection of the Ozone Layer, 1985, London 1990, Copenhagen 1992	As per Article 2.1 of this Convention, the Parties thereto undertook the obligation to take appropriate measures to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer. Pursuant to Resolution No. 8/93, of 8 December, the Republic of Mozambique acceded to the Vienna Convention for the Protection of the Ozone Layer and to its 1990 and 1992 Amendments.
The Montreal Protocol on Substances that deplete the Ozone Layer, 1987	Designed to control the production of ozone depleting substances in order to reduce their abundance in the atmosphere, and thereby protect the earth's fragile ozone Layer. Forbids the use of chlorofluorocarbons. Mozambique ratified this convention through Resolution No. 9/2009.
POLLUTION PREVENTION	
Stockholm Convention on Persistent Organic Pollutants (POPS), 2001.	Action and control at world level of chemicals that persist in the environment, bio-accumulate in the food chain and pose a risk to human health and the environment. These substances are listed in Annex I. Mozambique ratified this convention in 2005.
CULTURAL HERITAGE	
UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage	Designed to help identify and protect both cultural (monuments, groups of buildings and sites) and natural heritage (natural features, geological and physiographical formations and natural sites). Mozambique ratified the convention in 1982.
Convention for the Safeguarding of the Intangible Cultural Heritage (UNESCO), 2003	Safeguarding of the intangible cultural heritage and to ensure respect for the intangible cultural heritage of communities, groups and individuals. Ratified by Mozambique in 2007
Convention on the Protection and Promotion of the Diversity	Protect and promote the diversity of cultural expressions, promote dialogue between cultures and promote respect for cultural diversity. Ratified by Mozambique in 2007

Convention	Description
of Cultural Expressions (UNESCO), 2005	
HUMAN RIGHTS	
International Labour Organization conventions and national legislation relating to labor	- Forced Labour Convention, ratified on Jun 2003: Convention concerning Forced or Compulsory Labour - Freedom of Association and Protection of the Right to Organize Convention, Dec 1996: Convention concerning Freedom of Association and Protection of the Right to Organize - Right to Organize and Collective Bargaining Convention, Dec 1996: Convention concerning the Application of the Principles of the Right to Organize and to Bargain Collectively - Equal Remuneration Convention, Jun 1977: Convention concerning the equal remuneration for men and women workers for work of equal value refers to rates of remuneration established without discrimination based on sex - Abolition of Forced Labour Convention, Jun 1977: Convention concerning the Abolition of Forced Labour - Discrimination (Employment and Occupation) Convention, Jun 1977: Convention concerning Discrimination in Respect of Employment and Occupation - Minimum age specified: 15 years Jun 2003: Convention concerning Minimum Age for Admission to Employment - Worst Forms of Child Labour Convention, Jun 2003: Convention concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labour
International Covenant on Civil and Political Rights	Recognizes equal and inalienable rights to all human beings in terms civil and political freedom. Ratified in 1993.
International Covenant for the Elimination of Racial Discrimination	State Parties "undertake to pursue by all appropriate means and without delay a policy of eliminating racial discrimination in all its forms and promoting understanding among all races". Ratified in 1983
Convention on the Elimination of Discrimination against Women	States have the obligation to ensure the equal rights of men and women to enjoy all economic, social, cultural, civil and political rights. Ratified in 1997; 2008.
Convention Against Torture	State parties prohibit themselves under any circumstances from committing acts of torture and other cruel, inhuman or degrading treatments or punishments. Ratified in1999.
Convention on the Rights of the Child	Guarantees protection of children's rights. Signed in 1990 and ratified in 1999.
International Convention on the Rights of Migrant workers	Its primary objective is to protect migrant workers and their families, a particularly vulnerable population, from exploitation and the violation of their human rights. Signed in 2012; ratified in 2013.
International Convention on the Rights of Persons with Disabilities	States have the obligation to protect the rights and dignity of persons with disabilities; signed in 2007.
African Union related protocols	Several protocols and charters promoting and protecting human rights and basic freedoms, children rights and others on the African continent.

2.6 International Guidelines and Policies

As previously stated, the ESIA is being developed not only in line with national standards and regulations, but also in line with international best practice. Specifically, given that the Project is seeking funding from the WB, the ESIA is governed by the environmental and social policy and performance requirements as defined by the World Bank safeguard operational policies. Additionally, reference is also made to other internationally accepted best practice guidelines, such as the IFC

Performance Standards, and regional sectoral guidelines, such as the Southern Africa Power Pool ESIA guidelines.

2.6.1 World Bank Safeguard Operational Policies

Developers seeking financing from the World Bank (WB) are required to comply with the applicable WB environmental and social safeguards operational policies. As the STE Project is seeking financing from the WB, this ESIA is governed by both national law and the WB safeguard operational policies. A summary of the key objectives of applicable WB's environmental and social safeguard policies are provided below.

- Operational Policy 4.01 – Environmental Assessment: aims to identify, avoid, and mitigate the potential negative environmental impacts associated with Bank lending operations. Provides a framework for WB environmental safeguard policies and describes project screening and categorization to determine level of environmental assessment required. For category A projects, public consultation and disclosure is to be undertaken as part of the ESIA. It requires implementation of environmental and social management plans;
- Operational Policy 4.04 – Natural Habitats: seeks to ensure that WB-supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. Outlines the WB policy on biodiversity conservation taking into account ecosystem services and natural resource management and use by project affected people. Projects must assess potential impacts on biodiversity. Strictly limits circumstances under which conversion or degradation of natural habitats can occur;
- Operational Policy 4.11 – Physical Cultural Resources: Sets out requirements to avoid or mitigate adverse impacts on cultural resources;
- Operational Policy 4.12 – Involuntary Resettlement: aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts. Where land or other asset acquisition is necessary, it requires participation in resettlement planning, mandates compensation for assets at replacement cost, and expects that incomes and standards of living of affected persons are improved or at least restored to pre-project levels;
- Operational Policy 4.36 – Forests: aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development.

2.6.2 Other World Bank Policies

In addition to the World Bank Safeguard Policies, listed in the previous section, the ESIA also took into consideration the following WB policies:

- Operational Policy 4.20 – Gender and Development: aims to reduce poverty and enhance economic growth, human well-being, and development effectiveness by addressing the gender disparities and inequalities that are barriers to development, and by formulating and implementing gender and development goals;
- Bank Policy Access to Information: supports decision making by the Borrower and Bank by allowing the public access to information on environmental and social aspects of projects.

2.6.3 IFC Performance Standards (PS)

The IFC PS's on Environmental and Social Sustainability, which were published in January 2012 (IFC, 2012), are recognized as being the most comprehensive standards available to international finance institutions working within the private sector. It should be noted that while this ESIA is being governed by the WB safeguard operational policies, and not the IFC PS's, the latter are still referenced throughout the ESIA, when relevant, as an accepted international approach to the management of social and environmental issues.

The seven IFC Performance Standards relevant to the proposed Project are:

- **PS 1: Assessment and Management of Social and Environmental Risks and Impacts** underscores the importance of managing environmental and social performance throughout the life of a project. PS 1 requires the client to conduct a process of environmental and social assessment and to establish and maintain an Environmental and Social Management System (ESMS), appropriate to the nature and scale of the project and commensurate with the level of its environmental and social risks and impacts;
- **PS 2: Labour and Working Conditions** recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers;
- **PS 3: Resource Efficiency and Pollution Prevention** recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels;
- **PS 4: Community Health, Safety and Security**, recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts;
- **PS 5: Land Acquisition and Involuntary Resettlement**, recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land;
- **PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources**, recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development;
- **PS 8: Cultural Heritage** recognizes the importance of cultural heritage for current and future generations.

PS 1 establishes the importance of (i) integrated assessment to identify the impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of environmental and social performance throughout the life of the project.

IFC PS's 2, 3, 4, 5, 6 and 8 present requirements to avoid, reduce, mitigate or compensate for impacts on people and the environment, and to improve conditions where appropriate. Where impacts are anticipated, the client is required to manage them through its ESMS.

The IFC PS's are matched with corresponding Guidance Notes that provide guidance on the requirements contained in the standards and on good sustainability practices to help clients improve project performance.

2.6.4 World Bank Group Environmental Health and Safety Guidelines

WBG's Environmental Health and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice, as defined in IFC's PS 3 on Resource Efficiency and Pollution Prevention.

The WBG EHS Guidelines contain the performance levels and measures that are normally acceptable to WBG and are generally considered to be achievable in new facilities at reasonable costs by existing technology. For WBG-financed projects, application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets with an appropriate timetable for achieving them. The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to WBG, become project- or site-specific requirements.

Relevant Industry Sector WBG guidelines applicable to the proposed Project include:

- EHS General Guidelines;
- EHS Guidelines for Electric Power Transmission and Distribution.

2.6.5 Southern African Power Pool Guidelines

SAPP's Environmental Sub-Committee has developed a number of environmental management guidelines, aiming to ensure that energy sector activities are developed sustainably. For this ESIA, the following SAPP guidelines were taken into consideration:

- ESIA Guidelines for Transmission Infrastructure for the SAPP Region (September, 2010) - provides a recommended framework and guide to a systematic approach to performance of ESIA for power transmission infrastructure projects in the SAPP region;
- SAPP Occupational Health, Safety and Environmental Guideline (November, 2007).

3 ESIA Approach and Methodology

3.1 General Considerations

The ESIA Process, as defined in the ESIA Regulation, is a preventive environmental management tool, which aims to identify and assess, both quantitatively and qualitatively, the positive and negative environmental effects of a proposed project, and to define the necessary mitigation, so as to reduce the negative effects and enhance the positive ones.

This Chapter briefly outlines the approach to the ESIA and the process that has been followed to date. The approach to this ESIA complies with all applicable Mozambican environmental legal requirements and is in line with relevant international guidelines and policies.

3.2 Overview of the ESIA Process

The ESIA Regulation (Decree No. 54/2015, of 31 December) states that every private or public activity, that may directly or indirectly affect the environment, must be subject to environmental assessment (Article 3). The level of environmental assessment depends on the sensitivity of the environment and nature of the project, and is determined by MITADER, through a process of Pre-Assessment, based on a Screening Report submitted by the Proponent. Article 4 defines the following categories for proposed projects:

- **Category A+**: Developments that due to their complexity, location and / or irreversibility and magnitude of potential impacts, deserve not only a high level of social and environmental monitoring, but also the involvement of experts in the ESIA Process. Annex I of the ESIA Regulation lists the activities that are included in this category. Category A+ projects require an EIS, including an ESMP, with supervision by independent expert reviewers with proven experience. An EPDA and the ToR for the EIS must be compiled and approved by MITADER prior to the commencement of the EIS;
- **Category A**: Developments with potential impacts of high duration, intensity, magnitude and significance on living beings and environmentally sensitive areas. Annex II of the ESIA Regulation lists the activities that are included in this category. Category A projects require an EIS, including an ESMP. An EPDA and the ToR for the EIS must be compiled and approved by MITADER prior to the commencement of the EIS;
- **Category B**: Developments with potential impacts on living beings or environmentally sensitive areas which are likely to be of lower duration, intensity, magnitude and significance than those of Category A projects. Annex III of the ESIA Regulation lists the activities that are included in this category. Category B projects require a Simplified Environmental Study (SES) and ESMP. While no EPDA is required, the ToR for the SES have to be approved by MITADER prior to the commencement of the SES;
- **Category C**: Developments with negligible or insignificant negative impacts, that do not cause irreversible impacts and which positive impacts and more significant than the negative. Annex IV of the ESIA Regulation lists the activities that are included in this

category. Category C projects require an ESMP, to be prepared by the Proponent and approved by the environmental authority.

The proposed Project entails the construction and operation of a high-voltage power transmission line, and as such it was classified as Category A by MITADER, being subject to a comprehensive ESIA Process. For Category A projects, the ESIA Process consists of three phases, namely:

- **Screening Phase (Screening Report)**: the ESIA is initiated through the submission to MITADER of a screening report, indicating characteristics and location of the project, the activities to be undertaken and a brief description of the receiving environment. Based on this information, MITADER formally categorizes the project and defines the level of environmental assessment required;
- **Scoping Phase (EPDA Report)**: the main objectives of the second phase are to identify potential fatal flaws and impacts of the project, and to define the ToR for the EIS. The EPDA Phase thus aims to identify key issues and concerns associated with the proposed development. These could include project-related activities which may have the potential to contribute to or cause potentially significant impacts to environmental and socio-economic receptors and resources in the area;
- **Impact Assessment phase (EIS Report)**: the main objectives of the third phase are to assess the impacts identified in the EPDA, to define the mitigation measures and the development of the ESMP. The EIS Report supports the relevant authorities in the decision-making process, resulting in the environmental licensing or rejection of the activity. The main tasks undertaken in this phase are the following:
  - *Baseline Studies*: these studies are undertaken to review and ascertain existing environmental and social conditions relevant to the project area and its surroundings and to highlight receptors and resources sensitive to potential impacts;
  - *Assessment of Impacts and Mitigation:* the focus is to identify and evaluate the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimize or compensate for any adverse environmental impacts, to enhabnce any positive impacts, and to report the significance of residual impacts that occur following mitigation;
  - *Environmental and Social Management Plan:* the identified mitigation measures are integrated into a suite of customized management programs. The ESMP is developed to guide environmental and social management throughout the project's life cycle. This is the mechanism whereby mitigation and monitoring of environmental impacts (as defined in the EIS Report) are integrated with project implementation.

Figure 3.1 illustrates an overview of the ESIA process for Category A projects, while the main phases of these process are described in detail in the following sections.

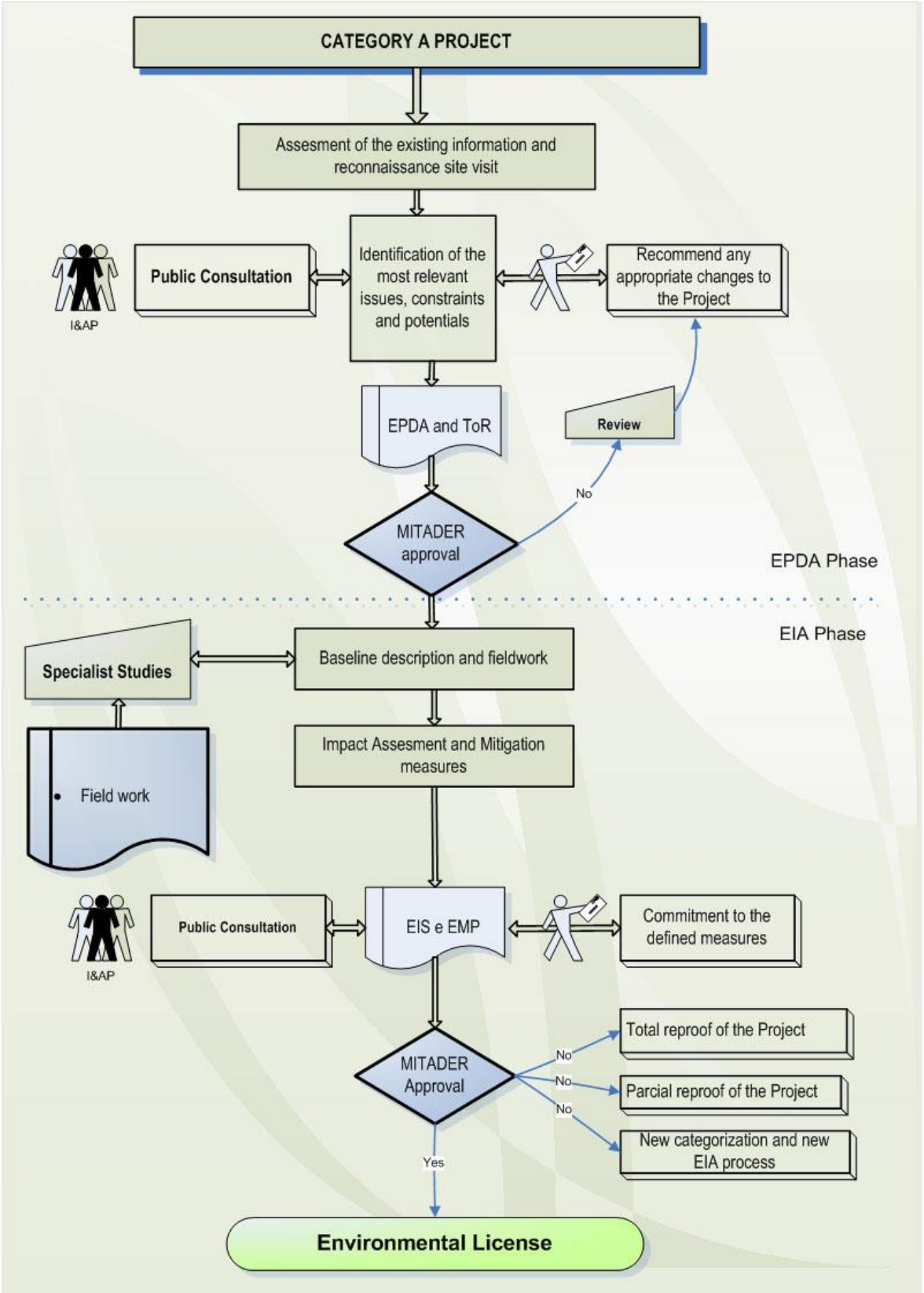


Figure 3.1 – Overview of the ESIA Process for Category A projects

3.3 Phase 1: Screening Phase

The first step of the ESIA Process was the Screening Phase. During this phase, a Screening Report was compiled and submitted to MITADER, to assist them in determining the level of environmental assessment required. The Screening Report contained information regarding the proposed Project and a description of the biophysical and socio-economic context of the area. A Preliminary Environmental Information Form was appended to the Screening Report.

The Screening Report and the Preliminary Environmental Information Form were submitted to MITADER on 29 March 2017. MITADER, through DINAB, confirmed that the Project is classified as Category A (letter Ref. No. 570/MITADER/DINAB/GDN/183/17, dated 31 of March 2017 - see **Annex I**, **Volume IV**), and must therefore be subjected to a full ESIA Process.

3.4 Phase 2: EPDA

As per Article 10 of the ESIA regulation, the EPDA's main goals are to *(i)* determine potential fatal flaws associated with the activity and *(ii)* define the scope of the environmental assessment to be undertaken in the EIS Phase. The objectives of the EPDA Phase were therefore to:

- Review existing data about the Project area in order to understand the sensitivity of the affected biophysical and social environment;
- Present the proposed development to I&APs and identify issues and concerns about the proposed development;
- Identify potentially significant positive and negative environmental and socio-economic impacts;
- Develop the ToR for the specialist studies and for the EIS; and
- Compile Project information and results of the PPP into an EPDA Report and submit to MITADER for decision-making.

To support the goals described above, the EPDA Report provided the following information (as per Article 10º of the ESIA Regulation):

- Non-Technical Summary (NTS), with the main issues, findings and recommendations of the Report;
- Information regarding the Proponent of the Project, as well as the consulting team responsible for the ESIA Process;
- Definition of the preliminary Project areas of influence;
- Description of the Project activities throughout its life cycle;
- Brief baseline description of the affected biophysical and socio-economic environment;
- Identification of potential impacts, negative or positive, that the proposed development might have on the environment and communities;
- Identification and assessment of any potential fatal flaws (environmental and social risks) that may threaten the viability of the Project; and

- Identification of the detailed studies to be undertaken in the EIS and development of the respective ToR.

The EPDA Phase also included a PPP (as per Article 15º of the ESIA Regulation), aiming to present the proposed Project to all I&APs and identify issues and concerns about the proposed development. The main objectives of the EPDA PPP were the following:

- Identify I&APs and compile an I&AP database, to be updated throughout the ESIA Process;
- Provide I&APs (including directly affected local communities, authorities, environmental organizations, interested members of the public and community based organizations) with information regarding the proposed Project and its potential impacts;
- Provide I&APs with the opportunity to participate effectively in the process and identify any issues and concerns associated with the proposed activity;
- Allow I&APs to review the manner in which identified environmental and social issues will be addressed in the EIS Phase; and
- Elicit comments from I&APs with regards to the ToR.

The detailed approach to the EPDA public consultation, and its main findings, are presented in Chapter 8 of this EIS Report (see **Volume II**).

The EPDA Report was concluded in June 2017. No fatal flaws associated with the Project were identified and the EPDA Report, including the ToR for the EIS, was submitted to MITADER on 8 June 2017. Following its review, MITADER approved the EPDA and ToR on 15 September 2017 (through letter ref. 448/MITADER/GM/183/17 - see **Annex I**; **Volume IV**), and informed that the ESIA Process should move forward to the EIS Phase.

3.5 Phase 3: EIS

3.5.1 EIS Objectives

The main goals of the EIS phase are to:

- Undertake the specialist studies, in accordance with the ToR approved by MITADER;
- Assess the social and environmental impacts associated with the Project;
- Define the mitigation measures for adverse impacts and the enhancement measures for positive impacts; and
- Integrate those measures in an ESMP, as clear, practical measures applicable to the local conditions, based on best practice and relevant legislation.

3.5.2 EIS Report

To support the above described goals, the EIS Report provides the following information (as per Art 11º of the ESIA Regulation):

- NTS, with the main issues, findings and recommendations of the Report;

- Information regarding the Proponent of the Project, as well as the consulting team responsible for the ESIA Process;
- Legal framework of the activity and its context within the existing planning instruments;
- Description of the activities to be carried out under the proposed Project, for all phases (planning, construction, operational and where relevant decommissioning), as well as alternatives considered;
- Definition of the Project areas of influence;
- Baseline assessment of the receiving biophysical and socio-economic environment;
- Identification and assessment of the Project social and environmental impacts;
- Definition of mitigation measures;
- Integration of the mitigation measures in an ESMP for the activity, also including monitoring programs and other management tools, where relevant; and
- PPP report.

Some of the key aspects of the EIS phase, such as the specialist studies, the development of the ESMP and the PPP, are further described in the following sections.

3.5.3 Specialist Studies

A number of specialist studies were undertaken during the EIS, in accordance with the ToR, developed in the EPDA Phase and approved by MITADER. These detailed studies focus on the environmental and social aspects that could be impacted by Project activities.

The specialists responsible for each EIS component are presented in **Erro! A origem da referência não foi encontrada.** in Section **Erro! A origem da referência não foi encontrada.** (see page **Erro! Marcador não definido.**). During the EIS phase, interaction between the specialists was encouraged in order to fully explore the linkages, commonalities and inconsistencies among the different aspects of the social and biophysical environment and the assessments thereof.

3.5.4 Environmental and Social Management Plan

The ESMP is a fundamental part of the ESIA Process. External decision-makers will rely on the EIS findings (e.g. significance ratings of residual impact) in the decision-making process. Because an EIS is based on predictions made in advance of an activity taking place, it effectively makes assumptions that the Project will implement certain controls and mitigation measures. If these are not implemented, then the EIS is undermined as a tool for I&APs and external decision-makers.

It is important, therefore, for these assumptions, i.e. the mitigation measures that have been agreed with the Proponent and described in the EIS, to be integrated within the Project, in order to ensure their future implementation. The ESMP is the tool that insures this integration of mitigation within the Project.

As such, this EIS report includes an ESMP (see **Volume III**), which integrates the mitigation measures and monitoring actions, as defined in the EIS Report, into a suite of management plans. If the need for additional studies or plans is identified in the EIS, to be developed by the Proponent, the ESMP will provide guidelines for their development and implementation.

The implementation of such plans should ensure that any unforeseen impact or issues that may arise will be dealt with in an effective manner in accordance with the relevant laws and regulations of Mozambique and international best practices. In this way, I&APs and external decision-makers should have confidence in the EIS as a tool to aid the decision-making process on the Project.

3.5.5 EIS Public Participation Process

The EIS phase also includes a PPP (Art 15 of the ESIA regulation), with the following main objectives:

- Update the I&AP database compiled for the EDPA Phase;
- Present the results of the specialist studies, impacts assessed, mitigation measures defined and the ESMP;
- Refer to the issues raised by I&APs during the EPDA PPP, and the way they were considered in the EIS phase;
- Provide I&APs with the opportunity to participate effectively in the process and identify any additional issues and concerns associated with the proposed activity, considering the more detailed studies undertaken during the EIS; and
- Elicit comments from I&APs with regards to the EIS report and the ESMP.

The approach and main findings of the EIS public consultation are summarized in Chapter 8 of this EIS report (please see **Volume II**). For PPP purposes, a draft EIS Report was compiled and made available at strategic locations for I&APs to access and provide comment. Public meetings were advertised and held, in order to record I&APs issues and concerns and all PPP activities were documented in a PPP report (see **Volume V**).

3.5.6 EIS Submission to MITADER

Following the PPP, this Final EIS Report was produced, reflecting the comments and inputs from I&APs, and submitted to MITADER for consideration. Subject to approval of the EIS and issuing of the environmental license for the Project, all associated activities shall be governed by the ESMP, as well as any additional conditions that may be stated in the environmental license.

The ESMP will need to be adopted and further developed, by the Proponent, into a Project Environmental and Social Management System (ESMS), so as to ensure that the Project is conducted and managed in a sustainable manner. The Proponent should also ensure that its contractors abide by the ESMP, by making it a part of the contractors' contractual obligations, whenever applicable and pertinent.

4 Project Description

4.1 Introduction

This chapter provides a description of the proposed Project – the Mozambican Integrated Transmission Backbone System (STE Project) – Phase 1: Vilanculos - Maputo. The Project description does not aim to provide an exhaustive account of the engineering design, but rather focus on providing a global understanding of the proposed undertaking and describing those activities that could generate potentially significant social and environmental impacts.

4.2 Project Overview

4.2.1 Objective and Desirability

As previously stated, the main goals of the STE Project, as a whole, are to connect and integrate the current two isolated power systems in Mozambique and to allow the evacuation to the southern region of surplus power generated in the north. Phase 1 of the STE Project (Vilanculos – Maputo), currently under assessment, is justified in general terms by these same objectives. However, implementation of Phase 1 is being prioritized by EDM, so as to enable the planned investments for a new gas-fed power plant in Temane.

The following paragraphs provide more detailed information regarding the desirability of the STE Project, as a whole, and of Phase 1 (Vilanculos – Maputo) in particular.

Objectives of the STE Project

Mozambique's power supply network, operated by EDM, is currently composed of two isolated power systems:

- Central-northern system – fed by Cahora Bassa hydropower plant (2 075 MW capacity), as well as by other smaller plants, namely Chicamba and Mavuzi hydropower plants (38 MW and 52 MW, respectively) and a gas turbine power plant in Beira (12 MW). This system supplies the northern and central regions of Mozambique, namely through the following infra-structure:
  - 220kV transmission line from Matambo substation to Nampula substation and 110kV system, which connects to Nacala, Moma, Lichinga, Pemba, Auasse and Marromeu;
  - 220kV transmission line from Matambo substation to Chibata substation. From Chibata substation, there is a link at 110kV with Chicamba and Mavuzi hydro power plants and then to the main load points namely Beira, Chimoio and Manica. From Manica there is an interconnection with Zesa system at 110kV (Manica – Mutare line).
- Southern system – fed by the Southern Africa Power Pool (via Maputo and Infulene substations, at 275 kV and 110 kV respectively), as well as by the 16 MW Corumana hydropower plant and gas-fired generating facilities in Maputo (52 MW capacity) and Ressano Garcia (270 MW capacity). This system supplies the southern region of

Mozambique, through a 110 kV system, from the Maputo, Infulene, Lionde, Xai-Xai and Lindela substations.

While the transmission and distribution system described above has been adequate to supply Mozambique's power needs in the last few decades, the expected rapid development of Mozambique's economy during the following decades, mostly due to the development of mining and oil and gas projects, will require a significant overhaul of the power transmission network.

Mozambique is in possession of abundant natural energy resources including a hydropower potential roughly estimated at 12,000 MW, large amounts of coal in the Tete area and substantial proven deposits of natural gas in the Buzi, Pande, Palma and Temane areas. These resources can provide Mozambique with electric power essential for economic development and for large scale power export to neighboring countries, both in the near term and long term future, and therefore serve as a source of substantial export revenues and economic growth.

In order to develop its vast energy resources, the GoM is pursuing the development of several large scale power generation projects (such as the 1 500 MW Mphanda Nkuwa plant on the Zambezi River, downstream from Cahora Bassa) and the construction of an Extra High Voltage (EHV) transmission system north-south in Mozambique, so as to ensure the evacuation of the power generated by those new projects, thus allowing both meeting Mozambique's growing domestic and industrial needs and power export to neighboring countries. This transmission system is known as the Mozambique Integrated Transmission Backbone System, or STE Project.

When fully developed, the STE Project will include (as per the current design), two transmission lines, one high-voltage direct current (HVDC) and the other high-voltage alternating current (HVAC), each approximately 1,400 km long, from Tete Province to Maputo Province, where they will connect with existing transmission lines to South Africa.

The goal of the STE Project, as a whole, is to link the Mozambican central-northern and southern electricity transmission systems and to strengthen the regional power integration through the two transmission lines described above. This will enable the evacuation of Hydro, Gas and Coal medium and large scale power from the Zambezi river and other sources (estimated at more than 3 100 MW total), thus allowing the development of Mozambique's vast energy resources both for domestic consumption and development and for export to neighbouring countries.

Desirability of the Phase 1 of the STE Project

Due to the scale and complexity of the STE Project, EDM plans to implement it in phases. Phase 1 of the STE Project (Vilanculos – Maputo), which is the scope of this ESIA, has been prioritized by EDM for implementation as it is needed to enable a new 400 MW gas fire power generation plant in Temane (named "Mozambique gas-to-Power (MGtP)" project). According to information provided by EDM, the MGtP's technical studies are currently in the final stages of preparation.

The MGtP is expected to be one of the first of the currently planned new power generation projects to come on line, and will require an anticipated construction of the Vilanculos – Maputo section of STE Project. It should be noted that the MGtP (including both the power plant itself and the power

line connecting it to Vilanculos substation) is outside of the scope of this ESIA, as it is being subjected to an independent ESIA Process.

Given the linkage between these two projects, relevant cumulative impacts from both developments, namely habitat loss and labor influx impacts, were considered and assessed in the cumulative impact assessment section (please refer to section 7.12 in **Volume II**), and relevant mitigation included in the ESMP (see Volume III).

4.2.2 Project Location

The STE Project Phase 1 includes a new 561 km long 400 kV HVAC transmission line between Vilanculos and Maputo, the construction of three new substations – Vilanculos, Chibuto and Matalane (in Marracuene) and the upgrade of the Maputo substation (in Boane). **Figure 4.1** (next page) illustrates the administrative location of the Project.

Table 4.1 below lists the Provinces and Districts crossed by the proposed transmission line.

Table 4.1 – Administrative units crossed by STE Project Phase 1 (Vilanculos – Maputo)

Province	Districts
Inhambane	Vilanculos, Massinga, Funhalouro, Panda
Gaza	Chibuto, Mandlakaze, Chokwe, Bilene
Maputo	Magude, Manhiça, Marracuene, Moamba, Boane

4.2.3 Project Alternatives

4.2.3.1 Previously Considered Alternatives

The current design of the STE Project as a whole is the result of a number of studies undertaken by EDM in the past 10 years, which have assessed several different alternatives for the transmission backbone system. The current alignment of the Vilanculos – Maputo section of the STE Project is thus the result of a long iterative design process, which has taken into consideration both project feasibility and environmental and social sustainability aspects. The main studies developed for the STE Project over the last few years are listed below:

- Pre-feasibility study (Vattenfall, 2008) – this study considered and discussed various options aimed at evacuating future power generation schemes planned in the Province of Tete to the south of Mozambique;
- Optimization study (Vattenfall, 2009) - this study built on the pre-feasibility study to develop a technical concept for a Regional Transmission Backbone;

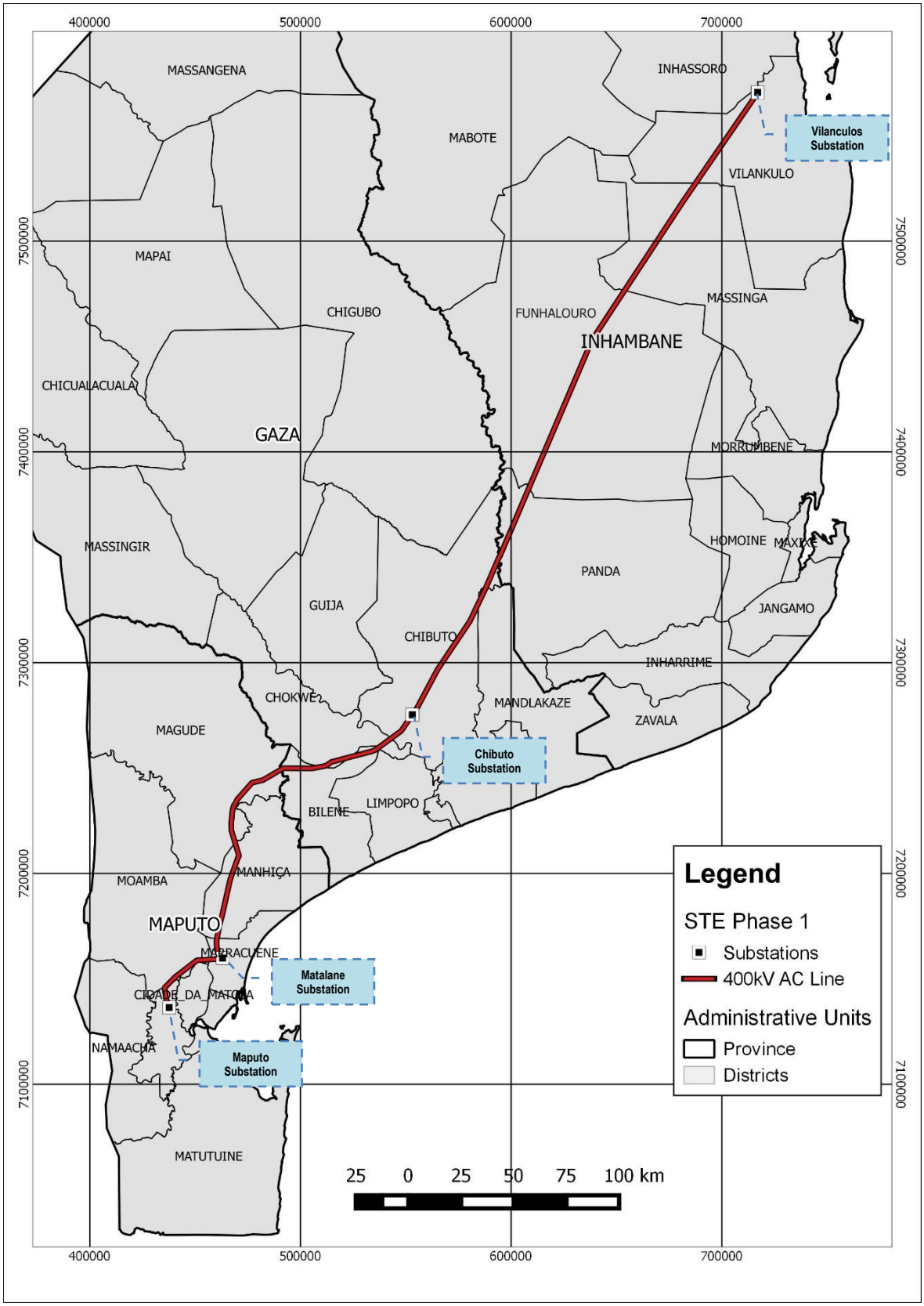


Figure 4.1 – Administrative location of the Project

- Following this, Vattenfall Power and Norconsult, the Feasibility Consultant, were hired to undertake a technical and economic feasibility study to establish the least cost option for a preferred 'Preliminary Line Route' corridor for Mozambique Regional Transmission Backbone Project as identified in the Optimization Report. The objective of the line-route study was to identify an option that met technical, social, environmental and strategic national requirements;
- In conjunction with the afore-mentioned feasibility study work, SCDS and Mott MacDonald were appointed to undertake an ESIA for the Preliminary Line Route and provide inputs into the preferred line route assessment. At all times throughout the feasibility study, the Feasibility Consultant and the ESIA consultant worked together to eliminate and refine potential routing options to reach an acceptable least cost solution that was considerate of environmental and social constraints. As such an ESIA for the STE Project was conducted between 2009 and 2011 and successfully completed (SCDS & Mott MacDonald, 2011);
- In 2012, a comprehensive technical and economic Feasibility Study (FS) of the STE Project was completed, and was again updated in 2015 (Norconsult, 2015). This FS updated the proposed routes for the STE Project, defined the production system, presented the possible scenarios, estimated costs and evaluated the economic and financial impact of the Project. One of the changes introduced in this study was the deviation of the final section of the line from Moamba to Matalane. The Project was considered viable from both a technical and economic perspective. The current ESIA is being developed to take into account the more detailed design developed in the 2015 FS.

The following sections provide a brief summary of the main Project alternatives that were assessed in each of the studies listed above.

Pre-feasibility study (Vattenfall, 2008)

In 2008, EDM and the consultant Vattenfall Power developed a pre-feasibility study, which aimed at developing the basic concept for a Regional Transmission Backbone, aiming at integrating the Central-Northern and Southern power systems and allow the evacuation of future power generation schemes planned in the Province of Tete to the south of Mozambique.

The primary consideration for this pre-feasibility study was identifying a least cost option that met these objectives, while also providing better development opportunities for Mozambique and supporting the revenue generation opportunities through export to neighbouring countries.

The pre-feasibility study included consideration of the following solutions and scenarios for the Regional Transmission Backbone:

- Only HVAC (400kV, 500kV, or 765kV voltage levels);
- Only HVDC (600kV or 800kV); and
- Combination of HVAC and HVDC.

The study concluded that the combination of HVDC at a voltage level of approximately 765kV and 400kV HVAC was the best techno-economic solution satisfying the twin objectives of national and regional development.

The initial pre-feasibility concept identified two initial schemes that became the basis for the Mozambique Regional Transmission Backbone Project:

- HVAC system (765kV) from Songo to Chibuto where it would then be transformed to 400kV to integrate into the existing southern 400kV network and eventually into the South Africa system. Phase I of the STE Project (Vilanculos – Maputo) is a part of this HVAC system; and
- HVDC system that transmits energy from existing Matambo substation to a new substation south of Maputo where it would be transformed to AC for onward connection to South Africa or into the Mozambique system.

Optimization study (Vattenfall, 2009)

In 2009, an optimization study was undertaken, that built on the pre-feasibility study to develop a technical concept for a Regional Transmission Backbone. The objective of this optimization study was to refine the pre-feasibility concept concentrating on minimizing capital costs, scheduling and finance ability. The scenarios identified for consideration included the following:

- One HVAC 765kV circuit from the north to the south;
- A second HVAC 765kV circuit form the north to the south;
- One HVDC 600kV pole from north to a new substation south of Maputo (monopole system);
- A second HVDC 600kV pole from north to a new substation south of Maputo, forming a bipolar system.

Using the above configurations a total of nine scenarios were evaluated on technical issues including stability, constructability, maintenance, operation, training requirements and resources. A specific objective in addition to technical compatibility was to maximize flexibility for future expansion potential in Mozambique to support economic and welfare development in the future, this aspect played a key role in the final decision making process. The final proposed concept design that became the STE Project was dimensioned for 3100 MW and included:

- A 400kV line (HVAC) from Songo to Maputo; and
- Pole 1 of the HVDC 800kV system (Songo-Maputo).

The optimization study also indicated the option of future expansion of the 800 kV System (Pole 2) to increase the capacity to 6 000 MW.

Preliminary Line Route Corridor (Vattenfall & Norconsult, 2011) and ESIA (SCDS & Mott MacDonald, 2011)

In 2011, Vattenfall Power and Norconsult (Feasibility Consultant) were hired to undertake a technical and economic feasibility study to establish the least cost option for a preferred 'Preliminary Line Route' corridor for the STE Project, as defined in the Optimization Study. The objective of the line-route study was to identify an option that met technical, social, environmental and strategic national requirements.

In conjunction with the afore-mentioned feasibility study work, SCDS and Mott MacDonald were appointed to undertake an ESIA for the Preliminary Line Route and provide inputs into the preferred line route assessment (SCDS & Mott MacDonald, 2011). At all times throughout the feasibility study,

the Feasibility Consultant and the ESIA consultant worked together to eliminate and refine potential routing options to reach an acceptable least cost solution that was considerate of environmental and social constraints.

The sections below briefly describe the alternatives assessment developed by the Feasibility Consultant and the 2011 ESIA team.

Routing Principles

The criteria that were adopted by the Feasibility Consultant and 2011 ESIA team to identify the initial potential corridors for the STE Project were the following:

- Principle 1 – Avoid altogether, if possible, the major areas of highest amenity value namely internationally and nationally recognized conservation sites and known archaeological sites;
- Principle 2 – Avoid areas of smaller amenity value or scientific interest including provincially and locally recognized conservation site;
- Principle 3 – Minimize effects of new infrastructure on communities by having particular regard to safety, noise and construction traffic;
- Principle 4 – Where possible chose inconspicuous locations for angle towers, terminal tower and sealing end compounds;
- Principle 5 – Choose tree and hill backgrounds in preference to sky backgrounds wherever possible. Where the line has to cross a ridge, secure the opaque background as long as possible and cross obliquely;
- Principle 6 – Prefer moderately open valleys with woods where apparent height of towers will be reduced and views of line will be broken by trees;
- Principle 7 – Minimize crossings with other high voltage transmission lines;
- Principle 8 – In country which is flat and sparsely planted keep the high voltage lines as far as possible independent of smaller lines, converging routes, distribution poles and other masts, wires and cables, so as to avoid concentration of 'wirescape'.

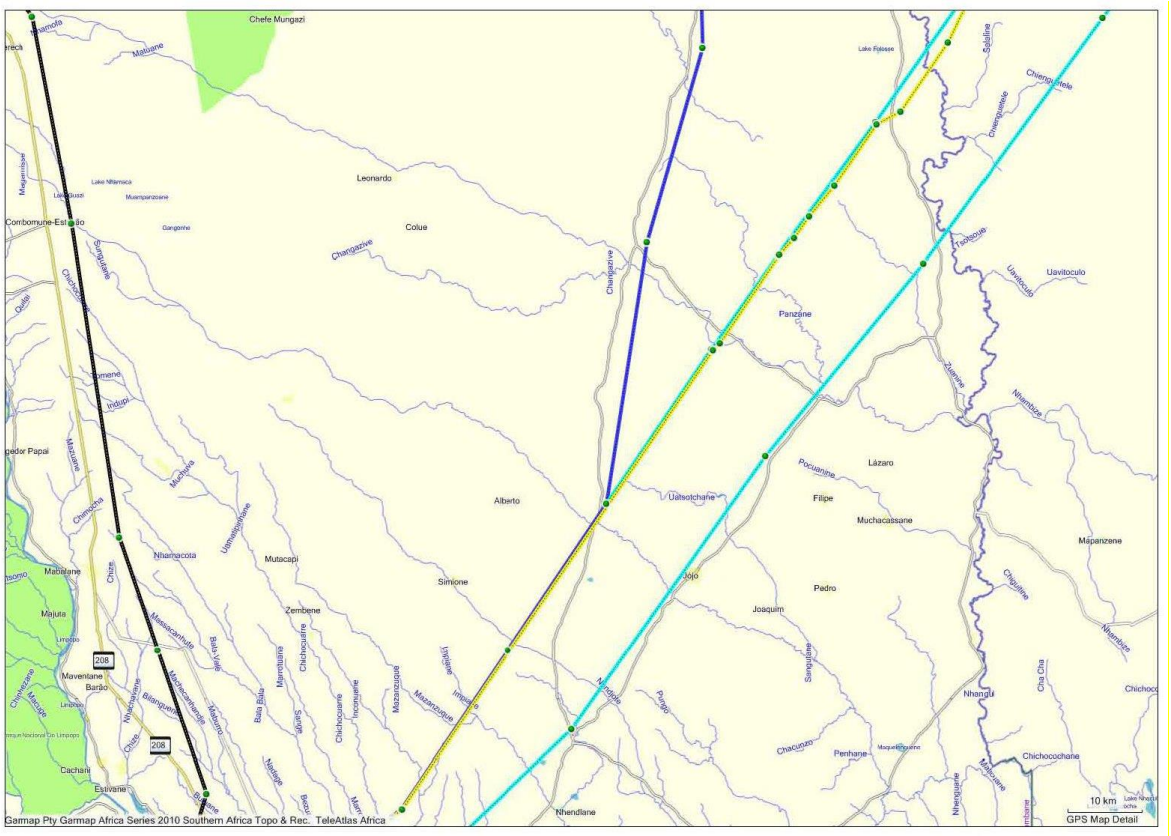
The initial potential corridor options were defined in accordance with these routing principles. These corridors were then assessed for their environmental and social suitability. Preliminary consultation was held at the district level to elicit views on the routing corridors and also from EDM in relation to their future system expansion plans.

This process also supported the identification of preferred substation locations along the 400kV overhead line (OHL) route. Through the application of the routing principles and the baseline characterization an initial review of all available options presented by the Feasibility Consultant was made by the 2011 ESIA team. Key decision making that informed the preliminary assessment stage included the elimination of all route corridors that exhibited the following:

- Passed through National Parks (including straight route options). It was considered that all alternate options though the national parks did not offer sufficient economic benefits to warrant their further consideration;
- Did not support the principle of avoiding major settlements; and

- Crossed areas of high topography or sensitive environmental features e.g. large water bodies.

Figure 4.2 below shows an example of one of the early corridors considered during this phase of project development. A complete description of all studied corridors in this phase is provided in SCDS & Mott MacDonald (2011).



Source: SCDS & Mott MacDonald (2011).

Figure 4.2 – Example of initial Project corridors assessed in the Preliminary Line Corridor Study in 2011

Route Verification

The selected corridors, based on this initial review, were then further refined through a systematic review of the key environmental and social components, in order to identify the routes with lowest impact on these components. This included the compilation of environmental and social baseline information, site visits, local consultation and a technical flyover. **Figure 4.3** illustrates potential routes that were verified during this phase of the alternatives assessment process.

Minor route re-alignments were made at this stage, in order to:

- Avoid small size permanent rural settlements (where possible);
- Deviate around granite outcrops;
- Avoid large specimen baobab where possible;

- Identify potential tower locations to minimize tree clearance through densely forested undulating terrain;
- Verify suitability of river crossings with respect to settlements, areas of cultural importance (grave sites) and agricultural land use;
- Identify locations that would minimize construction impacts near watercourses by enabling river crossings to be done with a single span;
- Readjust preferred location for angle towers and better align with existing access routes;
- Minimize number of road, existing lines and utility corridor crossings in particular major roads; and
- Verify the substation locations against substation sitting principles.

Source: SCDS & Mott MacDonald (2011).

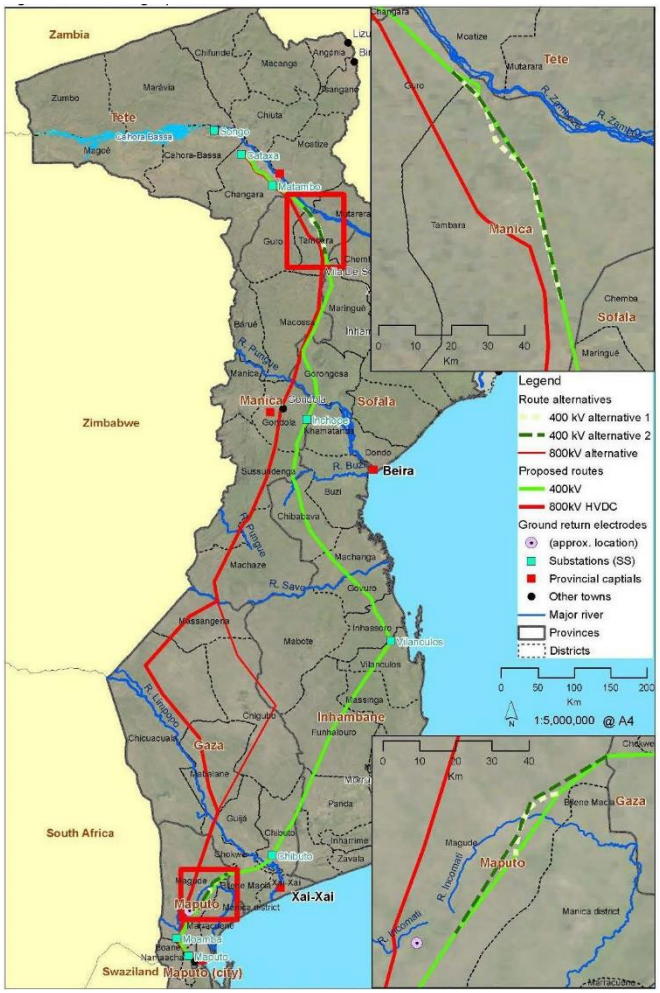
Figure 4.3 – Example of alternative routes assessed in the route verification phase

Following confirmation of the environmentally and socially preferred route option, each line route was subject to a final stage of assessment of the project specific engineering and economic considerations. The preferred 400kV HVAC and 800kV HVDC line routes were then taken forward for assessment in the 2011 ESIA.

Routing optimization as a result of the 2011 ESIA

As a result of the 2011 ESIA, the line routes were further subjected to small variations as a result of the environmental and social assessment. This included re-routing of sections of the line that passed

through the Xinavane sugar cane plantation (Maputo Province) and Coutada 13 (Manica Province), in order to avoid significant impacts in these areas. These revised routing decisions are illustrated in the following figures.



Source: SCDS & Mott MacDonald (2011).

Figure 4.4 – Re-routings of part of the STE Project to avoid impacts on sensitive areas resulting from the 2011 ESIA

Feasibility Study (Norconsult, 2012) and Feasibility Study updated (Norconsult, 2015)

Even though an ESIA was undertaken in the 2011, as described above, the STE Project did not go through to the implementation stage, as further development of the engineering was required. As such, a comprehensive technical and economic Feasibility Study of the STE Project was developed in 2012. This study updated the proposed routes for the STE Project, defined the production system, presented the possible scenarios, estimated costs and evaluated the economic and financial impact of the Project. In 2015 this Feasibility Study was updated (Norconsult, 2015), to reflect the latest changes to EDM's strategic approach.

The Project was considered viable from both a technical and economic perspective. This ESIA is being conducted based on the design from the 2015 Feasibility Study

Conclusion

The Vilanculos – Maputo power line alignment under assessment in this ESIA has thus been the result of a long iterative design process that has been developed during the last 10 years, through multiple engineering and environmental studies. Throughout those studies, several possible alternatives were investigated, both from an engineering and environmental and social point of view, in order to identify the best possible route alternative.

4.2.3.2 Alternatives Currently under Assessment

The current ESIA is being developed to take into account the more detailed design developed in the 2015 feasibility study (Norconsult, 2015). As previously described, the STE Project Phase 1 (Vilanculos – Maputo) alignment under assessment in this ESIA has been the result of a long iterative design process that has been developed during the last 10 years, through multiple engineering and environmental studies.

Throughout those studies, several possible alternatives were investigated, both from an engineering and environmental and social point of view, in order to identify the best possible route alternative, as discussed in the previous section. As such, only the best alignment selected by the engineering design process described above is under assessment in this ESIA Process. The alternatives currently under assessment are thus the following:

- Alternative 1: No-go alternative (no project).
- Alternative 2: STE Project Phase 1.

If the no-go alternative (Alternative 1) is selected, this implies that the proposed Project would not be executed. In this alternative, the environment would remain in its current state and there would be no negative or positive environmental and social impacts associated with the development. However, this would also imply that the related generation projects in Mozambique will be difficult to realize and potentially result in independent solutions being proposed rather than enabling an integrated approach to address the strategic need of Mozambique to improve its energy infrastructure. Furthermore the benefits in relation to integration with the SADC and revenue generation will be lost.

If Alternative 2 is selected (implementation of the STE Project Phase 1), then all the benefits of the Project will be realized (integration of Mozambique's power transmission systems, also enabling the development of power generation projects), as well as all associated negative and positive environmental and social impacts. These impacts are assessed in Chapter 7 of this EIS report (see **Volume II**).

It should be noted, however, that minor re-routings of the Vilanculos – Maputo alignment may still be introduced, during the detailed engineering design phase, as a result of the ESIA findings. Specifically, a minor line rerouting is proposed in this ESIA, in the Vilanculos-Chibuto segment, so as to avoid a patch of miombo forest that has been categorized as critical habitat (**Figure 4.5**).

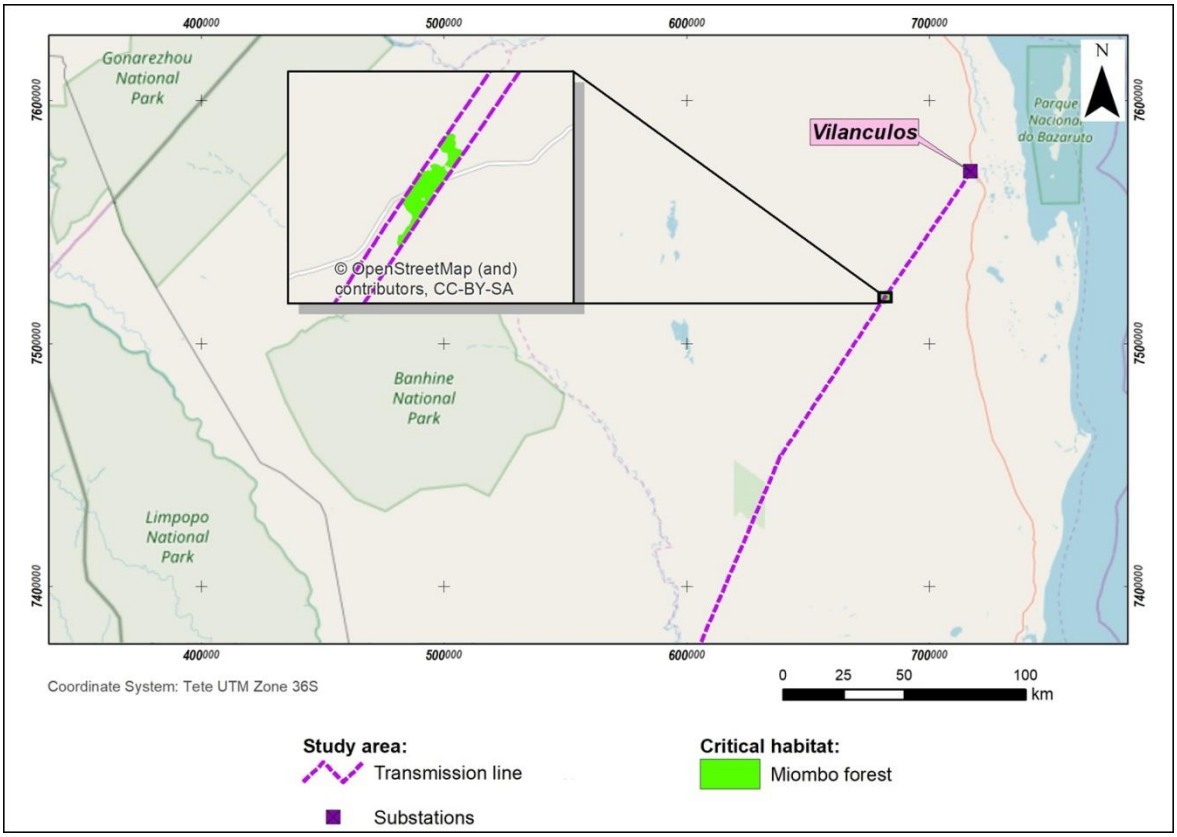


Figure 4.5 – Location of the patch of miombo forest for which a minor rerouting is proposed

4.3 Project Description

4.3.1 Main Project Components

The main components of the STE Project Phase I are the following:

- Construction of a 561 km long 400 kV HVAC transmission line, from a new substation near Vilanculos to the existing Maputo substation, in Boane. The capacity of the new transmission line will be approximately 950 MW;
- Construction of three new substations - Vilanculos, Chibuto and Matalane (in Marracuene);
- Upgrade of the Maputo substation (in Boane).

The following sections provide additional information for each of these Project components.

4.3.2 Project Components Description

This section describes the main technical characteristics of the Project components listed above, based on the Feasibility Study (Norconsult, 2015) and SCDS & Mott MacDonald (2011).

4.3.2.1 Transmission Line

The main component of the Project is the overhead transmission line (OHL). High-voltage OHLs transmit large amounts of electricity over long distances. The OHL will be supported by three main types of lattice steel towers, namely:

- Suspension towers, which support the conductors on straight stretches of line. Two different designs of suspension towers will be used on this Project - self supporting and guyed V-towers;
- Tension towers, which are used at points where the route changes directions. Self supporting tension Y-towers will be used; and
- Terminal towers, which are used where the line terminates at substations.

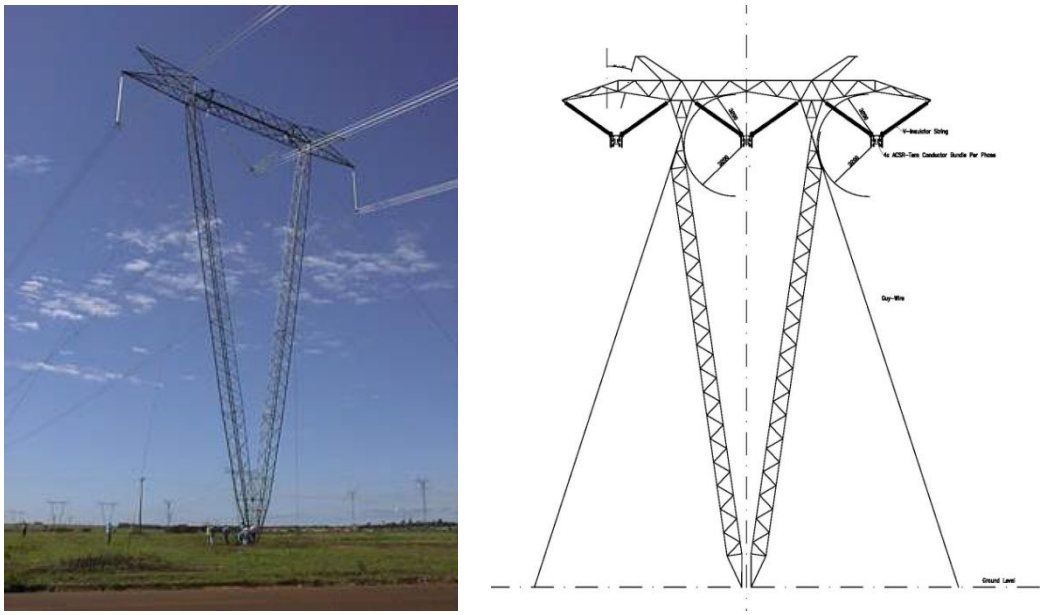
The distance between towers (span length) will typically vary between 400 m and 500 m, going up to 800 m in areas of difficult terrain or to facilitate single span river crossings. Tower height will be dependent on the terrain, height above sea level and span length. **Table 4.2** provides an overview of the OHL technical features.

Table 4.2 – Overview of technical features of the OHL

Technical Characteristics	400 kV OHL
Number of tension towers	51
Number of suspension towers[(a)]	1632
Typical distance between towers	400-500m
Typical tower height	20 - 35m

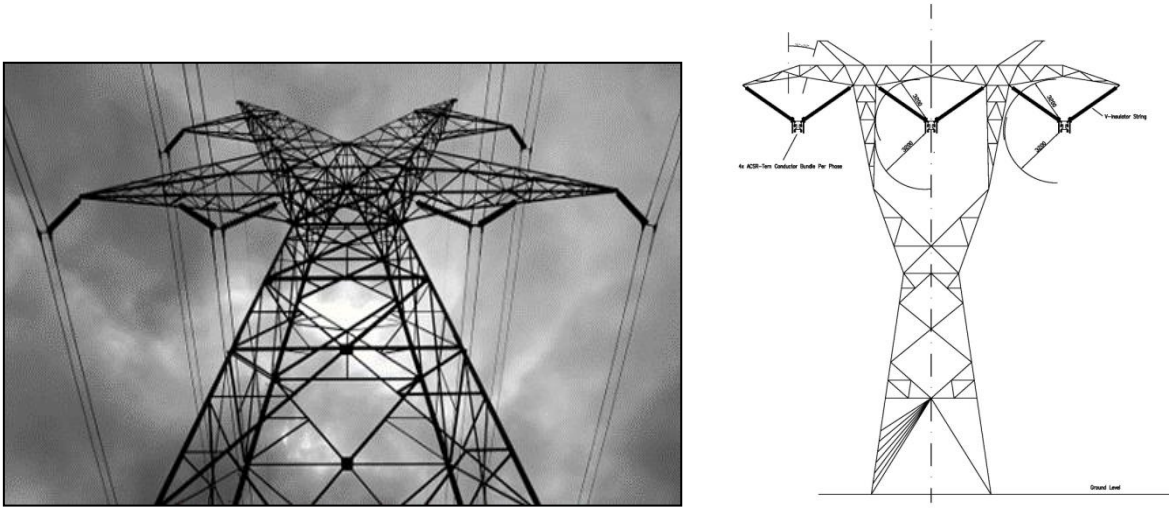
Source: Norconsult (2015); SCDS & Mott MacDonald (2011). **Note**: [(a)] - Based on a rough assumption of 3 towers per kilometer (excluding tension towers).

Examples and schematics of typical tower types are illustrated in the following figures.



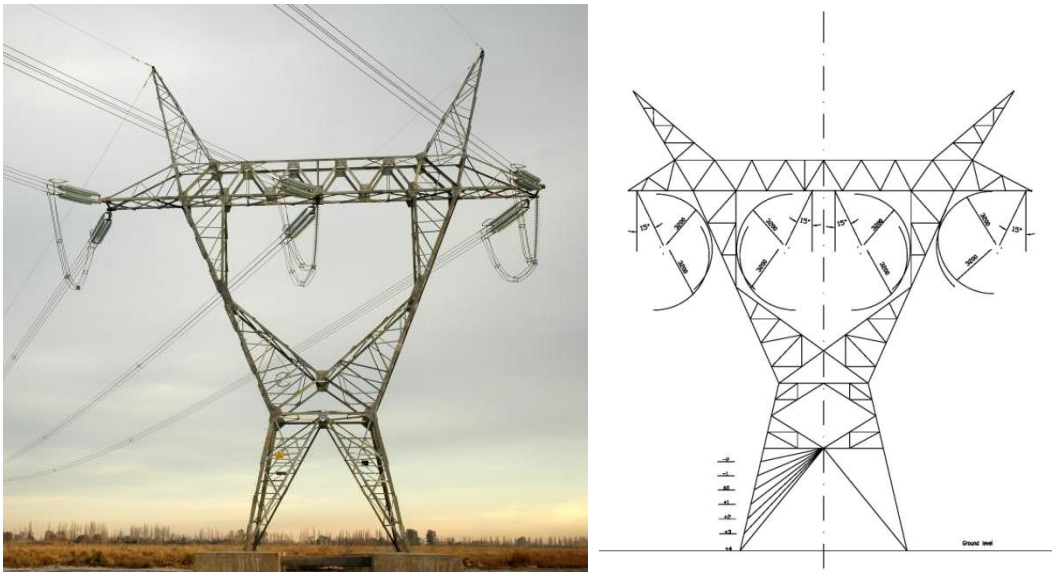
Source: SCDS & Mott MacDonald (2011); Norconsult (2015).

Figure 4.6 – Example and schematics of typical suspension guyed V-tower



Source: Consultec (2016); Norconsult (2015).

Figure 4.7 – Example and schematics of typical self-supporting suspension tower



Source: SCDS & Mott MacDonald (2011); Norconsult (2015).

Figure 4.8 – Example and schematics of self-supporting tension Y-tower

Table 4.3 summarizes tower footprint and foundation requirements.

Table 4.3 – Tower footprint and foundation requirements

Tower requirement	Tension Y-Tower	Suspension guyed V-tower
Number of foundations	Four concrete bases, normally installed 3 to 4 m deep in the soil.	One concrete foundation and 4 guy ropes with small foundations.
Average footprint	10 m x 10 m (100 m^2)[(a)]	65 m x 45 m (2925 m^2)[(b)]
Foundation type	Main type are 'piled', 'pad and chimney', and 'anchors'. Actual size and type will depend on the type of tower and the sub-soil conditions. Angle towers will require more extensive foundations	

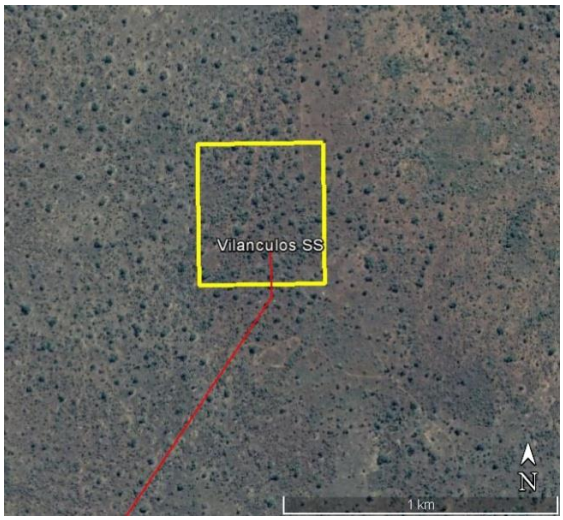
Source: SCDS & Mott MacDonald (2011). **Notes**: (a) - Footprint - outer border of the four concrete bases at ground level. (b) - Footprint defined as the outer border of the guy wires. The area inside the footprint can be used although may restrict movement of machinery.

4.3.2.2 Substations

As previously stated, the construction of three new substations will be required – Vilanculos, Chibuto and Matalane (in Marracuene). The location of these substations is illustrated in **Figure 4.1** above and **Figure 4.9**, while their main characteristics are provided in **Table 4.4** below.

Table 4.4 – Overview of technical features of the new substations

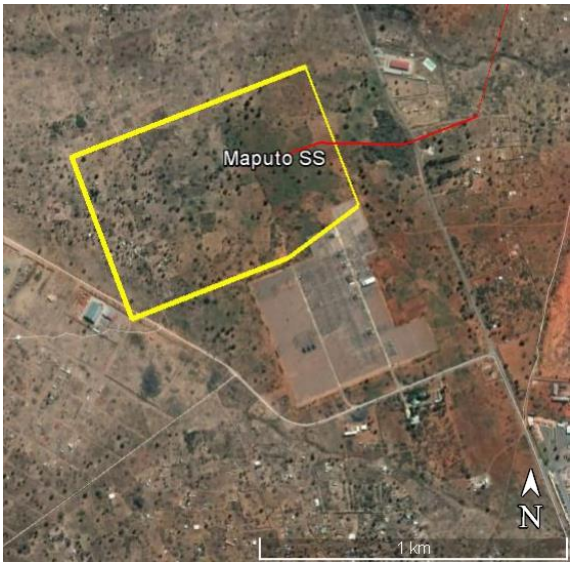
Technical Characteristics	Vilanculos	Chibuto	Matalane
Coordinates	S21° 57' 21.5" E35° 06' 05.7"	S24° 38' 08.1" E33° 31' 28.7"	S25° 40' 42.9" E32° 37' 55.0"
Transformers	400 / 110 kV	400 / 220 kV	400 / 275 kV
Operational area	250 m x 300 m (7.5 ha)	280 m x 300 m (8.4 ha)	1 000 m x 1 000 m (100 ha)
Access road	New access road of approximately 2 km from EN1.	New access from the N208 highway using existing track where possible.	New access from the N1 highway using existing track where possible.



Site of the new Vilanculos substation

Site of the new Chibuto substation

Site of the new Matalane substation (in Marracuene)



Site of the expansion of the Maputo substation (in Boane)

Figure 4.9 – Sites of the Project's proposed substations

Further to the new substations, the expansion of the existing Maputo Substation will also be required. The existing Maputo substation is similar in size compared to the extension required. The existing substation covers approximately 20 ha, but according to EDM the total reserved area available for substation expansion is roughly 100 ha. There is an access road through the existing substation site to the available land for the new extension.

A substation is located on an area of land comprising an operational compound enclosed by steel fencing with electric security fencing on top. The compound is typically level and surfaced with stone chippings, with the internal access roads constructed in tarmac. Stormwater drainage systems are required.

The conductors enter the site via landing gantries, approximately 15 m high, from where the conductors cross the site on a series of parallel, steel structures between the transformers. The transformers reduce the voltage from 400kV to a lower voltage for onward supply. Typically, the substation site also includes office buildings constructed from concrete blocks and a car park. The following figures illustrate typical components of a substation.

Figure 4.10 – Example of a typical substation – current Maputo substation in Boane

Source: SCDS & Mott MacDonald (2011).

Figure 4.11 – Examples of a typical transformer (left) and substation office buildings (right)

4.3.2.3 Support Components and Activities

Overview

Further to the Project's main components, described above, the implementation of the STE Project Phase 1 will require a number of complementary components and activities, which are required to support the Project's construction or to allow its operation and maintenance. These include:

- Development and maintenance of right-of-way (RoW);
- Construction of access roads, for line construction and maintenance purposes;
- Exploration of borrow pits to provide aggregates and inert materials;
- Establishment of construction camps, including temporary workers' accommodation and temporary storage sites for equipment and materials.

Some of these activities are discussed in further detail below.

Establishment of right-of-way (RoW) and vegetation clearance

A 100 m corridor (50 m to each side of the center line) will be established as the OHL RoW. The RoW is required to protect the system from windfall, contact with trees and braches and other potential hazards that may result in damage to the system, power failures or forest fires. The RoW will also be utilized to access, service and inspect the OHL.

The size of the proposed RoW has been specified with reference to the Land Law (Law No. 19/1997) and its regulation (Decree No. 66/98).

Any infrastructure located within the RoW will be removed or relocated. Impacts associated with the RoW clearance are assessed in this ESIA report. In terms of vegetation clearance, the minimum standards to be used for clearance are indicated in **Table 4.5** below.

Table 4.5 – Standards for vegetation clearance within the OHL RoW

Item	Construction clearance	Operational maintenance
Centre-line of the OHL (minimum clearance strip)	Clearance of all vegetation in a 30 m corridor (area directly under the line to be cleared)	Re-growth shall be cut within 50 mm of the ground and maintained through manual labor as necessary. The use of herbicide is not envisaged
Inaccessible valleys (trace line)	If no other alternative, clear 1 m strip for access by foot only, for the pulling of a pilot wire by hand or make use of a helicopter, or other technique, to fly line across	Vegetation not to be disturbed after initial clearance – vegetation allowed to re-grow
Vegetation within the RoW, but outside the minimum clearance strip	Selective trimming or cutting down of those identified plants interfering or posing threat to the integrity of the power line. This typically includes the clearance of all vegetation above 3 m height within a 50 m corridor. This also includes consideration of those trees that may grow to pose a future threat within the nominated maintenance period (typically three years).	Selective trimming.
Tower position and support / stay wire position	Clear all vegetation within the proposed tower position and within a maximum radius of 6 m around the position, including de- stumping cutting stumps to ground level, treating with herbicide and re-compaction of soil.	Re-growth shall be cut within 50 mm of the ground and maintained through manual labor as necessary. The use of herbicide is not envisaged

Source: SCDS & Mott MacDonald (2011); Norconsult (2015).

Construction of access roads

During construction, road access will be required to each tower location. Where possible, access will be via existing roads (which may need to be upgraded, in order to allow circulation of heavy vehicles transporting materials and equipments) or through the RoW. Where this is not possible, new accesses will be built. In principle, these will be temporary accesses, for use during the construction phase only, but it is possible that some permanent accesses are built, if they are essential for the operation and maintenance of the line infrastructure. The alignment of these accesses will be the responsibility of the construction contractor, under EDM supervision.

The ESMP (see **Volume III**) provides some guidance regarding the minimum requirements that the contractor will have to abide to, when defining accesses, so as to minimize their environmental and social impacts. Note, however, that new accesses may require additional environmental licensing, if their design triggers the criteria defined in the ESIA Regulation for road ESIA assessment. If additional environmental licensing is required, this will be the responsibility of the Contractor, under EDM supervision. The ESMP provides guidance on how the environmental assessment of construction access roads should be developed.

Opening and exploration of burrow pits

The inert materials and aggregates required for access construction and civil works associated with the OHL's and substations will be sourced from burrow pits. The aim will be to source these materials as close to the work site as possible. The location of these borrow pits is not defined at this phase of Project development, and will be selected by the construction contractor with approval from EDM and District authorities.

The ESMP (see **Volume IIII**) provides some guidance for borrow pit selection, so as to minimize their impacts. Note, however, that new borrow pit opening requires environmental licensing. If new burrow pits are required for Project implementation, their environmental licensing will be the responsibility of the Contractor, under EDM supervision. The ESMP provides guidance on how the environmental assessment of borrow pits should be developed.

Establishment of construction camps

A number of construction ancillary infra-structure will be required, including temporary worker accommodations, machinery parks, material and equipment storage areas and other construction support areas. Considering the full extension of the OHL (561 km) it is likely that camps will be establishment in more than one location. However, the location of these construction camps is not yet defined and will be the construction contractor responsibility, with approval from EDM and District authorities taking into account such aspects as access to the camp, to water and to other matters. The ESMP (see **Volume IIII**) provides some guidance for construction camp location, as well as other requirements, so as to minimize their environmental and social impacts. The ESMP also provides guidance on how the environmental assessment of construction camps should be developed.

4.3.3 Construction Phase

4.3.3.1 Construction Activities

Overhead line construction

Table 4.6 below describes the main construction activities associated with the OHL. It is expected that construction will begin in the north, near Vilanculos, and progress south towards Maputo. Construction of the 400kV OHL is likely to be undertaken simultaneously by teams of men operating in a sequential process through the key phases of site clearance, enabling works, civil works, steel erection, and commissioning. It is not yet determined whether more than one team will be working on different sections of the same line at the same time, this will be determined during the construction contractor appointment phase.

Table 4.6 – Typical phases of overhead line construction

Activity	Description
Site preparation	This may include vegetation clearance, where the line passes over or close to trees which could infringe safe clearances, as well as verification of local utilities and underground services, and geotechnical surveys, as necessary.
Work camps	Work camps that will be located along the proposed alignment. The number of camps required will depend on the detailed work schedule to be elaborated by the selected contractor and on the number of work teams required to respect this schedule.
Site enabling works	Vehicle access to each tower site is required either via direct access road or along the RoW. In certain circumstances where ground conditions prevent normal access, it may be necessary to construct a temporary access road.
Civil works	Tower foundations are constructed first. The foundations are mechanically excavated and filled with concrete. Piled foundations may be required in some areas where ground conditions are unstable. The dimensions of the excavation will differ depending on the type of tower to be installed. Concrete will be delivered by ready mixed concrete truck from batching plants strategically located along the route.
Steel erection	Steelwork sections for the towers will be delivered by road using a 4 x 4 lorry. The assembly of each tower at ground level would proceed as far as possible until the utilization of a crane becomes necessary to enable the higher sections of the tower to be completed. It is normal practice to use cranes to erect steelwork, subject to good access being available. Where terrain is difficult and to minimize disturbance, steelwork may be delivered by helicopter.
Conductor stringing	Stringing is undertaken using a winch to pull the conductor along the towers and a "tensioner" at the other end to keep the conductor above the ground. Typically the section length is 8-10 km. These winch locations are not fixed and can be selected to minimize impact in particular at sensitive locations.
Testing of equipment	Overhead line components including conductors, insulators, towers, joints and fittings are designed and tested to prove compliance with structural, mechanical and electrical requirements.
Reinstatement of tower construction area	At completion, the area will be cleared and tidied up. Fences and hedges will be repaired and access routes and disturbed land will be reinstated in agreement with the land users and title owners. Any site security fences would be retained throughout the dismantling and construction process.

Source: SCDS & Mott MacDonald (2011).

Substation construction

Table 4.7 below describes the main construction activities associated with the Project substations.

Table 4.7 – Typical phases of substation construction

Activity	Description
Site preparation	This may include vegetation clearance as well as soil and geotechnical investigations. Vegetation is cleared from construction site storage and working areas.
Work camp	Work camps that will be located close to substation or within the substation area. The size and organization of each camp will depend on contractor work team required to respect his construction schedule.
Site enabling works	The civil infrastructure for the site is established including piling as required for any new foundations. This includes creation of new access. Site drainage (where necessary) will be installed together with foundations for electrical plant and a security fence erected. The integrity of bunds is tested.
Plant installation	The key plant items including transformers are delivered to site and maneuvered into position using specialized methods suitable for abnormal loads. Other electrical plant and equipment is lifted into position using small mobile cranes. The equipment is bolted to the pre-constructed concrete foundations.
Electrical and control	Electrical cables, equipment, and protection and control instrumentation systems are installed by specialist contractors.
Commissioning	The commissioning phase will ensure that the substation control systems are in place and functioning correctly before the new substation equipment is put into operational use as part of the transmission system. Commissioning involves the testing of control systems and software and would require little or no additional construction activity. Impacts associated with commissioning are minimal.

Source: SCDS & Mott MacDonald (2011).

4.3.3.2 Construction Materials and Equipment

Materials

The following materials are expected to be required for the construction phase:

- Inert materials and aggregates required for construction of roads and civil works (tower bases and substations). These will be sourced from borrow pits, to be selected by the construction contractor(s);
- Water will be required for concrete batching and to supply construction camps and worker accommodation.

Chemical products

No relevant chemical products will be required for the construction phase, other than normal chemicals used in any civil construction works (such as lubricants, oils, cleaning products, etc.).

Equipment

The construction phase will use common civil construction equipment, including trucks, cranes, earthmoving machinery, etc.

Fuel and Oil Requirements

During construction, fuel and oil will only be required to operate the construction machinery, and as such will be similar to any similarly sized construction work. Fuel and oils will be sourced from commercial entities in the national market.

Water and Energy Consumption

During construction, electricity will only be required to supply the construction camps and worker accommodation, and will be sourced either from EDM's national grid or generators.

As for water consumption, and as stated above, water will be required for concrete batching and to supply construction camps and worker accommodation. The required volumes will be sourced from local sources or public supply.

4.3.3.3 Waste Management

The waste management procedures for the construction phase will follow the guidelines defined in the Waste Management Plan, included in the ESMP (see **Volume III**).

4.3.3.4 Workforce

Based on similar developments, a total of 250 workers, including specialized and non-specialized workers, will likely be involved in the transmission line construction works, while roughly 50 to 100 workers will be needed to install the substation equipment and instrumentation.

4.3.4 Operational Phase

4.3.4.1 Main Activities

Overhead line (OHL) operation

The main works associated with the OHL during the operational phase is keeping a cleared RoW maintained, tower and line inspections and line maintenance works. Clearance of vegetation is necessary to avoid disruption to the OHL and towers. If tree and plant growth is left unchecked, there are higher risks of power outages from contact with trees, forest and bush fires, corrosion of steel equipment, equipment access blockages, and interference with grounding equipment. The requirements for clearance of RoW during the operational phase are described above in **Table 4.5**. Wherever possible, EDM will seek to employ local teams along the route to undertake this vegetation control.

Access for technical inspection and repairs will be intermittent and use existing access roads and take place within the existing RoW. One aspect that will be monitored during technical inspections is the approximation of new infra-structure to the RoW that may constitute a risk to the OHL.

Substations

During operation the substations will be mostly automated. Each substation will have four permanent workers (operating a three shift system). Maintenance works will be intermittent and within the operational site boundary.

4.3.4.2 Operation Materials and Equipment

Materials

No raw materials will be required for the operational phase. Replacement parts may be required to replace broken or failing elements.

Equipment

During the operational phase, only standard equipment, such as light vehicles for RoW inspection and hand tools for vegetation clearance, will be used.

Fuel and Oil Requirements

The fuel and oil requirements during the operational phase will be negligible, as they will be limited to the vehicles used for RoW inspections and the emergency generator.

Water and Energy Consumption

No relevant water or energy consumption needs were identified for the operational phase.

4.3.4.3 Waste Management

The waste management procedures for the operational phase will follow the guidelines defined in the Waste Management Plan, included in the ESMP (see **Volume III**).

4.3.4.4 Workforce

Workforce needs for the operational phase are expected to be very low. The operation of the OHL and substations will mostly be performed by EDM's existing personnel. Further to this, and as stated above, local teams may be employed to perform maintenance clearance of the RoW and each substation may have four permanent workers.

4.3.5 Decommissioning Phase

Transmission lines are normally designed for a life span of 30 years or more, and they are rarely decommissioned but rather undergo regular maintenance. Hence, the decommissioning phase of the scheme, if effectively required, is likely to occur in a relatively distant timeframe, and as such the degree of confidence regarding the activities to be developed at that stage is relatively low. In general, however, the decommissioning phase will include the following activities:

- Removal of foundations and towers;
- Removal of wastes and decontamination of sites;
- Disposal of wastes and hazardous materials, in adequate waste disposal facilities; and
- Devolution and reuse of ROW, in line with the proposed end use.

Given the distant timeframe of these activities, a Decommissioning Plan should be developed by EDM prior to decommissioning, in order to minimize the environmental and social impacts of decomimissioning. The site will be returned to a condition suitable for reuse in line with the proposed end use. A full environmental departure audit will be undertaken that will examine, in detail, all potential environmental risks existing at the site and make comprehensive recommendations for remedial action as necessary. Following completion of the demolition, a final audit will be carried out to ensure that all remedial work has been completed.

4.3.6 Investment Budget

The total estimated investment budget for the Project is roughly of 600 million USD (American dollars). Please note that this figure is an estimate and may change during detailed engineering.

4.4 Project Timeframes

The construction and commissioning of the STE Phase 1 (Vilanculos – Maputo) Project will have a total duration of up to 4 years, with planned start in end 2019 and conclusion in 2023. The expected lifetime of the OHL and substations is of 30 years. However, with adequate maintenance and/or upgrading it may stay in operation for longer than that.

5 Project Areas of Influence

5.1 General Considerations

The ESIA Regulations define the Area of Influence (AoI) as the geographical space directly or indirectly affected by an activity's environmental impacts. Despite this seemingly straightforward definition, in practice the definition of a project's AoI is not an easy task, given that the AoI is a function of a large number of factors which have changing and varying degrees of influence on the areas surrounding the project throughout the course of the project's lifecycle.

The AoI can therefore be thought of as the sum of a number of fluctuating factors. The geographical extent of some of these can be partially quantified (e.g. the area of vegetation cut down in the OHL RoW), while the extent of others is very difficult to measure (e.g. direct and indirect economic effects). Project impacts also change over time, e.g. a project employing hundreds of workers during construction, but only a small number once operational, has a very different social AoI in those two phases.

A further consideration is the presence of other organizations or developments - each with their own AoI - within the AoI of the proposed project, making it very challenging to assign an AoI to each individual development. To this end it is often useful to consider and/or adopt existing units, such as shorelines, catchments, cadastral boundaries (national, provincial, local), linear infrastructure (notably railway lines, roads, rivers, canals etc.) when defining the AoI.

Considering the above, determining the AoI therefore requires informed but subjective judgment, based on available information and the knowledge of previous and similar project impacts, combined with practical findings.

The ESIA Regulations require the definition of an Area of Direct Influence (ADI) and an Area of Indirect Influence (AII). The following sections outline the AoI for the proposed STE Phase 1 Project, in line with the considerations described above, and based on the findings of the specialist assessments developed for this EIS.

5.2 Area of Direct Influence (ADI)

The Project's ADI is made up of two components:

- The footprint area, i.e., the area occupied by the Project's infrastructure; and
- The area where direct impacts from the construction and operational activities will be felt.

The footprint includes the area occupied by the OHL's towers, the substations and the RoW to be established. In the construction phase, the footprint also includes ancillary infrastructure such as temporary access roads and construction camp sites. It is expected that these ancillary infrastructures will be located in the immediate vicinity of the Project site, but their exact location is not known at this stage. Within the footprint area, several activities will be implemented such as soil stripping, vegetation clearing, earth movements, etc., but they will be contained to their footprint.

When considering the Project's direct impacts outside of the footprint area, it is useful to separate the biophysical and socioeconomic impacts. Therefore, the Project's ADI is delineated as follows:

- **Biophysical environment**: it is expected that all direct biophysical impacts resulting from Project construction and operation will be limited within a corridor centered in the OHL alignment, with maximum width of 300 m (150 m to each side of the center line). This width accounts for the RoW and for a wider construction corridor, which will likely be required to establish temporary accesses, machinery movement, etc.;
- **Socioeconomic environment**: the communities crossed by the proposed RoW. Even if employment and economy stimulation may extend to other communities, direct socioeconomic impacts are expected to be felt mostly by the villages and communities crossed, or near, the alignment. However, a map of community boundaries is not available for the Project area and therefore the socioeconomic ADI is illustrated using a 2 km wide corridor centered on the line's route.

Direct impacts are also to be expected in the areas where the auxiliary construction facilities will be located (construction camps, temporary accesses, burrow pits). However, the locations of these areas are not known at the present time, and thus they will not be taken into account for the definition of the Project ADI.

Figure 5.1 illustrates the socioeconomic ADI, which includes the biophysical ADI.

5.3 Area of Indirect Influence (AII)

The Project's AII is the geographic area where indirect impacts are likely to be felt, or in other words, where secondary impacts resulting from direct ones are felt.

In terms of the biophysical environment, few or no indirect impacts are expected outside of the AID. A notable exception to this will be the increase of the exploration of natural resources along the OHL RoW, in particular where the line crosses patches of woodland where other easy accesses are currently unavailable. The presence of the line RoW will increase the ease of access to these areas, which will likely increase the exploration of natural resources such as firewood. Other socioeconomic indirect impacts will likely be felt, namely associated with creation of job opportunities, mobilization of workforce, development of informal commercial activities, etc. These indirect impacts are likely to be experienced mostly in the areas closer to the OHL alignment.

As such, the Project's AII is defined as follows:

- **Biophysical environment**: a 2 km wide corridor, centered on the OHL alignment;
- **Socioeconomic environment**: the boundaries of the districts crossed by the OHL, as benefits and impacts from Project-induced changes in the ADI are likely to extend to other communities within these territories.

Figure 5.1 below illustrates the AII for the proposed Project.

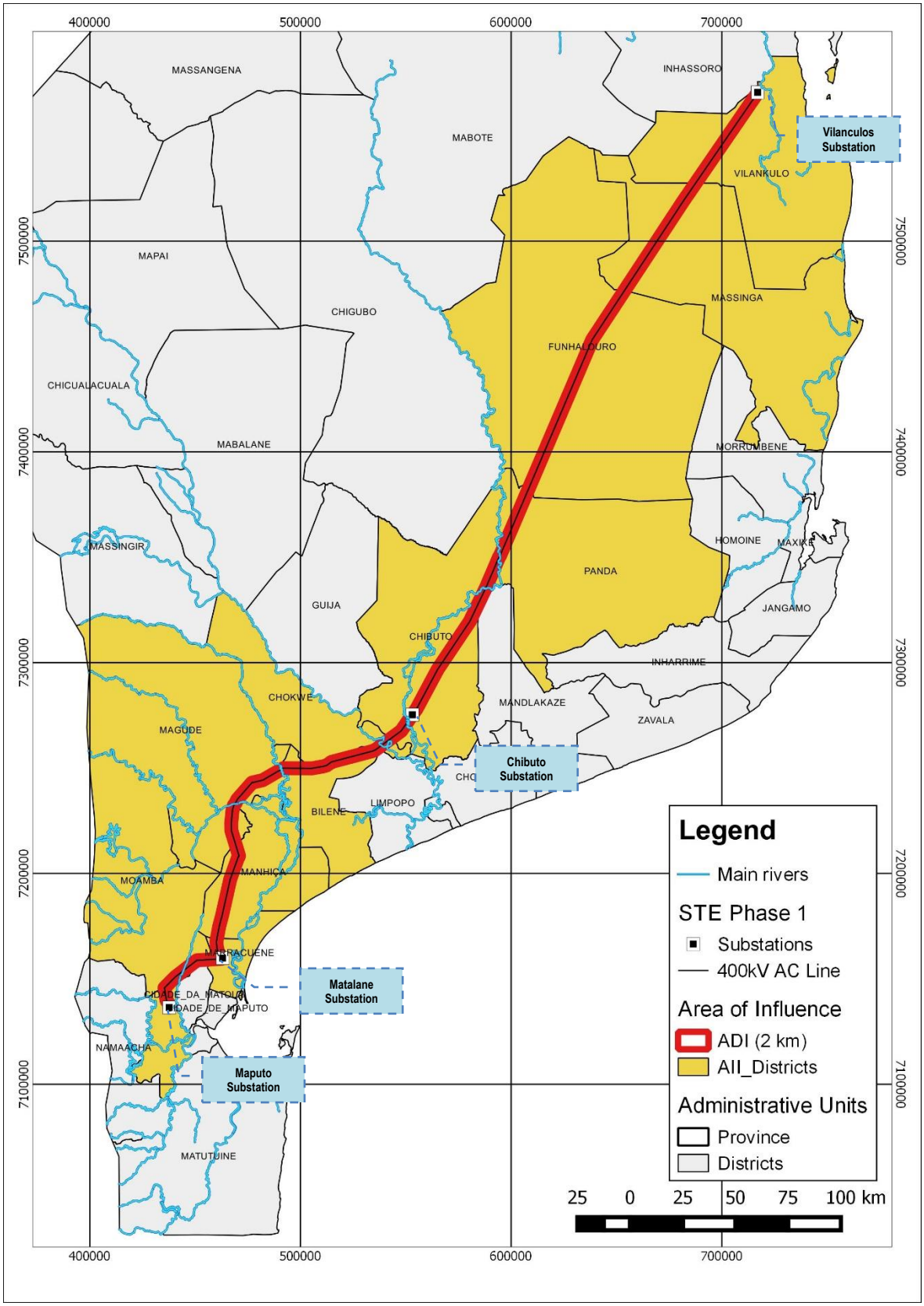


Figure 5.1 – Project areas of influence

6 Baseline Assessment

This Chapter provides the baseline assessment of the potentially affected environment within the Project's AoI, as defined in Chapter 5. An effort was made to focus the baseline on the more relevant environmental and social components, given the Project typology and expected potential impacts. **Table 6.1** shows the structure of the EIS baseline assessment.

Table 6.1 – Structure of the EIS baseline assessment

Environment	Component
Physical Environment	- Climate; - Air Quality; - Noise; - Geology and Geomorphology; - Soils; - Water Resources; - Landscape.
Biotic Environment	- Flora and Vegetation; - Fauna; - Conservation Areas; - Ecosystem Services; - Natural, Modified and Critical Habitat Assessment.
Socioeconomic Environment	- Administrative Divison; - Political Organization; - Demographics; - Heritage and Culture; - Education; - Health; - Basic Services and Infrastructure; - Housing; - Economic Activities.

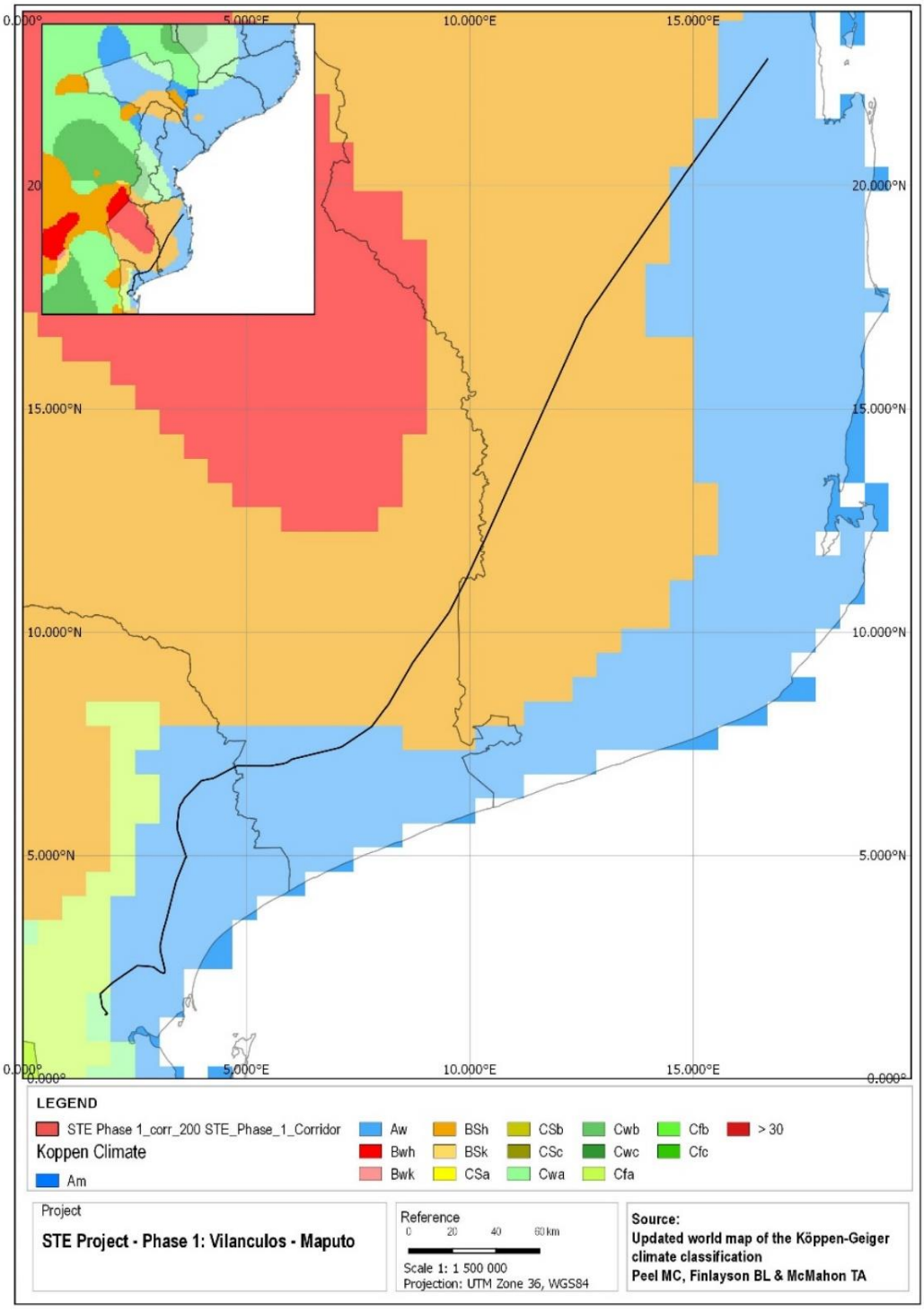
6.1 Physical Environment

6.1.1 Climate

6.1.1.1 Regional Climate

According to Köppen's climate classification, the Project's alignment crosses two distinct climate regions: Aw and BSh (**Figure 6.1**). Aw is a tropical savannah climate found along the Mozambican coastline with an extended dry season during winter time. Precipitation during the wet season is usually less than 1 200 mm, occurring only during the summer season. The interior regions crossed by the Project's alignment are classified as being a BSh climate type which means a subtropical arid hot desert climate influenced by the upper air stability and subsidence which is the result of the presence of the subtropical high pressure zone. In BSh climate, relative humidity in the interior regions is generally low, precipitation is very low in quantity and very infrequent in distribution, both

temporally and spatially. Temperature varies greatly both diurnally and annually with extreme diurnal ranges of temperature.



Source: Adapted from Peel *et al.* (2007)

Figure 6.1 – Mozambican climate classification according with Köppen

6.1.1.2 Regional Climatic Parameters

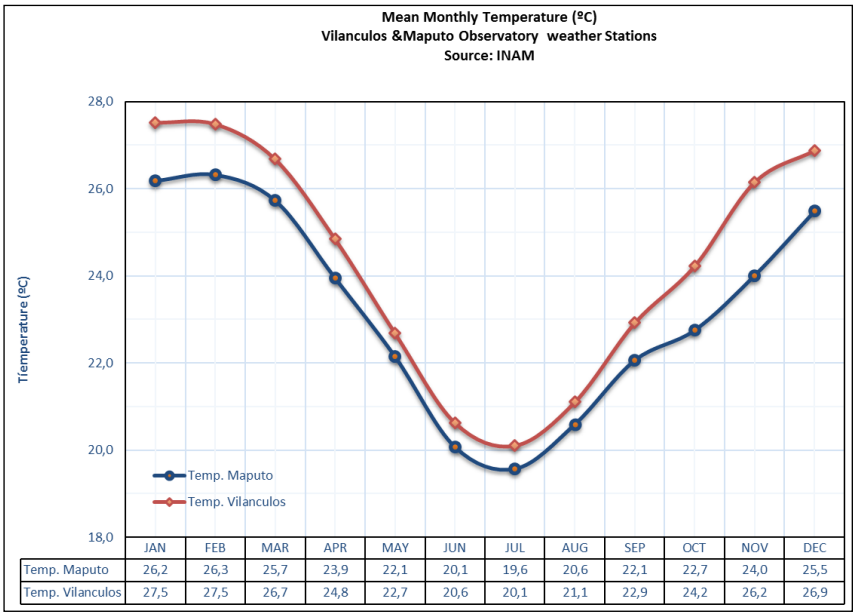
This section provides a description of the main climatic parameters of the region crossed by the Project, i.e., the coastal zone of southern Mozambique (Provinces of Inhambane, Gaza and Maputo). Regional climatic parameters were retrieved from 30 year climate data series from the Maputo Observatory Weather Station (WMO ID = 673390; located at 25,92º S 32,57º E; elevation of 144 mm) and from the Vilanculos Weather Station (WMO ID = 673150; located at 22º,01 S 35,31º E; elevation of 14 m). Meteorological weather station records ranged from 1983-2013, in the Maputo Weather station, and from 1982-2012, in the Vilanculos Weather Station.

These weather stations were selected, as they were considered to be representative of the climate parameters in the Project's region.

Temperature

In the Project's region, i.e., in the south of Mozambique, seasonal variations in temperature are around 5ºC between the coolest months (June, July and August) and the warmest months (December, January and February). Temperatures are warmer near to the coast in the lowland regions when compared with the inland regions of higher elevation.

Average temperatures in lowland parts of the country are around 25-27ºC in the summer and 20-25ºC in the winter. **Figure 6.2** illustrates the monthly average temperatures based in the above described data sets from the Vilanculos and Maputo weather stations.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Temp. Maputo	26,2	26,3	25,7	23,9	22,1	20,1	19,6	20,6	22,1	22,7	24,0	25,5
Temp. Vilanculos	27,5	27,5	26,7	24,8	22,7	20,6	20,1	21,1	22,9	24,2	26,2	26,9

Source: INAM (2016).

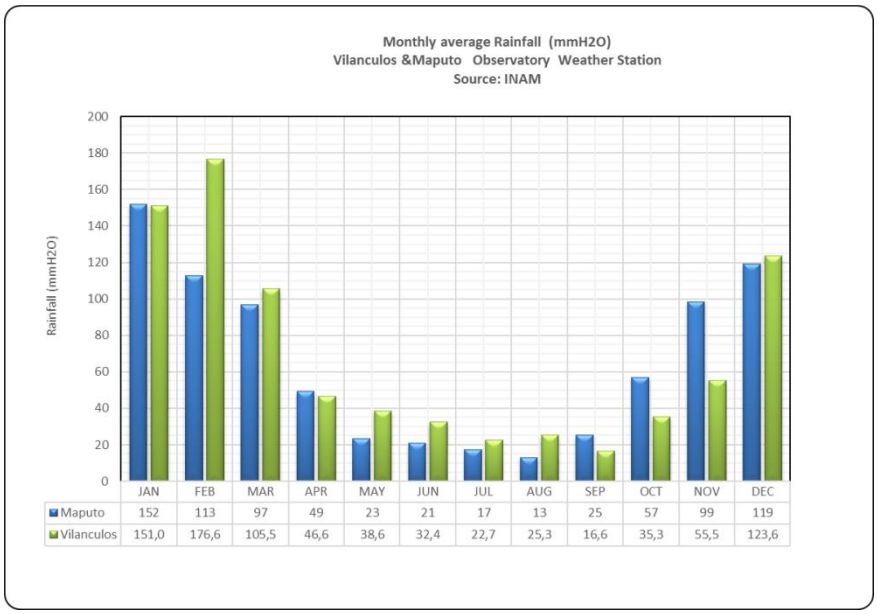
Figure 6.2 – Mean monthly air temperature

Precipitation

In the Southern Mozambican coast, where the Project is located, the total average annual precipitation is lower than 1,200 mm, being relatively high in the coast, but decreasing rapidly towards the interior regions of the country. Rainfall is mainly restricted to the months from October to March and is influenced by ocean currents, particularly the warm, southward-flowing Mozambique current.

Monsoons influence the existence of the previous cited two distinct seasons producing an uneven and irregular distribution of rainfall throughout the year.

The data analysis based on monthly averages of rainfall from Vilanculos and Maputo region (**Figure 6.3**), reveals that December and February are the wettest months, with precipitation reaching maximum monthly records up to 176 mm, while August and September are the driest months of the year with rainfall reaching minimum values of no more than 26 mm in Vilanculos region and 13 mm in the Maputo Region. The seasonal distribution analysis shows that approximately 95% of the precipitation occurs during the rainy season (November to March).



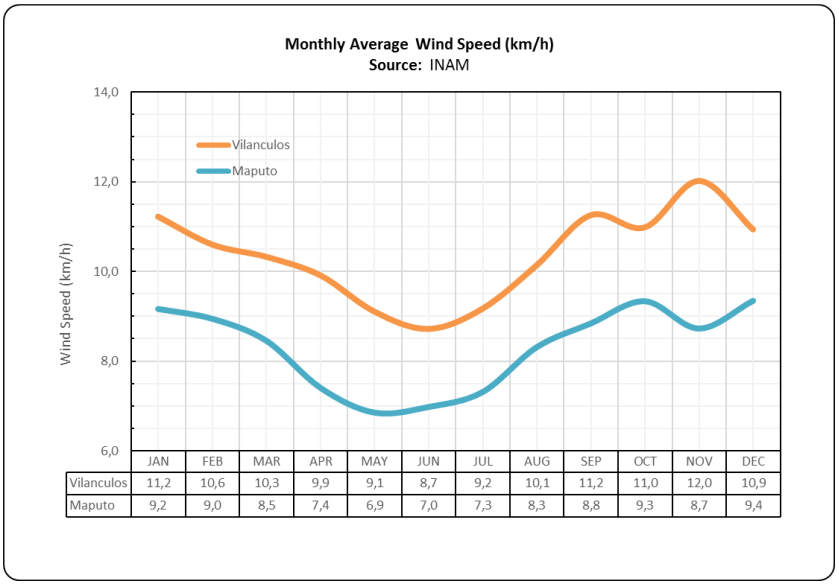
Source: INAM (2016).

Figure 6.3 – Monthly average distribution of rainfall

Wind regime

In the Project's area, according with INAM (2016), low wind velocities are to be expected (**Figure 6.4**). October and November are the months where stronger winds occur, ranging from 8.7 km/h up to 12.0 km/h. From December to June there's a general decrease in wind speed to a lowest monthly record of 6.9 km/h in the Maputo region and 8.1 km/h in the Vilanculos region. May and June have average monthly wind speeds below 9.5 km/h, reaching the minimum values recorded.

Regarding the predominant wind directions, statistics from both meteorological stations reveal dominant winds, in decreasing order, from the East, Southwest, South and Northeast quadrants. This is due to the atmospheric circulation that is clearly influenced by the low equatorial pressures with monsoon winds from the North East generated in turn by the subtropical anticyclone located south of the Zambezi River. Tinley (1971) describes a strong land-sea breeze system influencing this part of the country, with winds predominantly from the south during the morning, swinging to predominantly easterly during the afternoon.

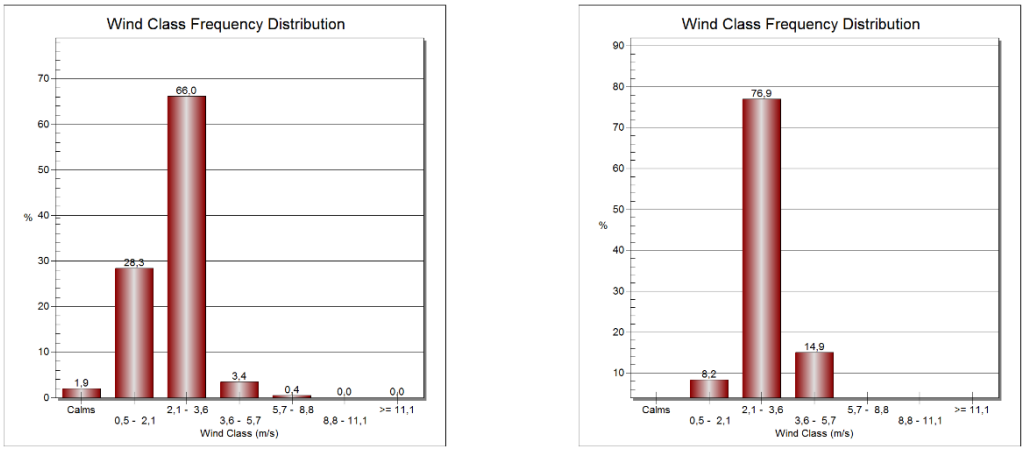


	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Vilanculos	11,2	10,6	10,3	9,9	9,1	8,7	9,2	10,1	11,2	11,0	12,0	10,9
Maputo	9,2	9,0	8,5	7,4	6,9	7,0	7,3	8,3	8,8	9,3	8,7	9,4

Source: INAM (2016).

Figure 6.4 – Mean wind speeds in the Project region the period 1968 to 2006

The most frequent wind speeds are in the 2.1 – 3.6 m/s range (7.5 to 12.9 km/h). This wind speed class has an annual mean frequency of 66% and 76.9%, for Maputo and Vilanculos regions respectively (see **Figure 6.5** below).

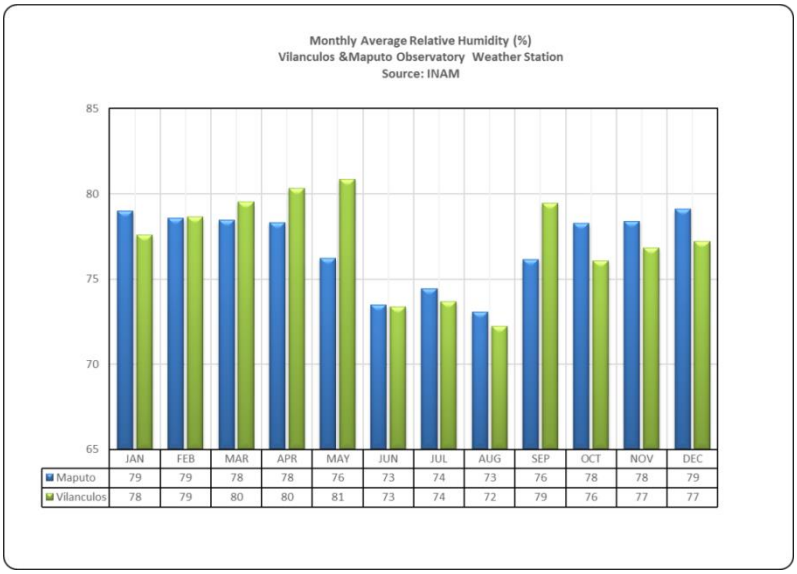


Source: INAM (2016).

Figure 6.5 – Wind speed class frequency distribution for Maputo (left) and Vilanculos (right) meteorological stations

Relative Humidity

Monthly analysis of the average relative humidity of the air is shown in **Figure 6.6**, based on the data sets from Vilanculos and Maputo weather stations. Both the highest and lowest humidity values were recorded in Vilanculos: 81% in May and 72% in August. June, July and August are the driest months of the year due to the low activity of the Intertropical Convergence zone in the south region of the country during this period.



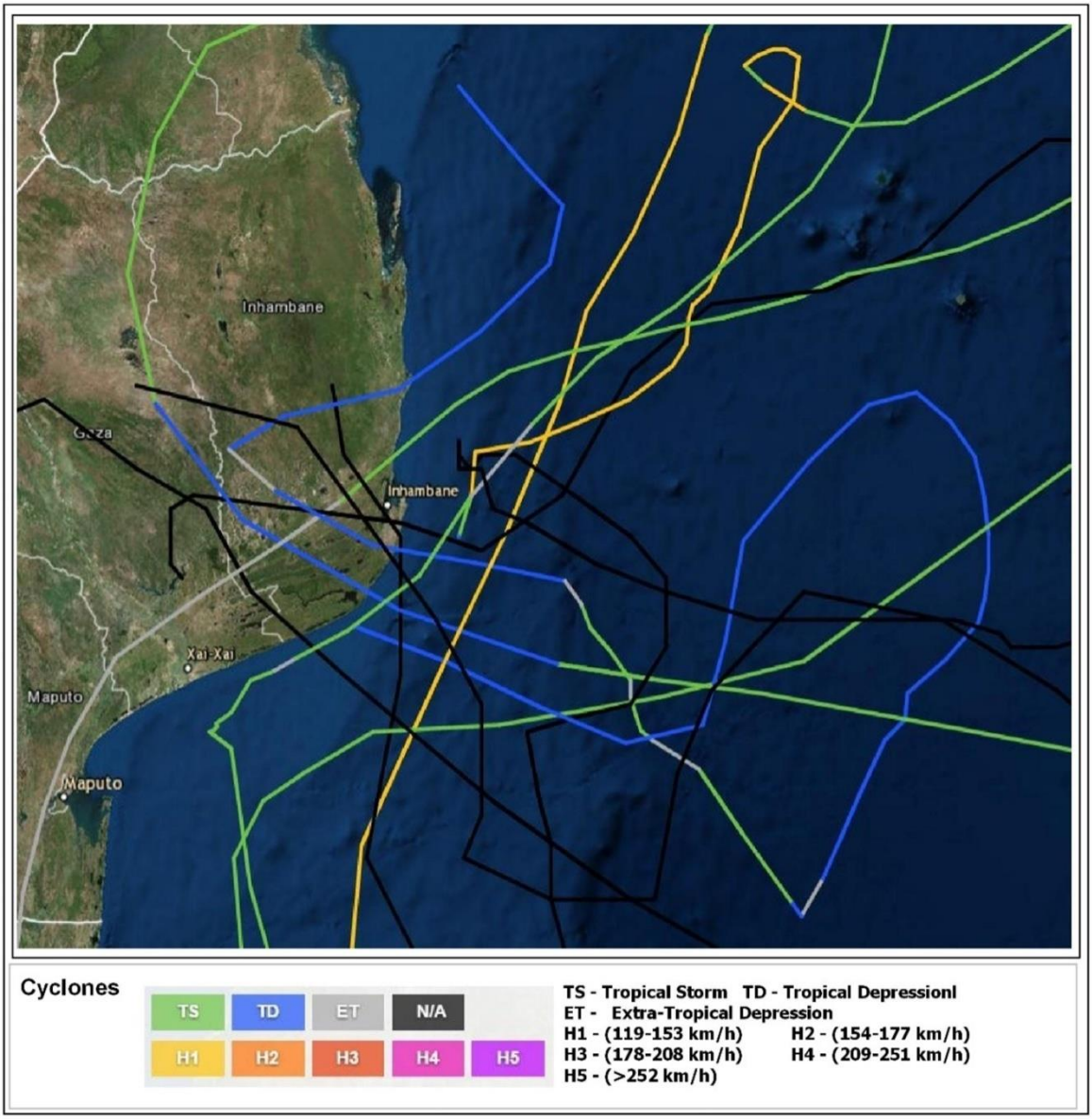
Source: INAM (2016).

Figure 6.6 – Predominant relative humidity in the Project's region

6.1.1.3 Vulnerability to Extreme Weather Conditions

Mozambique is a very vulnerable country to meteorological natural disasters, including droughts, floods and tropical cyclones, mainly due to its geographic features: a vast coastline extension (about 2700 km), the presence of several international rivers emptying into the Indian Ocean and the existence of vast areas below sea level. Other factors such as the low capability to predict extreme events, inadequate spread of timely warning notices and the high degree of poverty and dependence on natural resources, which in turn depends on climate variability, contribute to the country's vulnerability to extreme meteorological events.

Cyclones occur periodically, along with strong winds and torrential rains (see **Figure 6.7**). The cyclone season goes from November to April, with a peak in December and January. Between 1993 and 2012, 40 cyclones were recorded in the country (INAM, 2012), of which nine (9) were classified as very intense (maximum speed over 212 km/h). On average, three to five cyclones are formed every year in the Mozambique Channel (Tinley, 1971). However, only an average of just over two per year hit the Mozambican coast. The most frequent cyclones have winds from categories 1 to 4, with speeds from 63 to 212 km/h respectively. Category 5 cyclones, with speeds above 212 km/h, are rare. The regions which are more affected by cyclones are the central and Southern coastal zones.



Source: Tropical cyclones/Tracks; NOAA (2016).

Figure 6.7 – Main tropical depressions in the Indian Ocean off Mozambique coast in 2016

6.1.2 Air Quality

6.1.2.1 Air Quality Standards and Guidelines

In general, air quality standards aim to safeguard public health and the protection of ecosystems. They are established taking into consideration the different forms of absorption of gaseous compounds or particulate matter present in the atmosphere. Air quality standards in Mozambique are established through Decree No. 18/2004, of 2 June (Regulation on Environmental Quality Standards and Effluent Emissions), as amended by Decree No. 67/2010, of 31 December.

In what regards air quality standards, this regulation defines the pollutant emissions limits for fixed and mobile sources and the ambient air quality standards. At present, Mozambique has ambient air quality standards for sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), Total Suspended Particles (TSP). **Table 6.2** lists Mozambique's ambient air quality standards.

Table 6.2 – National ambient air quality standards

Pollutant	Unit	Concentration	Averaging period
Total Suspended Particles (TSP)	µg/m³	150	Average daily maximum
		60	Annual average
Nitrogen Dioxide (NO_2)	µg/m³	190	Average hourly maximum
		10	Annual average
Sulfur Dioxide (SO_2)	µg/m³	500	Instantaneous value – 10 min average
		800	Average hourly maximum
		100	Average daily maximum
		40	Annual average
Carbon Monoxide (CO)	µg/m³	30 000	Average hourly maximum
		10 000	8 hour maximum
		60 000	30 min maximum
		100 000	15 min maximum
Ozone (O_3)	µg/m³	160	Hourly maximum value
		120	8 hours maximum
		50	24 hours maximum
		70	Annual average

Source: Decree No. 18/2004, as amended by Decree No. 67/2010.

Mozambique has yet to establish standards for particulate matter with size up to 10 µm (PM10). In the absence of national standards, the World Health Organization (WHO) standards for this pollutant were considered: maximum concentrations of 50 µg/m³ (24-hour averaging period) and 20 µg/m³ (annual averaging period). For reference, **Table 6.3** presents other relevant international air quality guidelines, namely those established by WHO, European Union and South Africa, in comparison with Mozambique's standards.

Table 6.3 – International ambient air quality guidelines

Pollutant	Averaging Period	Mozambique (µg/m³)	WHO (µg/m³)	European Union (µg/m³)	South Africa (µg/m³)
PM10	24 hours	--	50	50	--
	1 year	--	20	40	--
SO_2	Instantaneous	--	500	--	500
	1 hour	800	--	350	--
	24 hours	100	--	125	125
	1 year	40	50	20	50
CO	1 hour	30 000	--	--	--
	8 hours	10 000	10 000	10 000	--
NO_2	1 hour	190	200	200	376
	24 hours	--	--	--	188
	1 year	10	40	40	94

6.1.2.2 Air Quality Baseline

General considerations

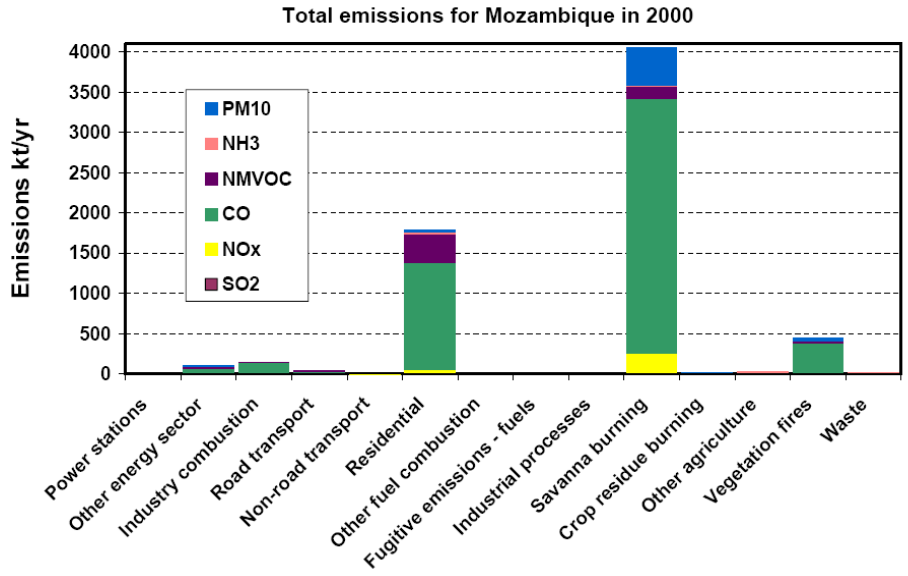
No air quality data is available from air quality monitoring stations in Mozambique. As such, a qualitative assessment of the ambient air quality is provided based on literature review, and data retrieval from international published databases such as those available from European Space Agency (Copernicus) and from WHO (Global Urban Ambient air pollution). Major pollution emission sources expected to be present in the study area were also evaluated. The assessment has been based on the most recent data available for the study area.

Air pollution at national level

As per Cumbane (2003), biomass burning is one of the main sources of emission of particulate matter into the atmosphere, followed by emissions from industrial activities. Cumbane & Ribeiro (2004) indicate that the main potential sources of pollutant emissions into the atmosphere in Mozambique are biomass burning of natural and/or induced occurrence, including the preparation of soil for subsistence agriculture; open-air burning of household waste (urban solid waste); road vehicle traffic; industrial activities and the burning of firewood and coal.

Cumbane (2003) and Schwela (2007) point to the uncontrolled burnings in rural zones especially in the North and Central regions of the country as one of the main sources of emissions of air pollutants into the atmosphere resulting in air pollution. Crutzen & Andreae (1990) reinforce this thesis referring that, of the different pollutant emission sources, biomass burning assumes a significant relevance as atmospheric emission source in the tropics.

As seen in **Figure 6.8**, the largest emission sources of pollutant gases into the atmosphere in Mozambique, in 2000, were caused by savannah burnings, followed by natural vegetation fires and residential fuel burning.



Source: Adapted from Gondwe, Kenneth J., APINA.

Figure 6.8 – Total emissions for Mozambique in 2000

The *Southern African Regional Science Initiative* (SAFARI) project was carried out by a group of American universities and aimed, among other scientific objectives, to assess the atmospheric concentrations of the main pollutants generated by biomass burning, during the dry season in East Africa. The SAFARI project involved several countries of Southern East Africa, including Mozambique. Flights were made at heights between 750 m and 4500 m to obtain quantitative concentrations of different gaseous and particulate compounds present in the low troposphere during August and September. **Table 6.4** shows the SAFARI results for Mozambique, as well as the average results for all countries where the study was carried out (Malawi, South Africa, Tanzania, Mozambique and Zimbabwe).

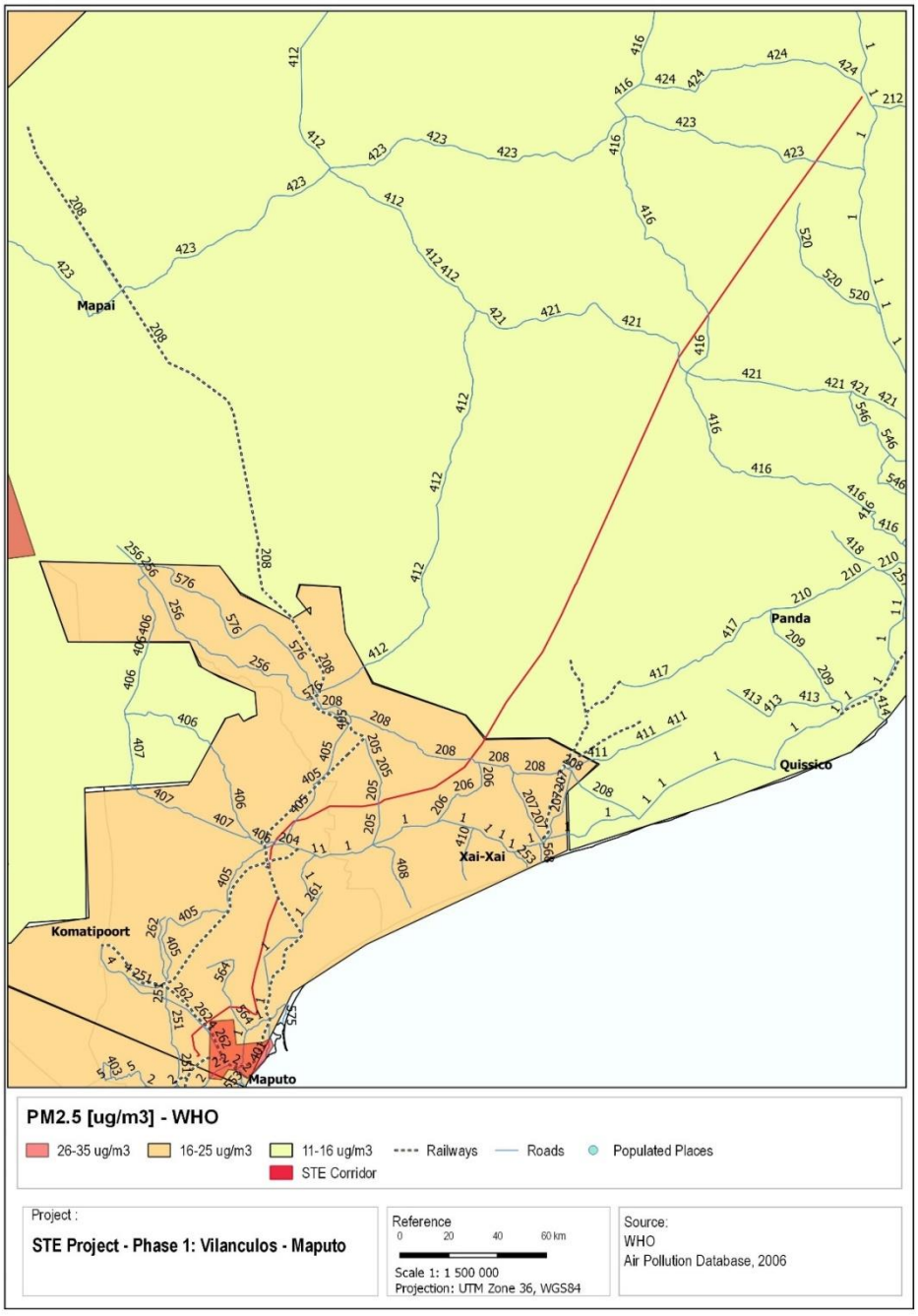
Table 6.4 – Average background concentrations of atmospheric pollutants in Mozambique (at altitudes under 5 km)

Pollutant	Units	Measurement Technique	Mozambique	Results relating to the five countries where the study was carried out
			Average Concentration	Average Concentration
CO_2	ppmv	GC/C AFTIR	384 ± 7	386 ± 8
CO	ppbv	GC/C AFTIR	165 ± 43	261 ± 81
CH_4	ppbv	GC/C AFTIR	1 710 ± 55	1735 ± 21
SO_2	ppmv	Teco 43S	2.9 ± 2	2.5 ± 1.6
O_3	ppbv	Teco 49C	51 ± 14	64 ± 13
CH_3Br	pptv	GC/C	8	9 ± 1
CH_3CL	pptv	GC/C	575	633 ± 56
CN	cm^{-3}	TSI 3025A	(3.4 ± 2.5) x 103	(4.5 ± 2.9) x 103
Total Particulates (< 3 µm)	µg/m³	Gravimetric/Filter	31.2 ± 23.5	26.0 ± 4.7
Organic Acid	µg/m³	IC/Filter	1.4 ± 1.2	1.1 ± 0.4
Sulphate	µg/m³	IC/Filter	8.5 ± 5.0	4.6 ± 3.6
Nitrate	µg/m³	IC/Filter	0.8 ± 0.3	0.8 ± 0.3
Potassium	µg/m³	PAES/Filter	0.5 ± 0.5	0.4 ± 0.1
Carbon Black (CP)	µg/m³	ATN/Filter	1.0 ± 0.5	2.3 ± 1.9
Total Carbon (TC)	µg/m³	EGA/Filter	5.9 ± 5.1	8.5 ± 4.8

Source: "*Journal of Geophysical Research*", volume 108 of 2003.

As can be seen from the previous table, the average background concentrations of CO_2 and SO_2 are well below the national air quality standards and applicable international guidelines. All other pollutants reported in the table similarly show very low background average concentrations. This study thus indicates that Mozambique has, in general, a non-degraded airshed (good air quality).

In what regards particular matter induced pollution, **Figure 6.9** represents the WHO modeled estimate of PM2.5 (particulate matter with a diameter of less than 2.5 µm) along the Project's alignment, according with WHO Global Urban Ambient air pollution database, adapted to 2016.



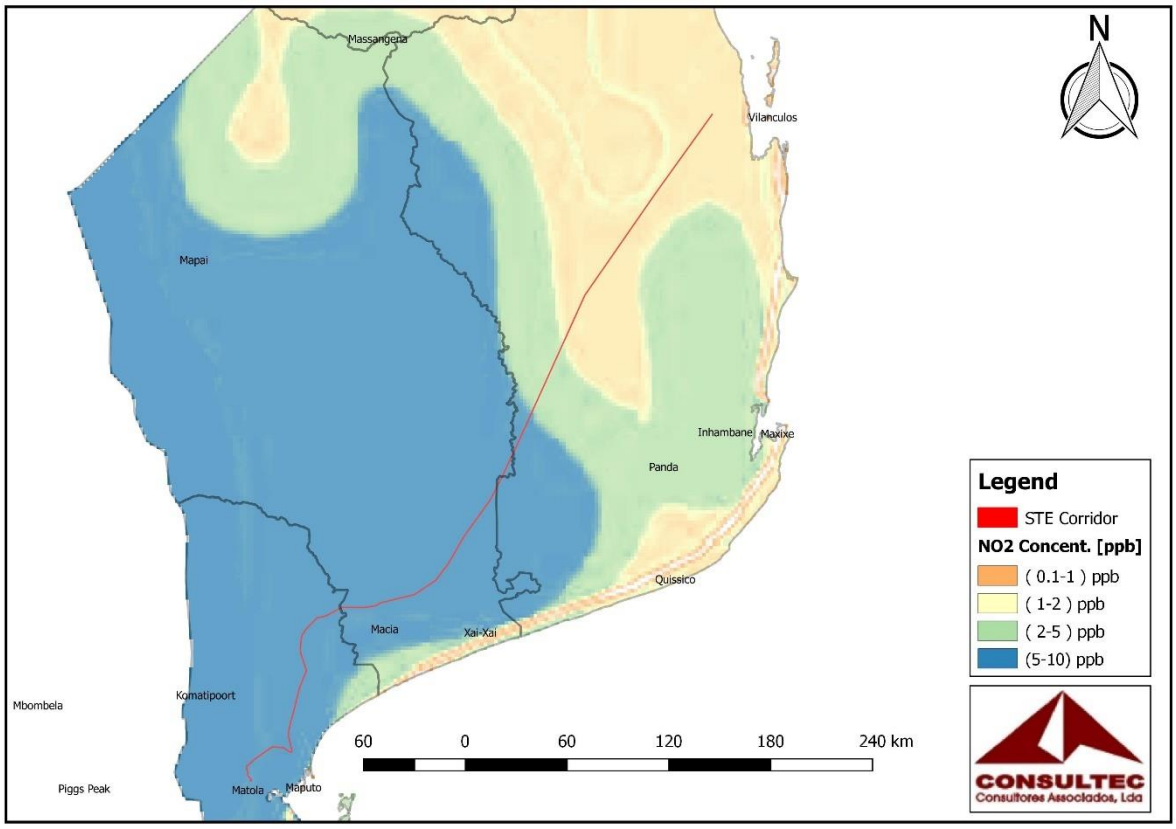
Source: Adapted from "WHO Global Urban Ambient Air Pollution Database. 2016".

Figure 6.9 – PM2.5 concentration distribution (µg/m³)

Based on the data illustrated in the figure above, background concentrations of Particulate Matter (PM2.5) in the Project area range from 11 µg/m^3 up to 35 µg/m^3 (this last value concerning the Maputo urban area). Higher particulate matter concentrations can be observed in the Maputo city area due to the higher anthropogenic activities occurring in the Maputo region namely air pollutant emissions from industrial sources and from line sources (road traffic).

Seinfield & Pandis (1998) suggest that globally background concentrations for particulate aerosols, among them PM10, have concentrations ranging from 5 µg/m^3 in remote locations, to 15 µg/m^3 in rural zones and to 32 µg/m^3 in urban areas. These values are in line with the PM2.5 concentrations modeled by WHO for Mozambique, as discussed above.

Figure 6.10 illustrates NO_2 background concentrations at ground level retrieved from the Copernicus Atmosphere Monitoring Service (CAMS, 2017) for the region crossed by the STE alignment, during March 2017 (beginning of the dry season). As illustrated in the figure, NO_2 concentrations in the regions of interest are fairly low, ranging from 1 to 10 ppb.



Source: Copernicus Atmosphere Monitoring Service (March, 2017).

Figure 6.10 – NO_2 background concentrations at ground level

Baseline summary

As previously mentioned, the air quality baseline description is based on a qualitative assessment of the main existing sources of emission in the study area and secondary data, as no air quality monitoring data exists for the Project area.

Few atmospheric pollution emission sources were identified in the Project area, and none of them are of high intensity (as discussed in the following section).

Considering the low significance of the existing emission sources along the Project area and the background concentrations of atmospheric pollutants, as discussed above, the ambient air quality of the study area can be described as good. The ambient levels of key pollutants, such as PM and NO_2, should generally be low and in full compliance with the limit values established by the national air quality standards. In conclusion, the ambient air quality is expected to be relatively good as the study area mainly falls in mostly undeveloped and rural areas.

6.1.2.3 Local Emission Sources

Most of the Project's area of influence has a markedly rural and natural character. Due to its length (561 km), the proposed corridor crosses several primary roads from Maputo to Vilanculos but only a restrict amount of human settlements. Some relevant sources of atmospheric pollutant emission can be identified along the Project's alignment. These can be roughly grouped in three types, namely line sources, point sources and area sources, as summarized below:

- **Road traffic** – line source responsible for the emission of gaseous and particulate emissions, generated by internal combustion vehicles exhaust emissions and vehicle entrainment on unpaved roads;
- **Miscellaneous fugitive dust sources** – area sources of dust emissions, generated by wind erosion from open areas (with low vegetation cover);
- **Household fuel burning** – gaseous and particulate emissions from household fuel burning found in human settlements; and
- **Biomass burnings** – gaseous and particulate emissions from biomass burning, including wild fires and slash-and-burn agricultural practices.

Road network - In Mozambique, roads are classified as primary, secondary, tertiary or vicinal. Most primary roads have been recently upgraded and are generally of good quality. The country's traffic density can be classified in general terms, as low across all existing network. The main roadways crossed by the Project's alignment are the following (see **Figure 6.11**):

- Primary roads: N4 (Maputo – Ressano Garcia), N101 (Mazivila – Mapapa),
- Secondary roads: N201 (Magude -- Xinavane), N220 (Chibuto - Daniel) and N222 (Fr. Mabote -- Mapinhane);
- Tertiary roads: R412 (Magude – Mataze) and R442 (Chibuto - Godide);
- Vicinal roads: R807 (Matola – Pessene); R808 (N1 – Vundiça), R859 (Xilembene – Chokwe), R444 (Rio Changane – Funhalouro) and R481.

As shown above, only two primary roads are crossed by the Project (N4, near Matola, and N101). All other roads crossed are secondary, tertiary or vicinal roads (most of these are unpaved).

Given the restricted vehicle activity in the area, vehicle entrainment of dust and vehicle exhaust emissions are anticipated to be of small significance. As such, no heavy air pollution is expected to arise from vehicular traffic across the study area. The only possible exception is the vehicle activity

near Maputo city, where vehicular activity is expected to be higher. However, in general terms, no air quality problems are expected to arise from vehicle emissions along the Project's alignment.

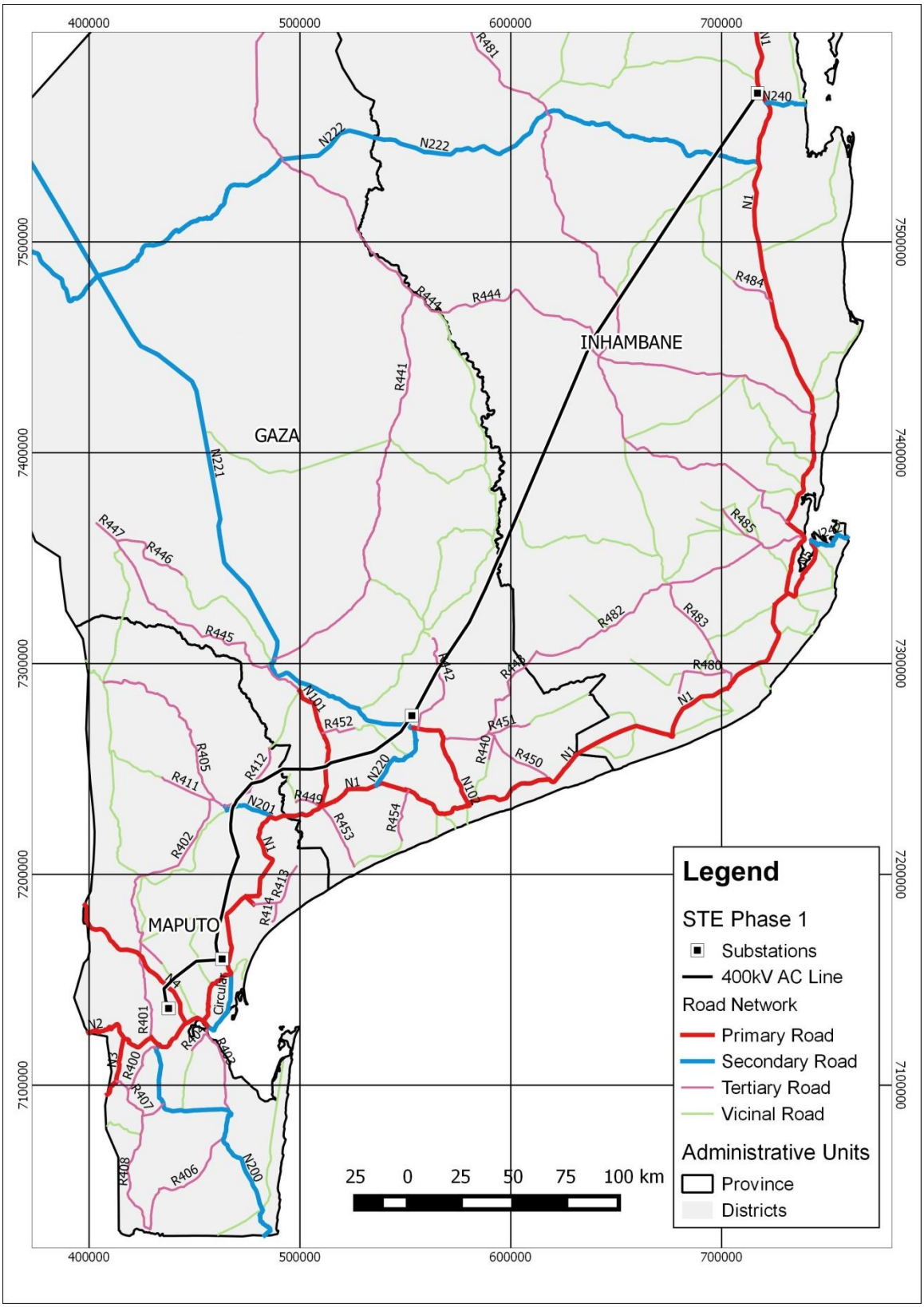


Figure 6.11 – Existing road network in the Project's corridor

Miscellaneous fugitive dust sources – Fugitive dust emissions can be generated from wind erosion in open areas, such as newly planted farming areas, scarcely vegetated areas and others areas where the soil has been exposed. The intensity of these emissions is a function of the extent, nature and duration of agricultural activities, on the wind regime and on the moisture and silt content of exposed soils. Some open areas are expected to occur along the proposed Project route which will constitute a source of fugitive dusts. Farming activities occur in the study area, but traditional sustenance agriculture accounts for the majority of farming lands, with low vegetation control. Considering the main land uses along the proposed alignment, fugitive dust emissions can be a contributor to air pollution in the Project's region.

Household fuel burning – Energy use within the residential sector includes three main categories, namely: *(i)* traditional - burning of wood, dung and bagasse, *(ii)* transitional - burning of coal, paraffin and LPG, and *(iii)* modern - use of electricity (increasingly includes use of renewable energy). Except for the major cities, which are electrified, most human settlements along the Project's proposed route resort to wood and coal as the main domestic energy sources. As such, household fuel burning constitutes one of the air pollutants emission sources in the provinces crossed by the STE Project. It should be noted, however, that it is unlikely that household fuel burning emissions levels are sufficient to cause exceedances to the Mozambican air quality standards (Decree No. 18/2004, of 2 June, as amended by Decree No. 67/2010).

Biomass burnings – Biomass burning includes the burning of evergreen and deciduous forests, woodlands, grasslands, and agricultural lands, and may result from wild fires or from human induced fires, as part of a slash-and-burn agricultural practice. Biomass burning is an incomplete combustion process, with CO, methane and NO_2 gases emitted to the atmosphere. Approximately 40% of the nitrogen in biomass is emitted as nitrogen, 10% is left in the ashes, and it may be assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds. The visibility of the smoke plumes is attributed to the aerosol (particulate matter content).

Prior to the rainy season, from July up to September/October, a considerable number of set fires which aim to clear new areas for traditional agriculture are expected to occur in rural areas. Slash-and-burn practices are common in this region, and this type of biomass burnings can be a significant emission source of Particulate Matter, CO, SO_2 and NO_2.

6.1.2.4 Sensitive Receptors

Potential air quality sensitive receptors mainly include the residential areas of the settlements located along or within the Project corridor (as well as the social infra-structure in those settlements, such as schools, health units and places of worship). In what concerns air pollution receptors, the Project's proposed corridor will pass through the northern outskirts of Maputo city, some dispersed settlements in Boane, Magude, Chibuto, Funhalouro, Vilanculos and through several small settlements located in the vicinity of the alignment.

Some inhabited areas have been identified in the vicinity of the future Chibuto substation (**Figure 6.12**) and Maputo substation (**Figure 6.13**), with some residential settlements located at distances of approximately 150 m and 120 m from the Chibuto and Maputo substations external perimeter,

respectively. No residential areas were found in the near surroundings of the Vilanculos and Matalane substations (i.e., within 200/500m of these substations, respectively).

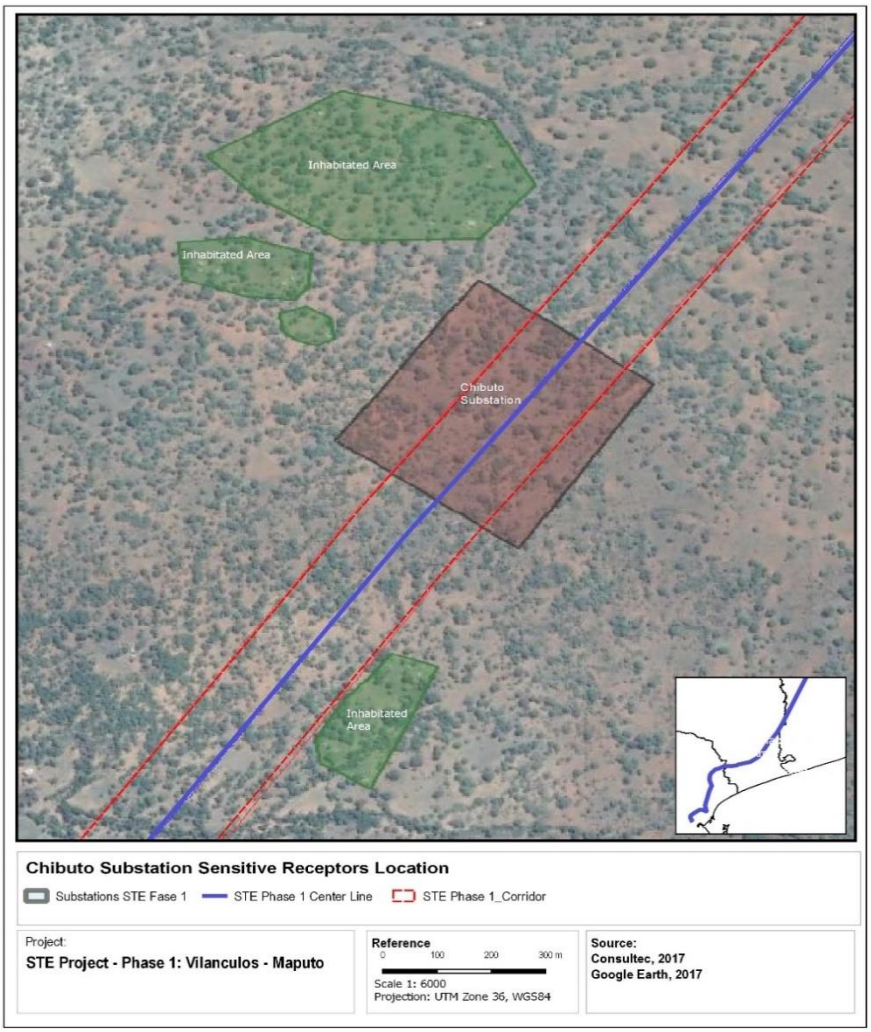


Figure 6.12 – Sensitive receptors near the proposed Chibuto substation

From field observations, the identified residential settlements can be characterized, in general terms, as of low density and composed essentially by peri-urban and rural type single family dwellings, generally with a single ground story, and a total height of no more than 2 to 3 m. **Figure 6.13** illustrates the proximity of these dwellings to the Maputo substation proposed expansion's external perimeter.

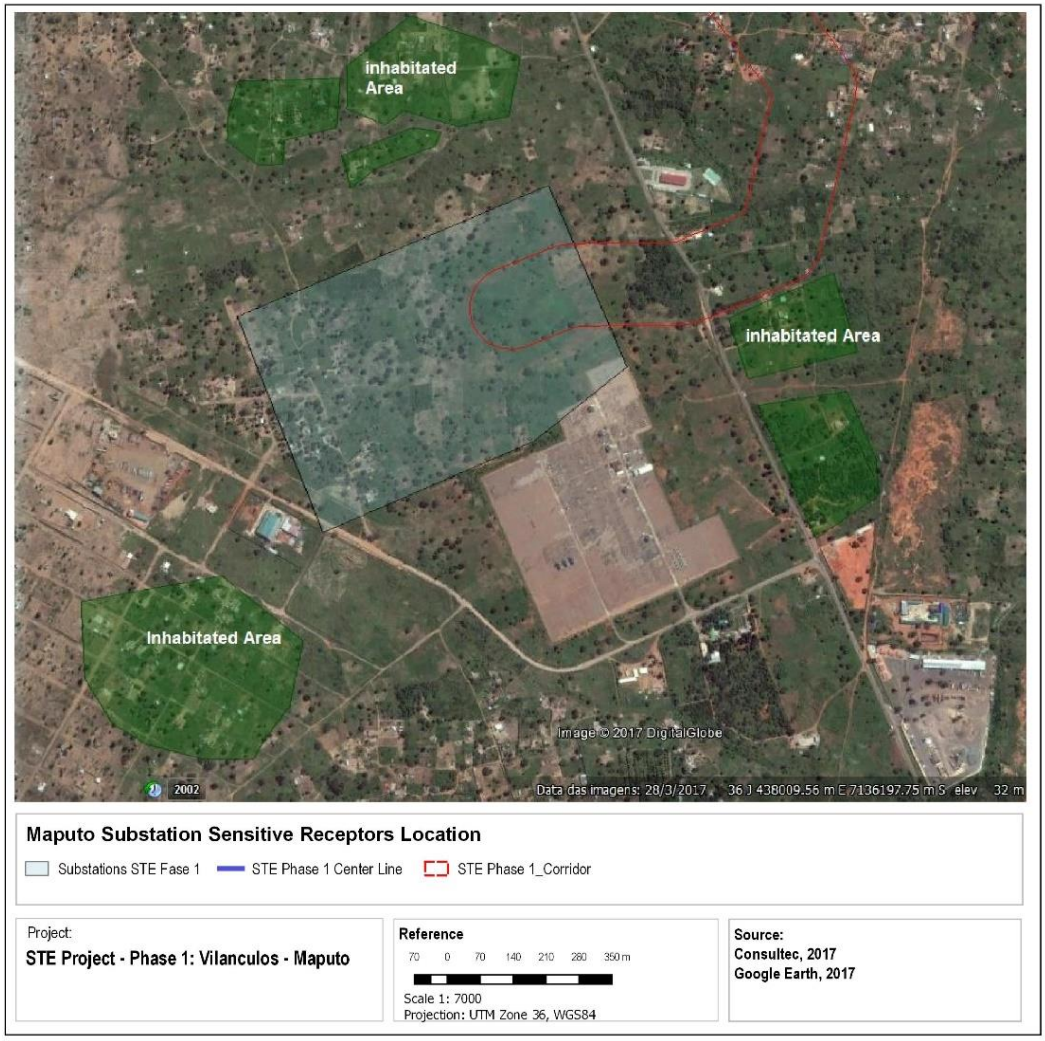


Figure 6.13 – Sensitive receptors near the proposed Maputo substation expansion

6.1.2.5 Climate Change and GHG Emissions

Climate change refers to any change in the current climate, attributed directly or indirectly to human activity, to which is added the natural climate variability observed over comparable time periods (MICOA, 2007). It is widely accepted by the scientific community that climate patterns worldwide are already changing and that the trend will be towards an overall increase in average air temperature, greater variability in rainfall regime, rise in the average level of the sea and the increased occurrence of extreme situations such as floods, cyclones and long droughts.

The observed warming since the mid-twentieth century is largely due to the increased concentration of greenhouse gases (GHG) emissions resulting from human activities. Excessive increase of GHG leads to the increase of retained heat and planet warming, which affects the climate globally. Some of the most common GHG include carbon dioxide (CO_2), water vapor, methane (CH_4), nitrogen oxides (NO_X) and chlorofluorocarbons (CFC's). The most relevant elements are water vapor and carbon dioxide. CO_2, for example, remains in the atmosphere for centuries after being emitted, and it is stored on earth in different forms.

According with the National Strategy for Climate Change report (2013-2025), published by MITADER, Mozambique is particularly vulnerable to climate change due to:

- Its geographical location, in the inter-tropical convergence zone and in the downstream shared hydrographic basins;
- Its long coastal area; and
- The existence of large areas with altitude below the current sea level.

Contributing also to Mozambique's vulnerability and low adaptive capacity are factors such as: poverty, limited investments in advanced technology, and the fragility of the infrastructure and social services, particularly health and sanitation. In Mozambique, climate changes are observed through the changes in temperature patterns. A report published by INGC (2009), indicates that for the 45 years' period between 1960 and 2005, a clear trend of increasing temperature in most of the country has being already observed. The warming trend has not been uniform throughout the country; increases of up to 1.6 ºC are evident in Central Mozambique during the winter, while temperatures have increased about 1.1 ºC in the north during the months of March-April-May and September-October-November.

Temperatures in Mozambique may increase between 1.2 to 1.7ºC until 2050 and 3.2 to 4.0ºC until 2095 (USGC). The rainfall variability will increase, potentially affecting the beginning of the rainy season and the rainfall distribution, resulting in more humid rainy seasons and drier dry seasons.

The central provinces are more prone to floods, tropical cyclones and epidemics, followed by the Southern and Northern provinces. The South with its savannah climate, tropical and dry, is more prone to droughts than the central and northern regions, which are respectively dominated by a rainy tropical climate and moderately humid climate modified by altitude (INGC, 2009).

According with the last GHG inventory conducted in 1994, the total direct GHG emissions of Mozambique was approximately 9 million tonnes of CO_2, 270,000 tonnes of CH_4, and 3,000 tonnes of N_2O. When expressed in terms of Global Warming Potential (GWP), these emissions amount to a CO_2 equivalent of about 15.9 $MtCO_2e$/year, that is 16 million tonnes (UNDP, 2016).

The most significant GHG emitted from the energy sector is CO_2, totaling in 1994 approximately 1.5 million tonnes. Other gases, such as N_2O and NO_x, are emitted in trace levels. In Mozambique GHG emissions from energy industries are related to the diesel used to generate electricity. However, Natural Gas is becoming relevant as a fuel source, and its use is expected to grow significantly in the future. The emissions from the energy sector in Mozambique emanate from the combustion of carbon-based fuels (fossil and biomass). CO_2 and CO are the main gases released from energy activities. CH_4, NO_X and Non Methanic Volatile Organic Compounds are also emitted in the combustion of carbon fuels, but in negligible quantities (UNDP, 2016).

6.1.3 Noise

6.1.3.1 Noise Standards and Guidelines

Mozambique has yet to establish national ambient noise guidelines. National environmental quality standards are established through Decree No. 18/2004, of 2 June (Regulation on Environmental Quality Standards and Effluent Emissions), as amended by Decree No. 67/2010, of 31 December, which determines the environmental standards and the limits to the emission of effluents, aiming to control and maintain acceptable concentrations of pollutants in the environment. This decree also states that ambient noise guidelines will be established by MITADER. However, to date, these specific guidelines regarding noise monitoring and assessing have yet to be published.

In the absence of national regulation, WHO and WB noise guidelines are referenced and will be adopted as Project standards. WHO's recommended noise guidelines were determined considering noise's potentially negative effects on health and specific environments. Under WHO's noise policy residential areas, schools and hospitals are considered to be sensitive receptors / land uses. **Table 6.5** lists WHO's ambient noise guidelines for such sensitive receptors.

Table 6.5 – WHO ambient noise levels guidelines

Land use / Specific Environment	Guideline (L_{Aeq} in dB (A))	Reference Period	Effect on Health
Outdoor of residential areas (day-time)	55 dB(A)	16 hours (06h00 – 22h00)	Serious annoyance
Outdoor of residential areas (night-time)	45 dB(A)	8 hours (22h00 – 06h00)	Sleep disturbance

Source: Berglund *et al*. (1999).

WB also has ambient noise guidelines, which state that noise impacts from a particular project should not exceed the levels presented in **Table 6.6** or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 6.6 – WB noise level guidelines

Receptor	One Hour LAeq (dB(A))	
	Daytime (07:00 - 22:00)	Night-time (22:00 – 07:00)
Residential; institutional; educational	55	45
Industrial, commercial	70	70

Source: IFC (2007).

As can be seen from the table above, the WHO noise guideline for outdoors of residential areas are the same as WB's guidelines for residential, institutional or educational receptors, for both the daytime and night-time periods.

6.1.3.2 Local Noise Emission Sources

The proposed transmission line alignment will mainly cross regions with very low population density and with low level of development and industrialization, excepting Maputo region, where a higher population density and anthropogenic activities do influence the noise climate.

The territory crossed by the proposed Project can be described as mainly natural or rural in nature. The main land uses in the Project corridor are traditional non-mechanized farming, natural woodlands

and savannahs. Outside of the human settlements, no significant anthropogenic noise sources were identified for the most part of the proposed alignment. Thus, excepting Maputo city area, the main noise sources that define the acoustic environment in the Project area are:

- Natural noises – noise generated by wind, rainfall and animals (insects, frogs, etc.);
- Human settlements – noise generated from human activities such as people talking, children playing, music, etc.; and
- Vehicular traffic – noise caused by heavy and light motorized vehicles circulating on the road network.

The Project's corridor will cross a few primary roads (N4 and N101) and secondary roads (N201, N220 and N222), as well as several other tertiary and vicinal roads. The road network in the Project area of interest is illustrated in **Figure 6.11** (see page 67).

In general terms, vehicular traffic in Mozambique can be described as of low to very low density. Traffic counts done in 2008 resulted in averages of 905 vehicles/day in primary roads, 147 vehicles/day in secondary roads and 58 vehicles/day on tertiary roads (AICD World Bank, 2008). Given the restricted vehicle activity across the Project area, vehicular traffic as a noise source can be considered to be as of low significance.

6.1.3.3 Baseline Noise Levels

No recent noise data is available for the Project area. As such a qualitative assessment of the global noise climate is presented, based on the local noise emission sources located in the study area as identified by literature review and from the main land uses. Additionally, noise measurements from previous baseline noise monitoring campaigns located within the Project area have been retrieved (Consultec, 2016) and are here presented with the objective of characterizing the expected baseline noise levels that may be found within the Project's influence area.

The proposed STE alignment will cross areas with different land uses and with different sensitivity to noise. Through aerial images observation it can be seen that the proposed alignment generally avoids crossing urban areas. In fact, residential areas in close proximity of the proposed alignment are scarce (considering the length of the proposed alignment) and those identified are generally of low density. The acoustic environment of the areas crossed by the Project can then be described as being typical of natural and rural areas, with low noise levels, which are only sporadically affected by road traffic that circulates in the existing roads crossed by the STE corridor.

Previous noise monitoring campaigns made by Consultec (2016) in the Vilanculos region (21º57`S; 35°18`E) revealed daytime noise levels ranging between 31.6 dB(A) up to 37.8 dB(A), and night-time noise levels ranging from 36.6 dB(A) up to 37.6 dB(A). At the monitored location, with mainly natural and rural land uses, the baseline ambient noise is mainly determined by natural noise sources. No exceedances of the WHO/WB guidelines are to be expected in both periods.

In 2016, a noise monitoring campaign was carried out by Consultec (2016) in the vicinity of the Maputo substation (25°53'S;32°24'E) in which noise measurements revealed higher noise levels

during the daytime reference period ranging between 66.0 and 67.5 dB(A) and reaching the same levels (65.7 dB(A)) during the night period.

In the vicinity of the Maputo sub-station, the main land use is typically peri-urban being characterized by a considerable degree of acoustic disturbance due to road traffic activity and other anthropogenic activities occurring at this location. Exceedances of the WHO/WB guidelines can be expected in both daytime and night-time periods.

Excepting the existing noise sources located in the influence area of Maputo city, no other significant anthropogenic noise source was identified that could result in significant changes to the local noise climate along the STE proposed corridor. Based on the noise sources inventory the ambient noise of most of the study area is expected to be typically of natural and rural areas, with low ambient noise levels complying with the adopted noise guidelines (WHO and WB).

6.1.3.4 Sensitive Receptors

Potential noise sensitive receptors mainly include residential areas of the settlements located near the Project corridor, as well as the social infra-structure in those settlements, such as schools, health units and places of worship. The proposed Project corridor will pass through the northern outskirts of Maputo city, some dispersed settlements in Boane, Magude, Chibuto, Funhalouro, Vilanculos and near several small rural settlements.

Figure 6.14 illustrates, at a macro level, the populated places located in the vicinity of the STE Project's corridor. As previously described in the Air Quality section (see section 6.1.2.4 above), some inhabited areas have been identified in the vicinity of the future Chibuto and Maputo substations (see **Figure 6.12** and **Figure 6.13**, in section 6.1.2.4), with some residential areas located at distances of approximately 150 m and 120 m from the Chibuto and Maputo substations external perimeter, respectively. No residential areas were found in the near surroundings of the Vilanculos and Matalane substations (i.e., within 200/500m of the substation).

From field observations, the identified residential settlements can be characterized, in general terms, has of low density and composed essentially of peri-urban and rural type single family dwellings, generally with a single ground story, and a total height of no more than 2 to 3 m.

6.1.3.5 Noise Baseline Summary

From the description above, the study area, along the full extension of the Project corridor, can be characterized as being mostly natural or with rural characteristics. No significant noise emission sources have been found, since most the study area (Project corridor) can be considered as being rural or a wilderness area, where only natural noises occur. On the segments where the proposed alignment crosses or passes near urban settlements (residential areas) the existing noise environment is influenced by human activities and by some low traffic activity. As such, the noise climate should be that typical of areas of this nature, and the ambient noise levels are expected to be well within the relevant guidelines, with the exception of more urbanized areas.

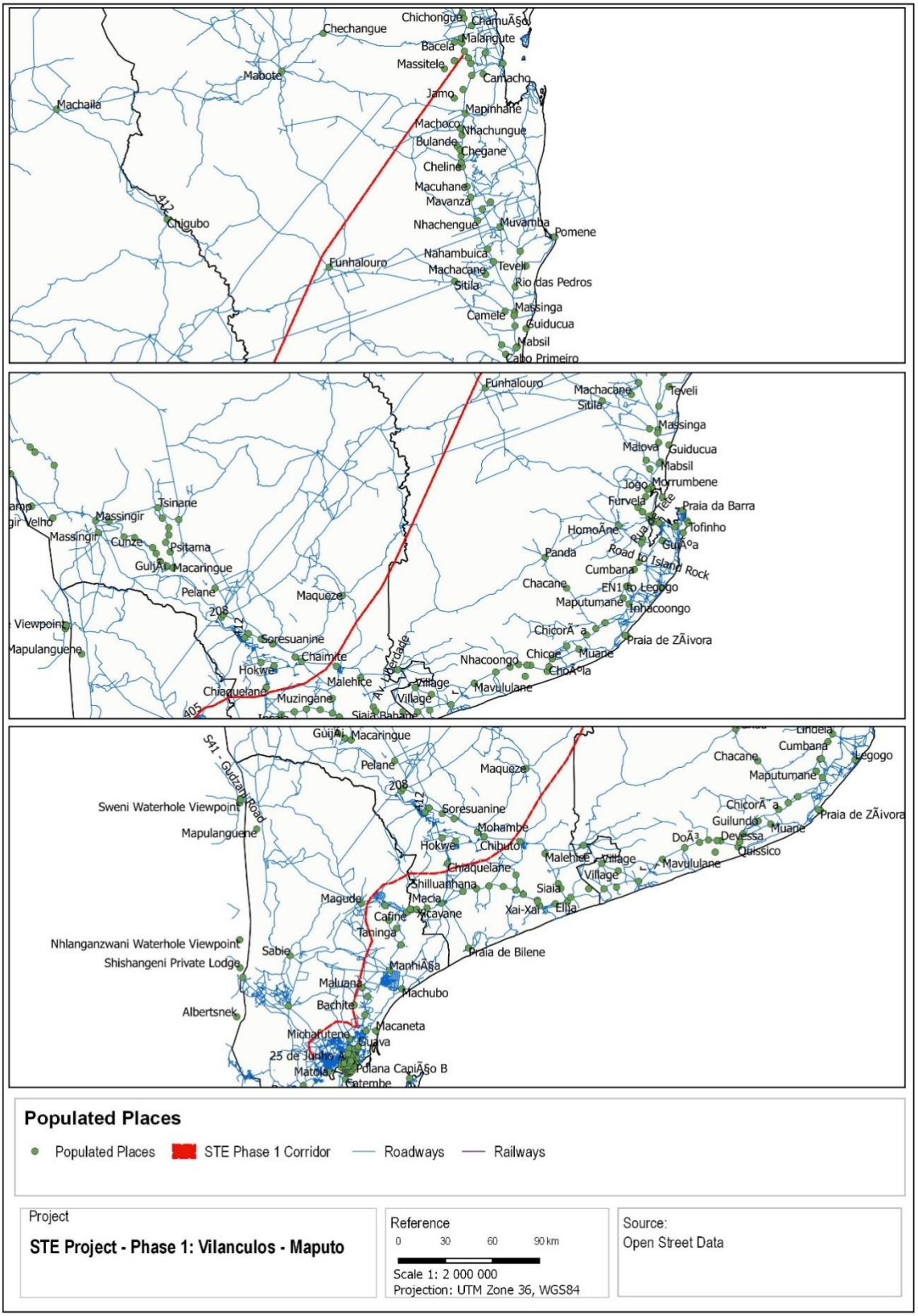


Figure 6.14 – Populated places located in the vicinity of the STE Phase 1 Project

6.1.4 Geology and Geomorphology

Geologic characterization of the study area was based on literature. Of the several bibliographic sources reviewed, special mention should be made to the geologic maps of National Directorate of Geology (DNG) at scale 1:250 000, in particular sheets 2234/2235, 2334/2335, 2333, 2433, 2431/2432 and 2532, which cover the region under study.

The following sections present the geologic characterization of the study area. The information is first provided from a regional point of view, followed by a more local perspective, focused on the proposed corridor for the power line.

6.1.4.1 Geomorphology

Geomorphologically, the Mozambican territory can be divided into 4 physiographic zones (Afonso *et al*., 1998):

- **Mountainous Zones**, with elevations of more than 1000m. This region occurred as a result of the permo-carbonic Gondwana movements. The mountain tops and ridges are intrusive-tectonic in metamorphic formations of the Upper Archaean and Proterozoic Eras;
- **Great Plateau Zone**, with elevations from 500 to 1000m, resulting from the erosive cycle associated with the break-up of the Gondwana during the Lower Cretacic. These are characterized by surfaces of erosive-denuded surfaces, ruffled by granitic inselbergs carved in the Pre-Cambric formations and Karoo rocks;
- **Middle Plateau Zone**, with elevations from 200 to 500m, resulting from the tilting movements during the middle Tertiary. These regions have flat areas, depressions, volcano-sedimentary rock surfaces and accumulation lowlands;
- **Great Coastal Plains Zone**, with elevations of less than 200 m, attributed to the Congo cycle, which probably initiated in the Plio-Pleistocene. This zone, dominated by tertiary and quaternary sediments, covers the region south of the Save River and the coastal strip. The study area falls within this sector.

These units are delimited by more or less accentuated escarpments, and as a general rule, the altitude progressively increases from the coast to inland. In the coastal zone, the characteristic geomorphological forms are the depositional depressions, associated with the eolic-fluvial flow and marine abrasion, and the depositional plains of the eolic and fluvial types.

The study area is located in the Mozambique Sedimentary Basin, which is directly related to the breakup of Gondwana in the late Paleozoic and Mesozoic – Gondwana Break-Up phase; followed by a Stabilization Phase and Neo-rifting Phase. The latter corresponds to an acceleration in the development of the East African Rift System (GTK, 2006).

The present structural framework of the Mozambique Basin is composed of a mosaic of approximately N-S elongated grabens and smaller horst-like plateaus, in places intersected by poorly defined NE-SW faults. In **Figure 6.15** some grabens can be easily identifiable from relief-shaded SRTM images.

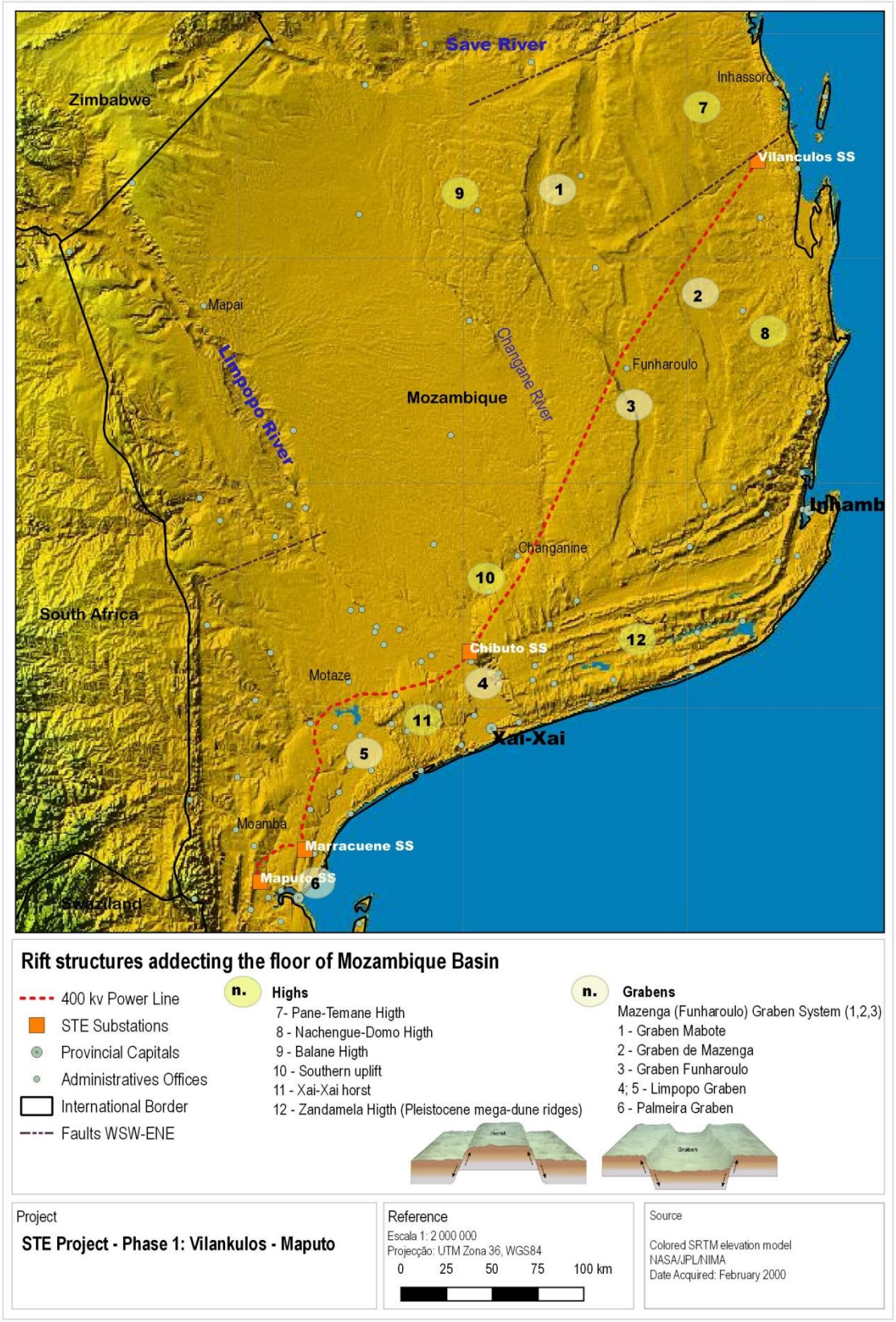


Figure 6.15 – Rift structures affecting the floor of the Mozambique Basin

Regarding the morphology of the Mozambique Basin, a number of highs are recognized from N to S (GKT, 2006); these include the Balane High, the 'Southern Uplift' and the Xai-Xai horst (flanking the large Limpopo Graben). In the eastern regions, occur from S to N: the Zandamela high separated from the more northerly Nhachengue-Domo High by the SW-NE oriented narrow Inhambane graben. These entities are limited to the west by the large Mazanga-Funhalouro Graben System (Mabote; Funhalouro and Mazanga grabens); north- and eastwards of this are the Pande-Temane High (the site of gas fields).

Grabens distinguished from north to south are the Changani Graben and Limpopo Graben extending into the Palmeira Graben. The reactivated segments of the Limpopo Graben consist of the Chidenguele Graben and the offshore part as Xai-Xai Graben.

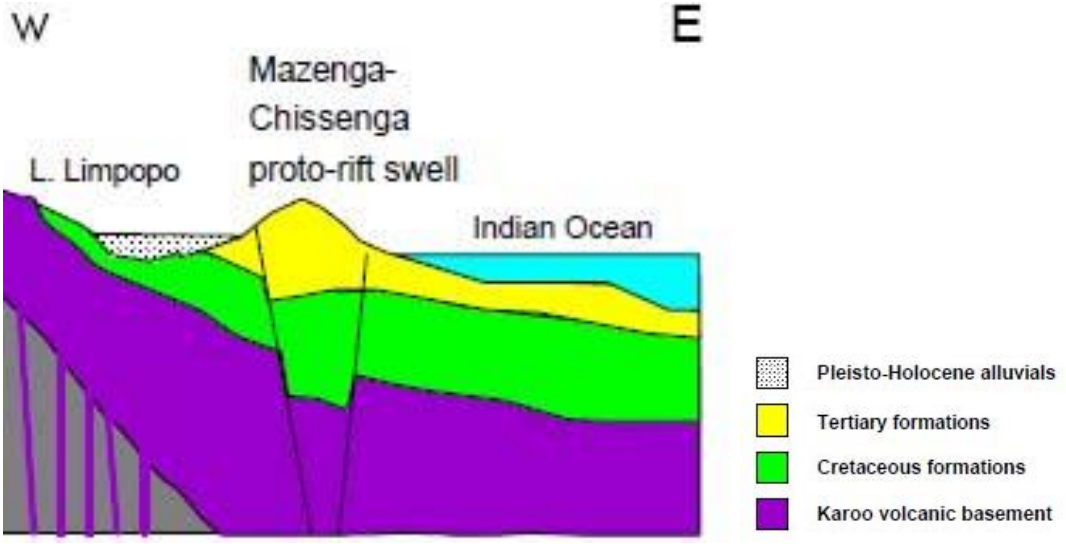
A major fault system with a NE-SW orientation occurs along the line Inhambane – Magude and is exactly parallel to the Pleistocene mega-dune ridges.

6.1.4.2 Geological Framework

Mozambique has a rich and complex geology, including formations ranging from the Mesoarchaic age (3 200 million years), where 2/3 of the country are built of pre-Cambrian rock types, to formations of Quaternary age - mainly in the Center-Southern regions and in the north-eastern coastal strip, occupying the remaining territory - 1/3 of the country.

The Phanerozoic coverage of Mozambique is represented by the lithologies that were deposited after the Pan-African Orogenic Cycle, and can be divided into two major groups: the Karoo Supergroup (SGK) and the East African Rift System (SREA).

The geology of the Project area is mostly built up by sedimentary rocks, composed, from top to bottom in the stratigraphic sequence, of Cenozoic and Cretaceous rocks, overlying Karoo basalts. The Cretaceous and Tertiary units are exposed underneath a Quaternary cover.



Source: Adapted from SADAC (2003). **Note**: Vertical scale exaggerated.

Figure 6.16 – Schematic W-E Geological cross-section of the Mozambique Coastal Basin

The Quaternary deposits are subdivided into Pleistocene deposits such as the Internal Dunes, Fluvial Terraces, Coastal Sandstones (or 'Beach Rock') and Lacustrine Limestones and Holocene deposits such as flood plain deposits of a sandy-clayey or mud composition.

6.1.4.3 Local Geology

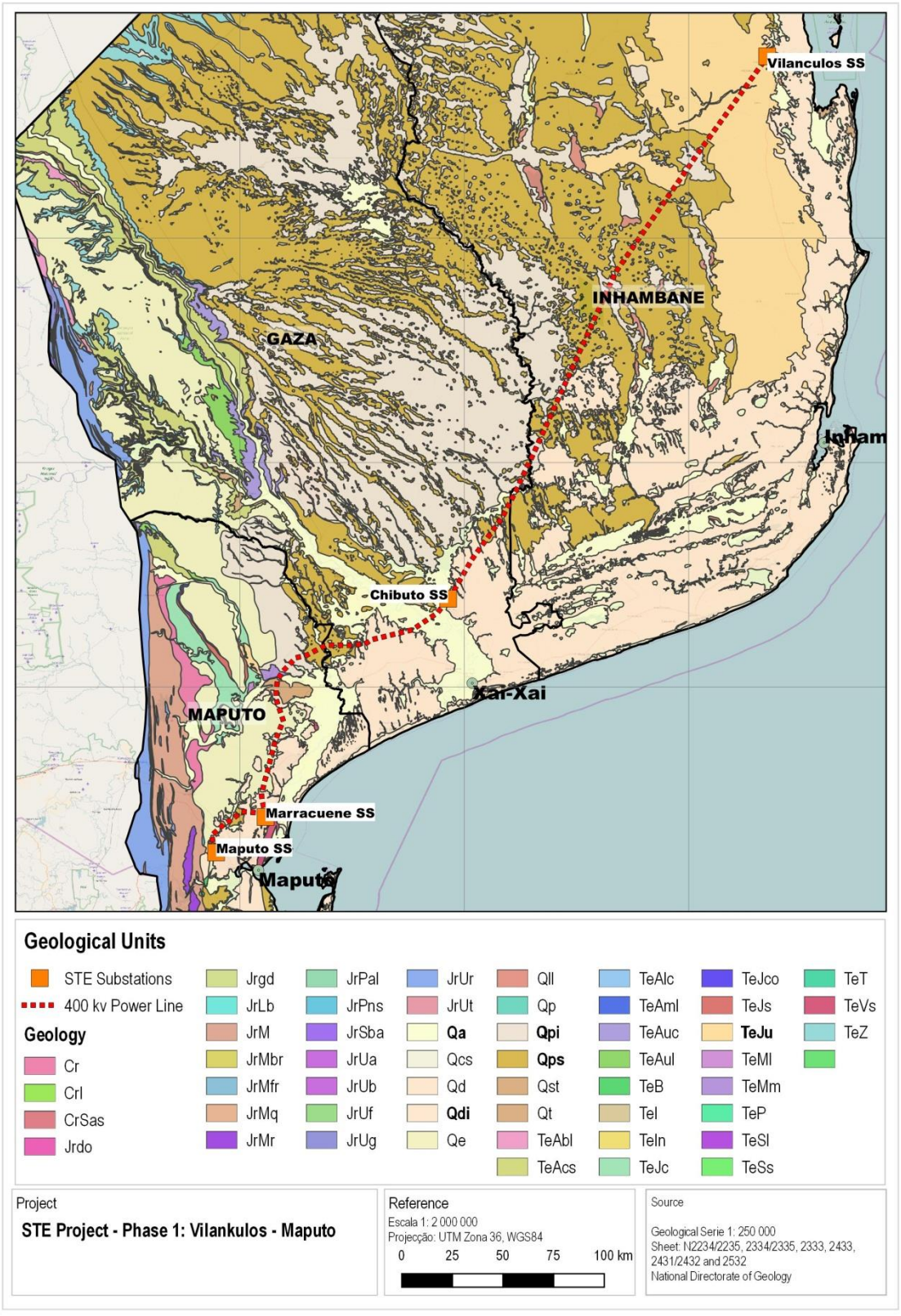
The surface geology of the Mozambique Basin is hampered by scarcity of outcrops due to low relief depositional surfaces, alteration of sedimentary rocks and the presence of weathering residues such as laterite, calcrete, caliches and ferricrete (GTK, 2008).

The geological formations intercepted by the proposed Project are shown in **Figure 6.17**, with each geological formation noted with its code, as per the Geologic Map. **Table 6.7** provides the key (legend) to **Figure 6.17**.

Table 6.7 – Geologic formations intercepted by the Project

Code	Lithology	Period
Qdi	Internal dune; red aeolian sand	Quaternary
Qe	Aeolian sand	
Qt	Fluvial terrace gravel and sand	
Qpi	Eluvial floodplain mud	
Qps	Eluvial floodplain clayed sand	
Qa	Alluvium, sand, silt, gravel	
TeJu	Jofane Formation, Urrongas Member, limestone and breeciated limestone.	Paleocene - Pliocene
TeMn	Mangulane; Magude Member; ferruginous sandstone	

The sediments of the study area are inserted mostly in sequence 6 of the post-Karoo sedimentary formations, which corresponds to quaternary deposits and in sequence 4 and 5 of the Paleocene – Pliocene (Tertiary formations); the Jofane Formation at NE, near Vilanculos SS.



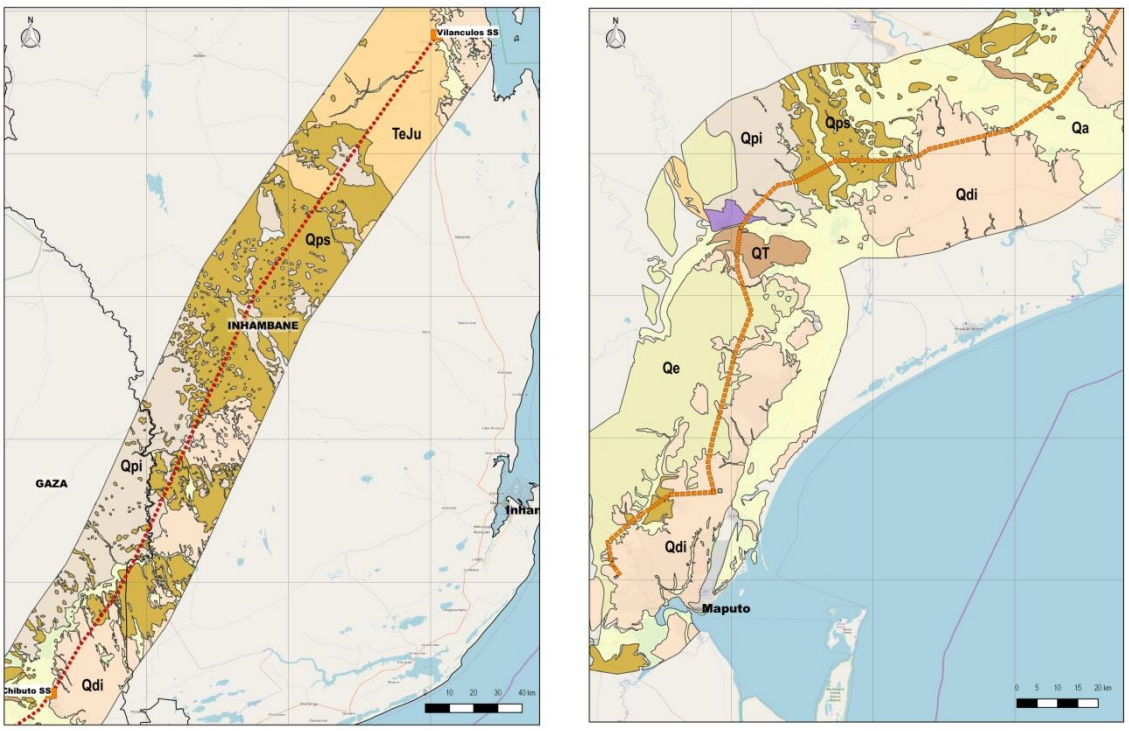
Source: DGM (2006). **Legend**: Please see Table 6.7.

Figure 6.17 – Geological formations intercepted by the Project

6.1.4.4 Lithostratigraphy

The deposition of the Quaternary is partly controlled by endogenic forces exercised during basin development. More important for the Quaternary deposition are, however, exogenic processes, notably significant sea level fluctuations, that can be seen in nature of the sediments now intercepted by the Project (fluvial, lacustrine, aeolian, sandstones and limestone etc.).

Figure 6.18 below shows the major geological formations intercepted by the Project, which are then described in greater detail below.



Major Geological Formations from North to South:

Vilanculos SS → Chibuto SS : **TeJu; Qps; Qpi; Qdi** Chibuto SS → Matalane SS → Maputo SS: **Qa; Qdi; Qps;Qpi; Qdi**

Source: GTK (2008).

Figure 6.18 – Major geological formations

TeJu - Jofane Formation, Urrongas Member, limestone and breeciated limestone - The Jofane Formation extends over more than 300 km from parallel 24° 30' S up to the north of the mouth of the Save River. This vast zone of outcrops and near-outcrops (they are commonly covered by a thin veneer of Quaternary deposits) have been recognized at depths of 5 to 15 m and consists of white to pale-yellow calcareous marine limestone and calcarenite that overlie the Temane evaporite (Salman and Abdullah, 1995). **Urrongas Member** appears restricted to the Nhachengue–Domo horst and the Pande- Temane high in Inhambane Province and attains a thickness of ~ 35 m in total. The unit comprises three levels with limestone and marl at the base, followed by fossiliferous brown limestones and compact crystalline limestones (Barrocoso, 1968).

Qps - Eluvial floodplain clayey sand - this type of deposit is found intimately associated with eluvial floodplain mud deposits. This floodplain unit refers to a widespread deposit of loose clay and sand

without dune features or any remarkable relief. Sometimes, the presence of argillaceous material causes retention of water during long periods, leading to the formation of numerous and usually small and shallow lakes. Sand grains in clayey material are generally of aeolian origin.

Qpi - Eluvial floodplain mud - Eluvial floodplain mud deposits cover very large areas with a flat morphology, situated at a lower elevation with respect to surrounding higher ground formed by the mud-arenaceous floodplains. These terrains have a very low permeability due to the high clay content and, consequently, these areas are frequently flooded and covered with lagoons and swamps that persist for long time after rainfall.

Qdi - Internal dune - These dunes are composed of reddish, brownish and yellowish aeolian sands consolidated by vegetation. The dunes are located inland, generally not far from the present shoreline, but are not part of the present active dune system.

Qe - Aeolian sand - Wind-blown sands cover vast areas. These slightly reddish, non-consolidated sand layers form superficial sheets, generally a few metres in thickness. They have been formed by ablation of the Internal Dunes, located further to the south.

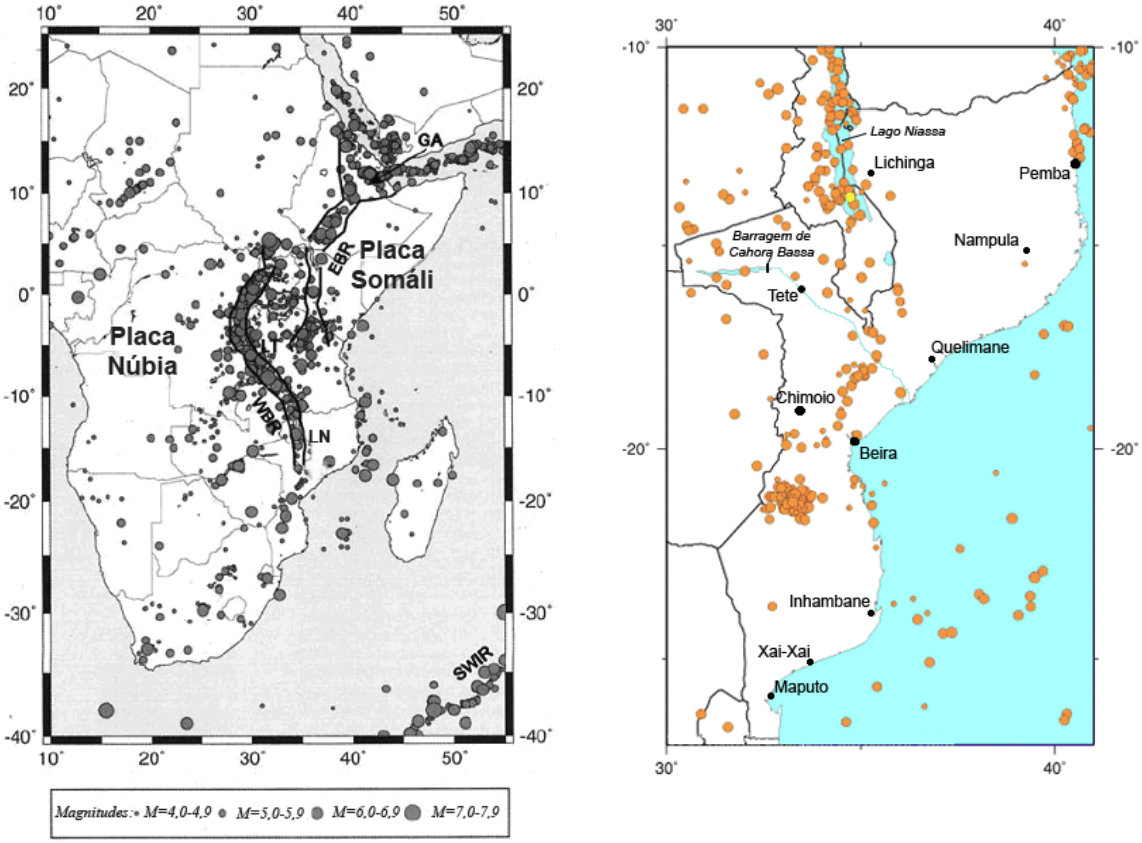
6.1.4.5 Seismicity

Central Mozambique is under the influence of the Great Rift Valley, which separates the Arabian, African and Indian plates, has an approximate length of 5,000 km and extends in the north-south direction from northern Syria to central Mozambique.

The rift begins in the Red Sea, in the separation of the African and Arabian plates, extending along the NW-SE direction to the Gulf of Aden. Then it is directed south to the Urema region, within the African plate. Prolongations of this Rift to the south can also be observed in the area of Machaze (Manica) in Graben region of Funhalouro, apart from others in the same region. The southern section is part of Niassa Lake, following the Chire River until it flows into the Zambezi River, about 250 kilometers downstream from Moatize.

According to USGS (2006), 190 earthquakes were recorded in Mozambique since 1973. More than half were of magnitudes greater than 4.0, and at least 15 had a magnitude equal or greater to 5.0, which is considered the lower threshold with the potential to cause structural damage.

The greatest earthquake recorded in Mozambique territory occurred on February 22nd, 2006, in the Machaze district, southern Manica Province, with a magnitude of 7.0 (Sousa, 2006). The majority of recent continental seismic activity epicenters are located in the Machaze region (**Figure 6.19**).



A. Southern and East Africa Seismicity (1927-1994 period), showing the Epicenters of Earthquakes of Magnitude greater than 4.0

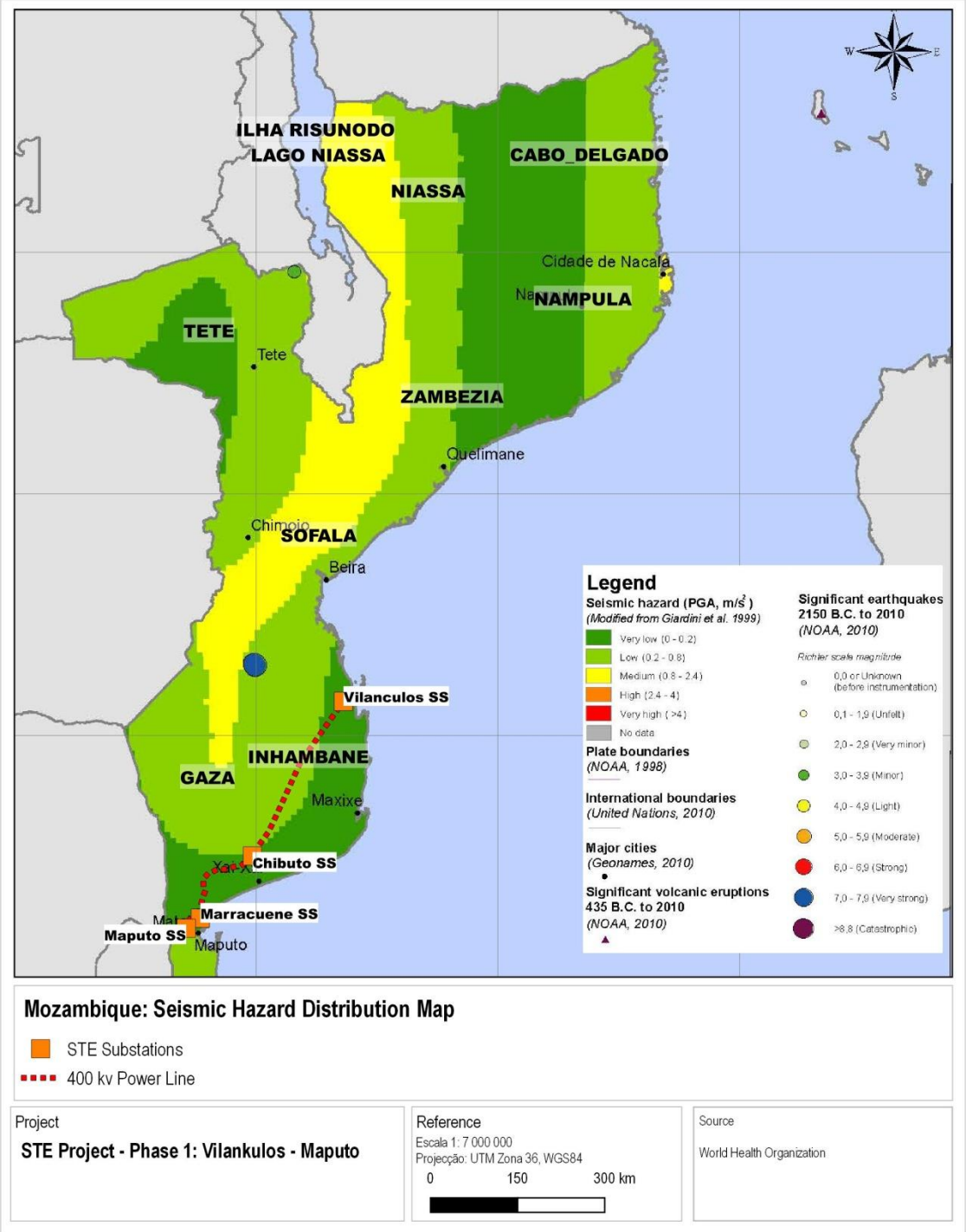
B. Seismic Activity (Epicenters) in Mozambican Territory (1973-2006)

Source: Sousa (2006).

Figure 6.19 – Seismic activity epicenters in Mozambique

From the data presented, it can be seen that the earthquake activity in Mozambique, though recurrent, is generally of low magnitude, and is fundamentally concentrated in central Mozambique, due to the influence of the Great Rift Valley.

Seismic activity in southern Mozambique, where the Project is located, is very low. This is corroborated by WHO's seismic hazard map for Mozambique, illustrated in **Figure 6.20** below. According to this map, the Project corridor crosses areas that were classified as having low to very low seismic hazard.



Source: WHO (2010).

Figure 6.20 – Seismic hazard map of Mozambique

6.1.5 Soils

6.1.5.1 Soil Occurences

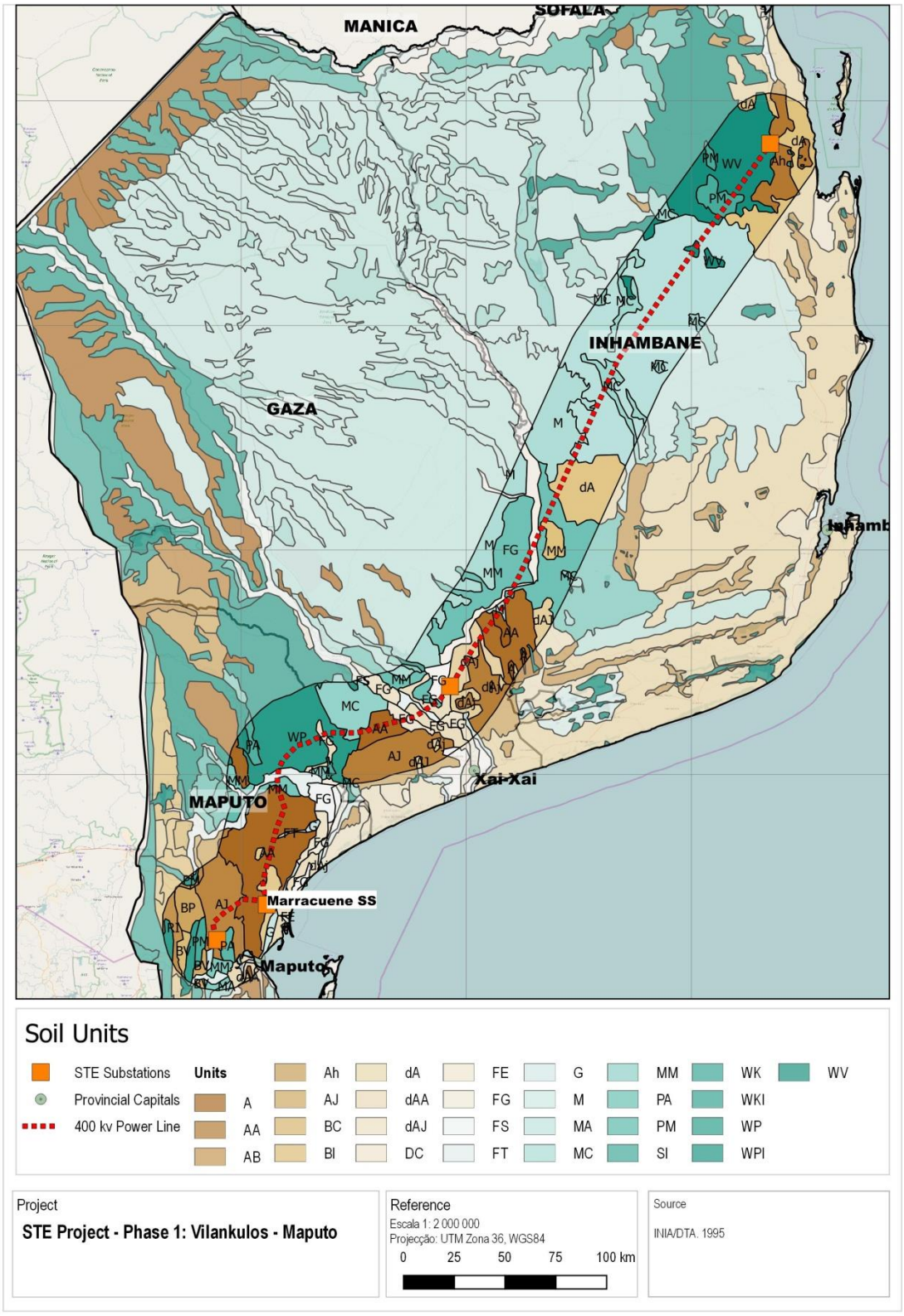
The description of the soil units in the study area is based on the National Soil Map (INIA, 1994), which allows for the identification of the several soil units present in the study area, and the description of their main characteristics. **Figure 6.21** shows an overview of the soil units present in the study area, representing each main group of soils by their code letter, as per INIA (1994). The soil classification key, i.e. the legend, for **Figure 6.21** is provided in **Table 6.8** below.

Table 6.8 – Soil Classification Key for the study area

Physiographic Unit	Parental Material	Soil Criteria	Symbol	Landform
Alluvial and fluvio- marine areas	Alluvial Sediments	Clayey; sandy and soil with peaty layer	FG; FS; FT	Valleys and plains
	Estuarine Marine Sediments	Clayey soils	FE	Estuarine plains
Sedimentary basin	Coastal dunes	Sandy soils	DC	Coastal dunes
	Cover sands and interior dunes	Sandy soils (yellow; orange, white)	A; AA; AB; AJ; dA; dAA; dAJ Ah	Sand plans; Internal dunes; Hydromorphic sandy depressions
	Red sandstone	Sandy soils	G	Low hills
	Mananga sediments Intimately associated with eluvial floodplain mud deposits	Soils with sand cover (max 100 cm) clayey colluvial soils	M; MA; MM MC	Plains, valley bottoms in cover sands area; Circular depressions at the foot of side slopes, drainage ways
	Post-Mananga deposits	Textured soils (fine - medium and coarse)	PA; PM	Colluvial slopes
	Sedimentary rock outcrop of Karroo, Cretaceous or Tertiary	calcareous sedimentary rocks and others	WK; WV; WP	Hills

The geologic framework (parent materials) strongly influences the pedogenetic processes, although other factors also contribute to soil formation, such as climate, living organisms, relief and time. The main soil units in the study area are therefore associated with the sedimentary conditions that originated the parent materials. In line with the classification criteria used in the legend of the National Soil Map (INIA), the identified soils can be grouped into 2 major physiographic units:

- **Alluvial and fluvial zones** – these soils occur in the areas associated with the main rivers and water lines, on valleys and plains; mostly along the Changane river; Limpopo estuary; Incomati and Matola rivers;
- **Typical deposits of sedimentary basins** – the dominant soils are Mananga sediments (M, MM and MC) which are sandy soils developed on quartzose (sometimes calcareous) sands of several origins, such as residual materials remaining after long term weathering of acid rocks, or from aeolian deposits or fluvial sediments. They fundamentally derive from unconsolidated sandy materials of eluvial floodplain.



Source: INIA/DTA (1995). **Legend:** please see Table 6.8 above.

Figure 6.21 – Soil units intercepted by the Project

Mananga soils are defined as colluvial and with a possibly high calcium content occupying depressions at the foot of slopes. Mananga is a local name (Changane) used by local people to

designate a thick, homogeneous mantle of yellowish-brown, saline, sodic, calcareous, sandy clay loam (to sandy loam) created in a large slightly sloping plateau.

6.1.5.2 Local Soils Description

The following tables present the major soil types intercepted by the Project, including their characteristics and area of occurrence, divide by the following parental materials:

- Alluvial and fluvio - marine areas (**Table 6.9**);
- Typical cover sands and interior dunes (**Table 6.10**);
- Mananga sediments (**Table 6.11**);
- Rock outcrops of Karroo, Cretaceous or Tertiary and Pós-Mananga sediments (**Table 6.12**).

Table 6.9 – Major soil types and characteristics from Alluvial and fluvio- marine areas intercepted by the Project

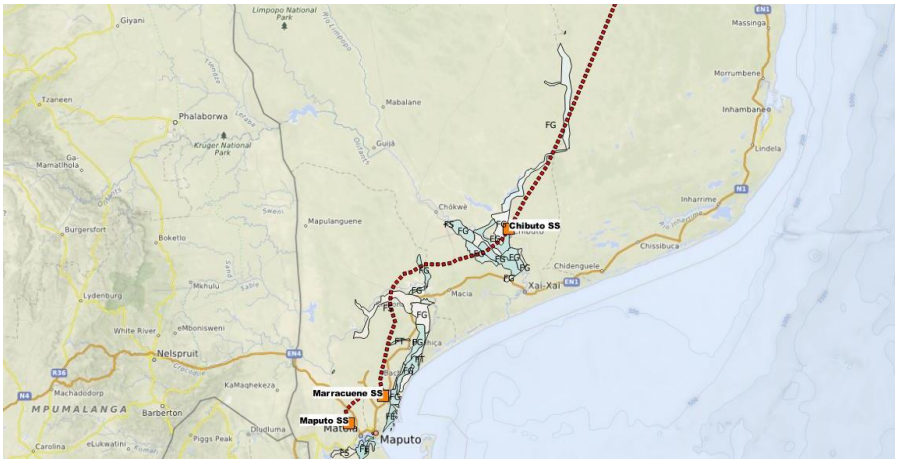
Symbol	FE	FG	FS
Map			
Soil Grouping	Soils of estuarine marine sediments	Clayey alluvial soils	Soils of coarse or medium-textured stratified alluvium
Dominant characteristics	Clayey, grey, deep and frequently saturated	Dark grayish brown; clayey; deep soils	Sandy loam, grayish brown, deep
Geology	Holocene estuarine-marine sediments	Alluvial deposits of the Holocene	Holocene alluvium
Geomorphology	Estuarine Plains	Valleys and plains	Valleys and plains
Soil depth (cm)	> 100 cm	>100 cm	> 100 cm
Drainage	Poor to very poor	Moderate to poor	Imperfect to poor
Acidity and Alkalinity (pH)	Top Soil: 7.5 - 8 Sub Soil: 7.5 – 9	Top Soil: 6 - 8 Sub Soil: 6 - 8.5	Top Soil: 6 – 7.5 Sub Soil: 6.5 – 7.5
Main Limitations for Agriculture	salinity, sodicity, drainage, flooding	drainage, sometimes salinity & sodicity	Sometimes drainage & sodicity
Organic Matter	Moderate (1 – 3 %)	High (3 - 4.5 %)	Low to high (0.5 – 3.5%)
FAO (1988) Classification	Salic Fluvisols	Mollic Fluvisols	Eutric Fluvisols
land suitability for irrigation (USBR)	Marginal for pasture	Moderately suitable	Very suitable - Special use (overhead irrigation, rice)

Table 6.10 – Major soil types and characteristics from typical cover sands and interior dunes intercepted by the Project

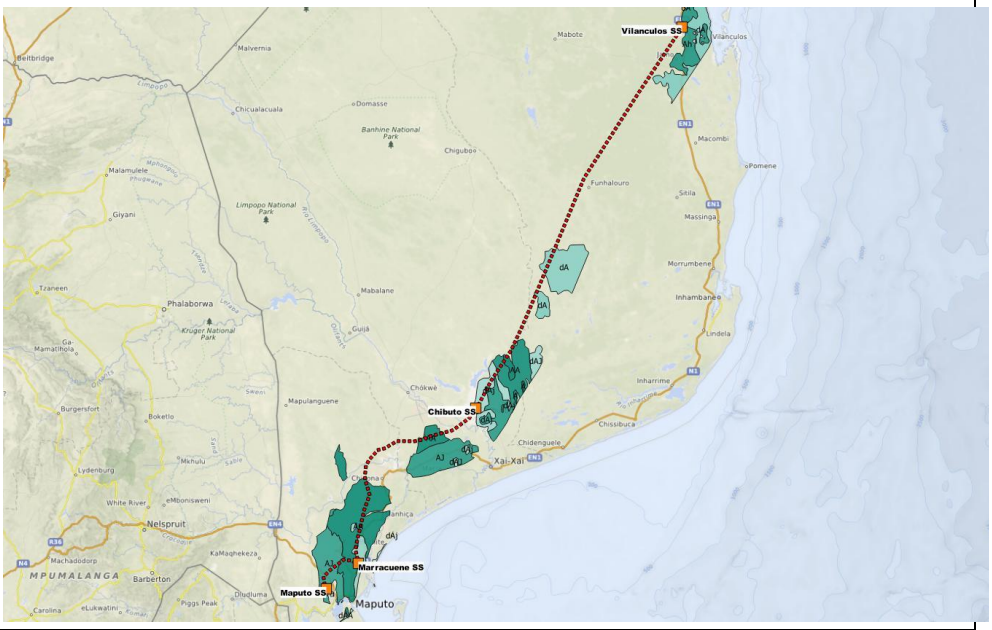
Symbol	A	AA	Ah	dA	dAJ
Map					
Soil Grouping	Unspecified sandy soils	Yellowish sandy soils	Hydromorphic sandy soils	Unspecified sandy soils, dune phase	Orange sandy soils, dune phase
Dominant characteristics	Sand, very deep	Yellowish brown sand; very deep soils	Sand, brown, very deep	Sand, very deep	Sand, orange, very deep
Geology	Pleistocene cover sands and aeolian sands	Sandy cover; aeolic sands; Pleistocene	Pleistocene cover sands and aeolian sands	Pleistocene cover sands and aeolian sands	Pleistocene cover sands and aeolian sands
Geomorphology	Sand plains	Sand plains	Hydromorphic sandy depressions	Interior dunes	Interior dunes
Soil depth (cm)	> 180	> 180 cm	> 180	> 180	> 180
Drainage	Good to excessive	Good to excessive	Poor to very poor	Good to excessive	Good to excessive
Acidity and Alkalinity (pH)	Top Soil: 4 – 7 Sub Soil: 4 – 8.5	Top Soil: 4 – 6 Sub Soil: 4 – 6.5	Top Soil: 5 – 7 Sub Soil: 5.5 – 7	Top Soil: 4 – 7 Sub Soil: 4– 8.5	Top Soil: 5 – 6.5 Sub Soil: 5 – 6.5
Main Limitations for Agriculture	Water holding capacity, fertility	Water holding capacity, fertility	Drainage, flooding, sometimes sodicity	Water holding capacity, fertility	Water holding capacity, fertility
Organic Matter	Moderate (0 – 3%)	Low to moderate (0 – 3%)	Low to high (0 – 5%)	Moderate (0 – 3%)	Low to moderate (0.5 – 2%)
FAO (1988) Classification	Arenosols	Ferralic Arenosols	Gleyic Arenosols	Arenosols	FerralicArenosols
land suitability for irrigation (USBR)	Special use (overhead irrigation, rice)	special use (overhead irrigation, rice)	not recommended, potentially suitable	special use (overhead irrigation, rice)	Not recommended, potentially suitable

Table 6.11 – Major soil types and characteristics from typical Mananga sediments intercepted by the Project

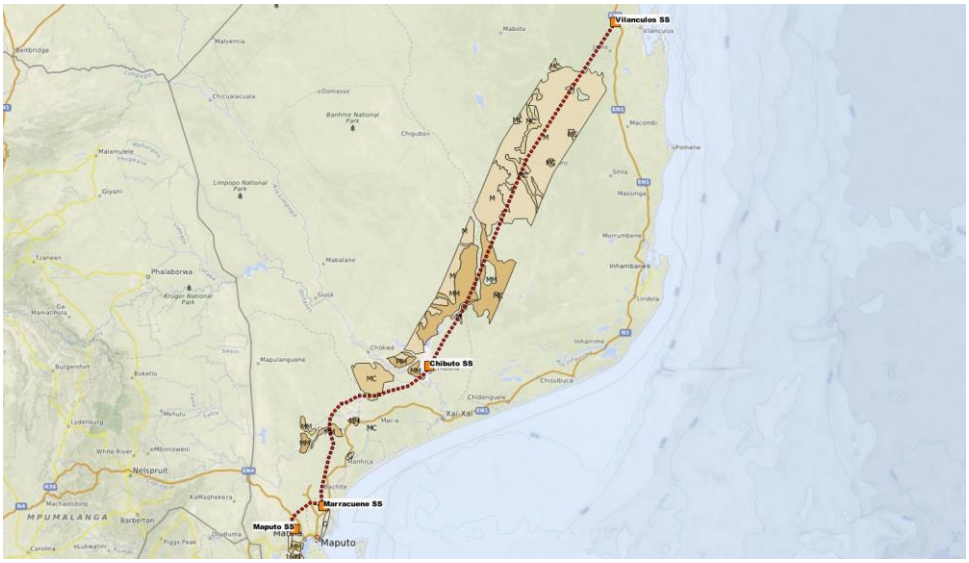
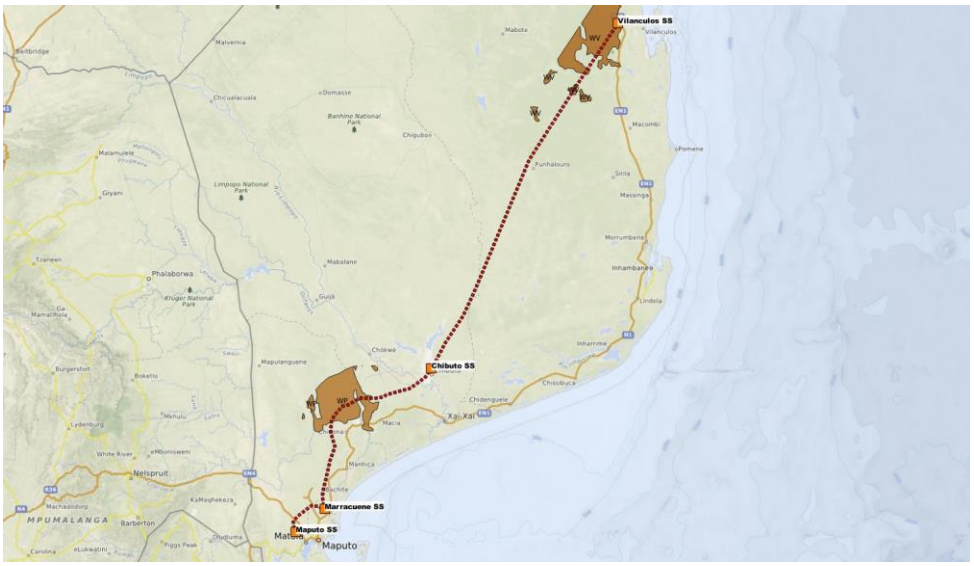
Symbol	M	MA	MM	MC
Map				
Soil Grouping	Soils of Mananga with sand cover of varying thickness	Soils of Mananga with sand cover of varying thickness	Soils of Mananga with sand cover of varying thickness	Soils of clayey Mananga colluvium
Dominant characteristics	Unspecified Mananga soils	Sandy clay loam, yellowish brown, moderately thick surface sand layer	Unspecified Mananga soils	Clayey, dark greyish brown, deep
Geology	Mananga sediments: layer of < 20 m of hard sodic Pleistocene deposits	Mananga sediments : layer of < 20 m of hard sodic Pleistocene deposits	Mananga sediments : layer of < 20 m of hard sodic Pleistocene deposits	Colluvium derived from Mananga
Geomorphology	Plains, valley bottoms in cover sands area	Plains, valley bottoms in cover sands area	Plains, valley bottoms in cover sands area	Circular depressions at the foot of side slopes, drainage ways
Soil depth (cm)	> 100	> 100	> 100	> 100
Drainage	Imperfect to moderate	Moderate	Imperfect to moderate	Imperfect to poor
Acidity and Alkalinity (pH)	Top Soil: 5 – 8 Sub Soil: 5.5 – 8.5	Top Soil: 5 – 7.5 Sub Soil: 5 – 8	Top Soil: 5 – 8 Sub Soil: 5.5 – 8.5	Top Soil: 6.5 – 8.5 Sub Soil: 7 – 9
Main Limitations for Agriculture	Soil hardness and permeability, sodicity, sometimes salinity	Water holding capacity, fertility	Soil hardness and permeability, sodicity, sometimes salinity	Salinity, sodicity, drainage, flooding
Organic Matter	Low to high (0.5 – 5%)	Low to moderate (0.5 – 3%)	Low to high (0.5 – 5%)	Moderate to high (2 – 4.5%)
FAO (1988) Classification	Stagnic or Haplic Luvisols	Ferralic Arenosols	Stagnic or Haplic Luvisols	Mollic Solonchaks
land suitability for irrigation (USBR)	Not recommended	Not recommended, potentially suitable	Not recommended	Moderately suitable - Not recommended

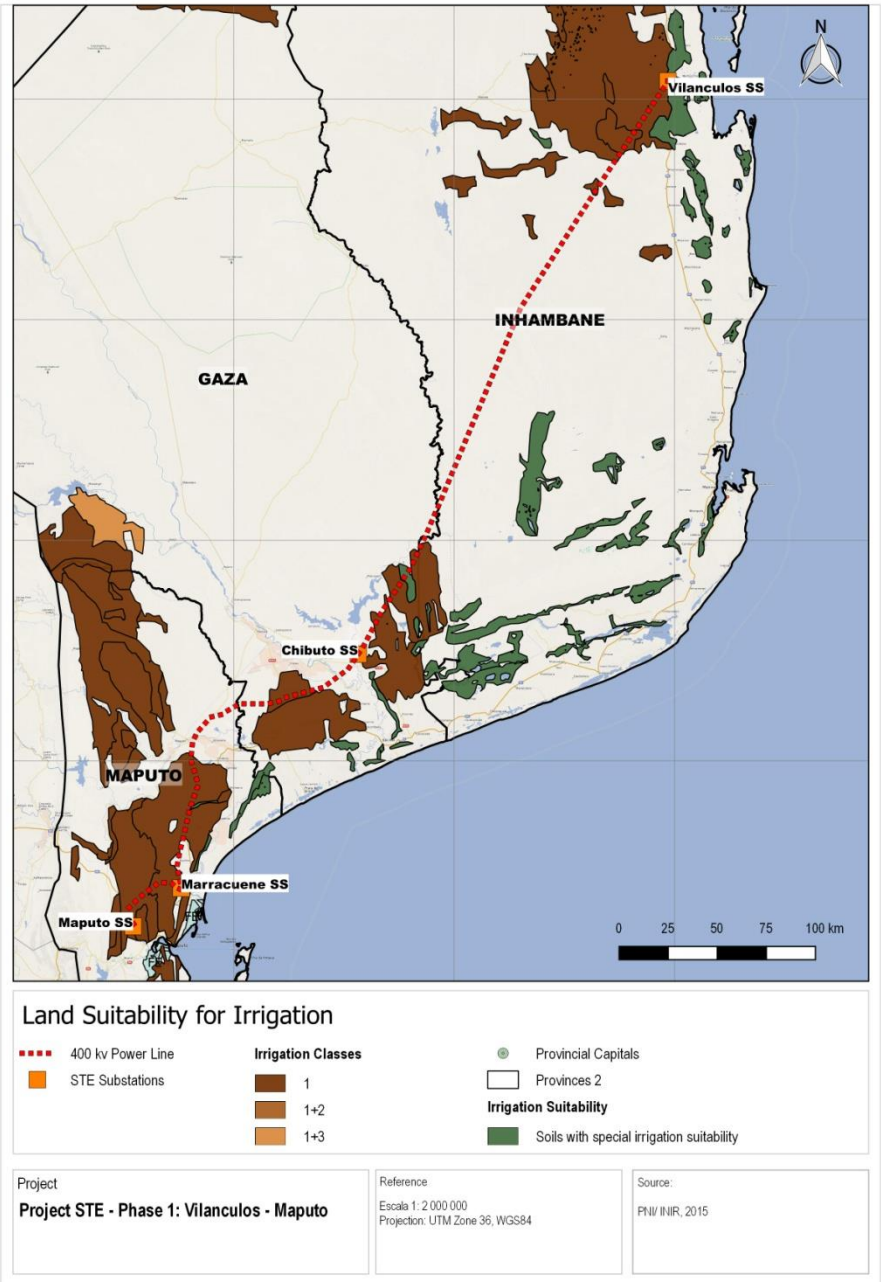
Table 6.12 – Major soil types and characteristics from sedimentary rock outcrop of Karroo, Cretaceous or Tertiary and Pós-Mananga sediments intercepted by the Project

Symbol	WK	WV	WP	PM
Map				
Soil Grouping	Shallow soils on calcareous rocks	Clayey red soils derived from calcareous rocks	Shallow soils on non-calcareous rocks	Medium-textured soils of Post- Mananga
Dominant characteristics	Sandy clay loam, brown, moderately deep, calcareous	Clayey, reddish brown, moderately deep	Clayey, brown, moderately deep	Sandy clay loam, reddish brown, deep and moderately deep
Geology	Sedimentary rock outcrop of Karroo, Cretaceous or Tertiary	Sedimentary rock outcrop of Karroo, Cretaceous or Tertiary	Sedimentary rock outcrop of Karroo, Cretaceous or Tertiary	Red upper Pleistocene Post-Mananga deposits (0.5-10 m) of valleys' side slopes,
Geomorphology	Hills	Hills	Hills	Colluvial slopes
Soil depth (cm)	Generally <100	<100	<100	70 – 25 cm
Drainage	Imperfect-good	good	Imperfect-moderate	Good
Acidity and Alkalinity (pH)	Top Soil: 6.5 – 8 Sub Soil: 6 – 9	Top Soil: 5.5 – 6.5 Sub Soil: 5.5 – 6.7	Top Soil: 6 - 7 Sub Soil: 6 – 7	Top Soil: 6 – 7.5 Sub Soil: 5.5 – 7.5
Main Limitations for Agriculture	Soil depth, sodicity, sometimes salinity	Sometimes soil depth (<1 m), erosion (on slopes)	Soil depth, drainage, soil fertility	Sometimes soil depth (<1 m), erosion (on slopes), salinity, sodicity
Organic Matter	Moderate (1 – 3%)	Moderate (1-1.5)	Low to moderate (0 - 2.5%)	Moderate to high (1 – 4%)
FAO (1988) Classification	Typic Ustochrepts	Chromic Luvisols or Haplic Lixisols	Eutric Cambisols	Haplic Lixisols or Chromic Luvisols
Land suitability for irrigation (USBR)	Marginally suitable - Special use (overhead irrigation, rice)	Moderately suitable	Marginally suitable	Moderately suitable

6.1.5.3 Soil Suitability for Irrigation

The soil suitability for irrigation cartography was elaborated at Phase 1 - Inventory and Cartography of the National Irrigation Program (PNI) (2014), where the soils were grouped in classes of suitability, according to their potentialities and limitations, that is, according to their capacity to withstand the

usual irrigation crops, for long periods of time, without resulting in degradation. Four classes were considered, ranging from Class 1, which includes soils that are suitable for irrigation, to Class 4, which includes soils that are unsuitable for irrigation. The definition of suitability for irrigation was based on the potential of the production of the soils in conditions close to the present ones, without making use of investments of adaptation to irrigation. **Figure 6.22** shows the occurrence of soils of Class 1 in the study area (or soils of class 1 mixed with class 2 and 3).



Source: INIR (2015).

Figure 6.22 – Land suitability for irrigation

From the 22 hydrographic basins considered in the PNI, eight were identified as more favorable for irrigation, namely: Maputo, Limpopo, Búzi, Zambeze, Licungo, Melúli, Lúrio and Rovuma. Zambezi

basin is the more favorable, as a result of the high availability of water and irrigable soils and its strategic position in the country and in relation to development corridors. The three basins that follow are in the North and Center of the Country: Rovuma, Lúrio and Licungo, also fruit of the availability of water and soil and the location in relation to the development corridors and the mega-projects in perspective. Finally, the basins of Melúli, Búzi, Limpopo and Maputo also present favorable conditions for the development of irrigation.

According with the same document, in Limpopo Basin, current irrigation is concentrated in two areas (excluding the Massingir Agro-Industrial Project), namely Chokwe and Xai-Xai. In Chokwe, the infrastructure area is about 22 000 ha, but only about 8 000 ha are in use, 7 000 ha in rehabilitation, and the remaining 7 000 ha to be rehabilitated later. In Xai-Xai there are about 4 000 ha recently rehabilitated. There are plans to increase the irrigated area to 9 000 ha. The existing area uses the combination of percolated mountain water and pumped water from the Limpopo River, depending on the month of the year (INIR, 2014).

Figure 6.23 – Irrigation lands (Limpopo floodplain) crossed by the Project

6.1.5.4 Erosion Risk

The only available erosion risk information for the study area is the Mozambique Erosion Risk Map, produced at a national scale (1:2 000 000). The erosion risks, for the study area, crossed by the proposed alignment, are shown in **Figure 6.24**.

Soil formation and soil erosion are two natural and opposing processes. Many natural, undisturbed soils have a formation rate balanced by a rate of erosion. Under these conditions, the soil appears to remain in a constant state as the landscape evolves. Generally, the rates of soil erosion are low unless the soil surface is exposed directly to the wind and rainwater. Erosion problems arise when the natural vegetation cover is removed and rates of soil erosion are greatly accelerated. In such

cases, the rate of soil erosion greatly exceeds the rate of soil formation, and erosion control practices are required to reduce erosion rates and maintain soil productivity.

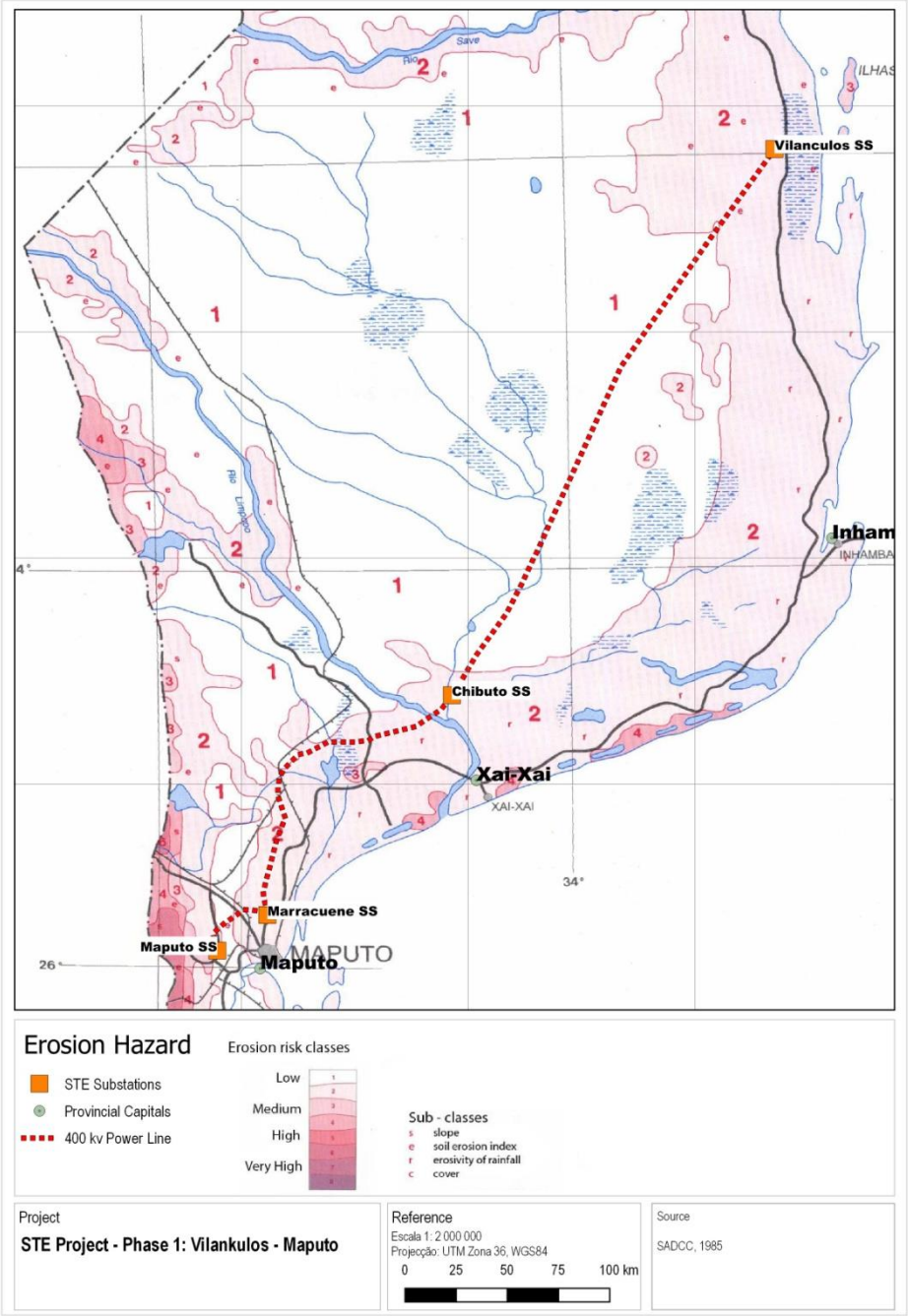


Figure 6.24 – Erosion risk

As can be seen in **Figure 6.24** above, at regional level, the proposed line is within a region with a low erosion risk. However, at local level, there may be areas where erosion may constitute an important risk, due to specific local conditions, in particular in the case of the fossil dunes that mark the interior of the coastal planes. Dunes are normally composed of sand with low water retention capacity and a low organic matter contents. Rainfall is typically concentrated in high energetic torrential rains and removal of vegetation on or close to slopes is likely to increase erosion.

6.1.6 Water Resources

6.1.6.1 Regional Hydrological Framework

The hydrology baseline description was based on a review of existing secondary information for the Project's region. The more relevant sources were the following:

- Hydrographic Basins Cartography, scale 1: 2,000,000, Republic of Mozambique;
- Integrated Water Resources Management Plan for Inhambane Province (Consultec, 2009);
- Profile of the Limpopo Basin in Mozambique (UEM, 2009);
- Limpopo River Basin Monograph (Aurecon, 2012);
- Design of a Water Quality Monitoring Network for the Limpopo Basin, Mozambique (Chilundo, 2007); and
- Assessment of the Hydrological Situation of Mozambique in the Context of Floods 1977-2013 (Consultec, 2014).

The proposed alignment develops generically in a NE-SW direction, while the regional river network follows preferably NW-SE or W-E direction, following the natural hypsometry of the territory. As such, the alignment develops perpendicularly to the regional hydrological network. From this, it results that the alignment crosses a great number of rivers and water lines along its length, which can be divided into the following four major hydrographic basins, North to South (see **Figure 6.25**): Govuro, Limpopo, Incomáti and Matola.

A description of the alignment's interferences with water resources within these four basins follows:

- The northern part of the alignment (roughly from Vilanculos to Funhalouro, along 140 km) falls inside the Govuro basin. In this basin surface water resources are scarce. The only significant river is the Govuro River that flows in the S-N direction following the natural depression from local coastal morphology. The Project does not cross any major river within this basin;
- Heading south, the alignment then crosses the Limpopo basin (roughly from Funhalouro to EN101 Macia-Chokwe, along 250 km). Limpopo is the third largest basin in Mozambique, after the Zambezi and Rovuma basins. The proposed alignment crosses the Changane River, the main tributary of the Limpopo River in Mozambique territory, on three occasions: two crossings upstream of Nhangule Lake (Ch1 and Ch2, see **Figure 6.26**) and one crossing about 25 km downstream the lake (Ch3, see **Figure 6.26**), near Chibuto village. In this section the Project crosses several small tributaries (seasonal rivers) of Changane River. The proposed alignment then proceeds through about 25 km of Limpopo river flood plain (see **Figure 6.27**), crossing the Limpopo River and other tributaries (namely Chinaugue and Munhuana rivers). In this area, river meanders and flood ramification are constant, and the region is very vulnerable to floods. The alignment crosses several of these flood ramifications;

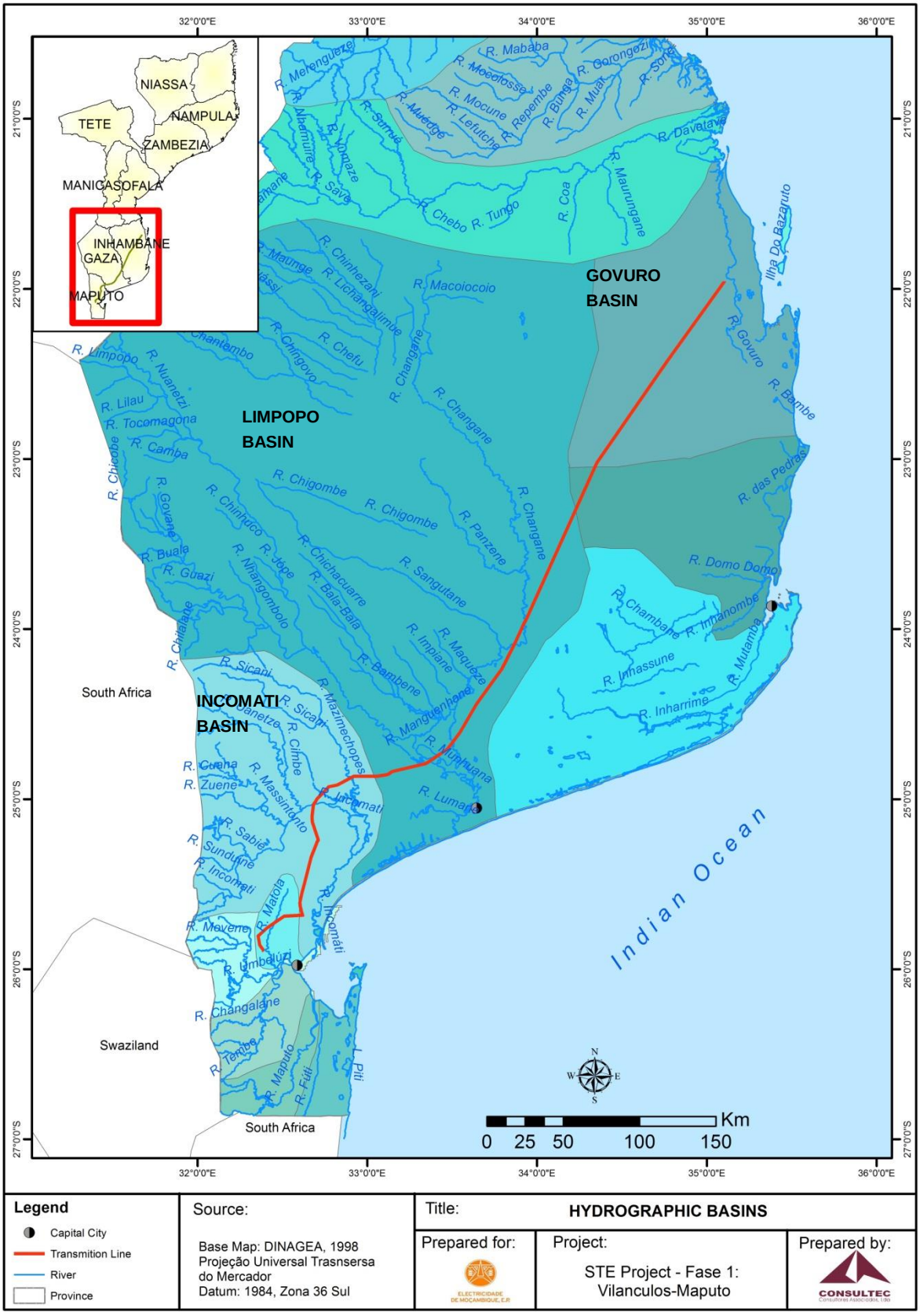


Figure 6.25 – Main hydrographic basins crossed by the proposed Project

Figure 6.26 – Limpopo basin – Changane River crossings

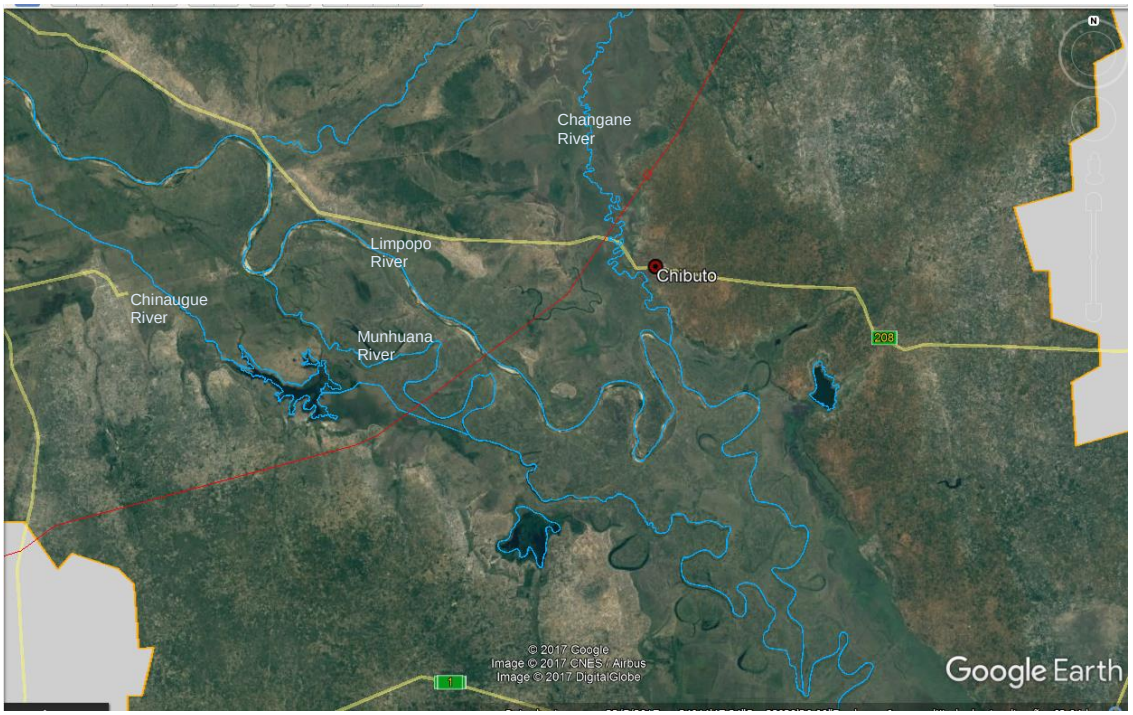


Figure 6.27 – Limpopo basin – Limpopo River crossing

- The alignment then crosses the Incomati basin (roughly from EN101 Macia-Chokwe to Maluana, along 105 km). In this basin the proposed alignment crosses the Incomati River (3 km east of Magude) and its tributaries Mazimechopes and Tesátsen rivers (see **Figure 6.28**).

The route also cross smaller seasonal rivers, including some flood ramifications near Magude; and

- Further south, the alignment crosses the Matola River (Matola basin). The Matola River develops in a North-South direction towards the Espírito Santo Estuary. It has a small drainage basin.

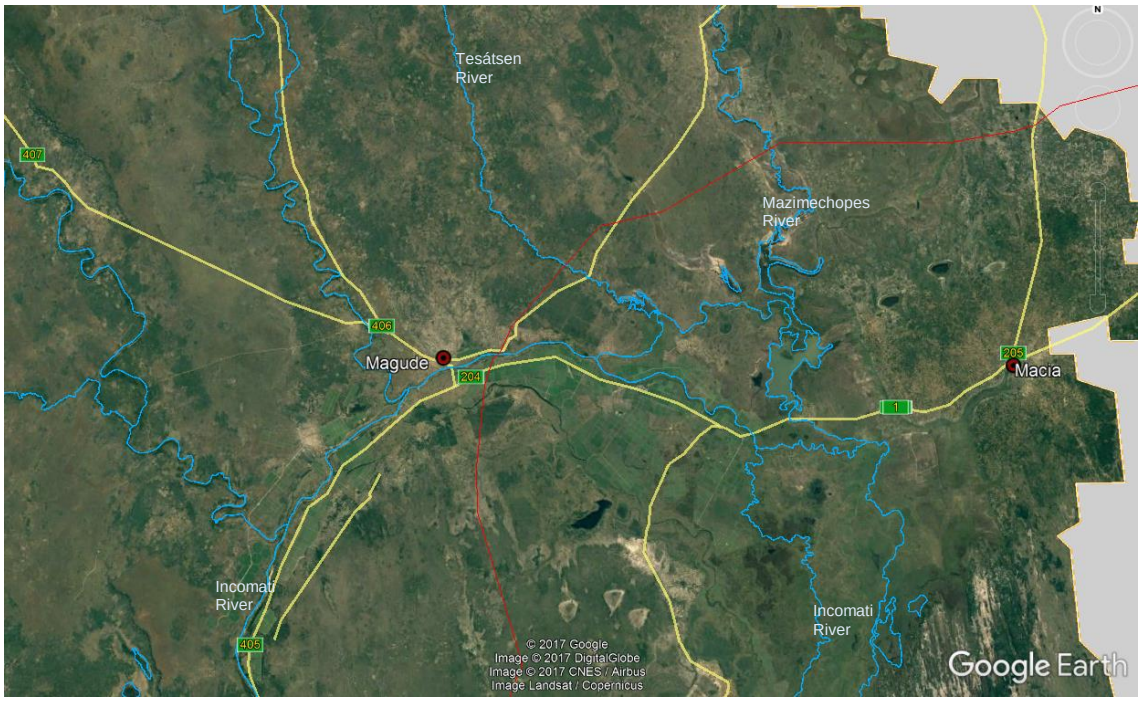


Figure 6.28 – Incomati basin

The following table summarizes the main features of the river basins crossed by the Project.

Table 6.13 – Hydrographic basins crossed by the Project

Hydrographic Basin	Total Area (km²)	Area within Mozambique (km²)	Length of Main River (km)	Rivers Crossed by the Project
Govuro basin	11,200	11,200	185	-
Limpopo basin	412,000	79,600	1,460	Changane, Limpopo, Chinaugue and Munhuana rivers
Incomati basin	46,246	14,925	714	Incomati, Mazimechopes and Tesátsen rivers
Matola basin	2,362	2,362	58	Matola river

A more detailed description of each of these main four hydrographic basins crossed by the Project is provided in the following sections.

6.1.6.2 Govuro Basin

Hydrological Framework

The Govuro basin is a costal basin located in Inhambane Province (see **Figure 6.25**, page 95). The basin is rectangular in shape and presents an area of about 11,200 km². The Govuro River is the most important river in the northern region of Inhambane Province, in Vilanculos District.

The Govuro River develops in a S-N direction following the natural depression resulting from the local coastal morphology, with an extension of approximately 185 km. The river has a low slope and drains the calcareous and dune water table. The basin's average altitude is about 80 m, and the highest heights are approximately 140 m in the southwest end, near Funhalouro (Consultec, 2009). The Govuro River has no significant tributaries. It should be noted that while the proposed alignment starts in the Govuro basin, the Govuro River itself is not crossed by the Project.

Water Availability

Generally, surface water resources in this region are scarce, with the exception of the Govuro River and associated streams. The Govuro River presents significant changes in the river flow, due to natural climate seasonal changes. Downstream Mapinhane the river is almost perennial (Consultec, 2009). In the dry season the river present small flows. The average annual water flow is 120 million m^3/y (based on E49 monitoring station records, Consultec 2009).

Infra-structures

This basin has no relevant water management infra-structures.

Water Use

Surface water in the region is scarce, and the majority of the population uses wells and boreholes for water collection. In coastal areas, lakes are also an important source for water supply. Due to the general scarcity of water, agricultural practices are predominantly small scale. Along the downstream part of the Govuro River basin, several private farmers have developed small scale irrigation systems, in spite of local water quality problems (high salt content) (Consultec, 2009).

The collection and use of rainwater is a common practice all over the Province of Inhambane, mainly in interior regions. Water collected is stored in cisterns (mostly home cisterns), the construction of which varies from quite simple systems (manually excavated cisterns with walls covered with cement mortar and sand) to more complex systems (in masonry, brick on brick). Another traditional form of rainwater storage is the use of the baobab's trunk.

6.1.6.3 Limpopo Basin

Hydrological Framework

The Limpopo basin is the third largest basin in Mozambique, after Zambezi and Rovuma. Limpopo is an international basin shared by three other SADC Member States namely South Africa (45%), Botswana (20%) and Zimbabwe (15%) (see **Figure 6.29**). The total catchment area has approximately 410,000 km^2, of witch 79,600 km^2 (20%) are located in Mozambique.

The Limpopo River has an extension of about 1,460 km, marking the international border between South Africa and its neighbors Botswana and Zimbabwe. The river crosses into Mozambique in Pafúri (Chicualacuala District, Gaza Province) and flows in a NW-SE direction along an extension of about 561 km until it drains into the Indian Ocean, near Xai-Xai (Xai-Xai District, Gaza Province).

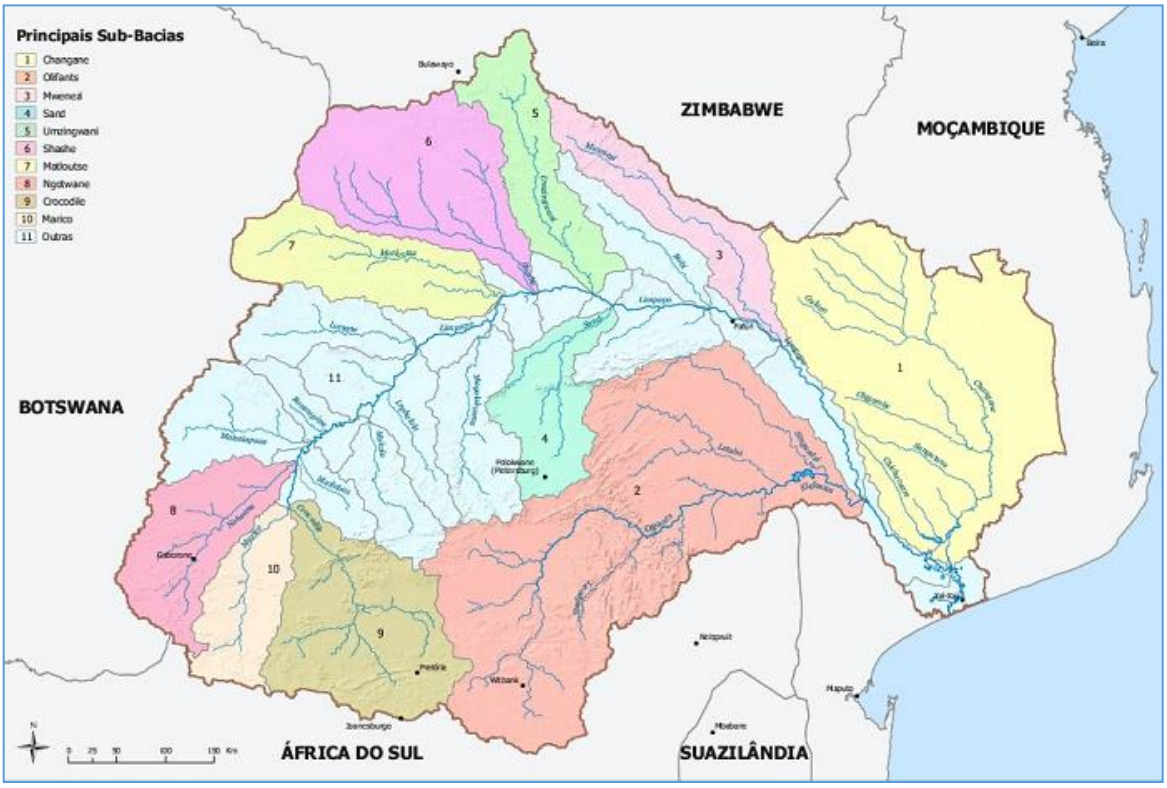
Three important tributaries join the Limpopo River in Mozambique: Nuanedzi River (with origin in Zimbabwe), Elephants River (the tributary with the larger basin, with origin in South Africa) and

Changane River, the only totally national sub-basin (with origin in Mozambique, near the Zimbabwe border). The Changane River catchment area, of about 68,160 km^2, is very flat and a large proportion of the catchment acts hydrologically as a series of wetlands (Aurecon, 2013). The Changane River contributes only with a small percentage of runoff to the Limpopo River, due to the flat nature of the topography. The Changane River joins the Limpopo River near Chibuto town.

Water Availability

The regional climate is characterized by a prolonged dry season and an intense rainy season between December and February, leading to significant sazonal changes in river flows. The Limpopo River and its larger tributaries are marked with seasonal cyclical patterns, with floods in the rainy season and small flows in the dry season. In Mozambique, the Limpopo River often dries out (between Chicualacuala and Sicacate) due to the intensive use of water upstream (Consultec, 2014). In the wet season, the Limpopo is very vulnerable to floods, especially downstream Chokwè, where the basin is very flat (in the last 175 kilometers, between Chokwè and the sea, the elevation is less than 20 masl (Consultec, 2014)). Downstream Chokwè, meanders and flood ramification are constant. When floods occur, the river flow is very slow, leaving flooded areas for a long time. The Limpopo basin is subject to cyclical floods, some of which with catastrophic effects (with cattle and crops losses, infrastructures destruction such as roads, railways, bridges and houses, among others). In Mozambique the major floods occurred in the years: 1915, 1918, 1925, 1937, 1955, 1972, 1975, 1977, 1981, 1988, 2000 and most recently in 2013 (Consultec, 2014).

Most of the smaller Limpopo tributaries are seasonal, and only have water when it rains.



Source: Consultec (2014).

Figure 6.29 – International Limpopo basin

Infra-structure

The international Limpopo basin has 79 large dams[1] (Aurecon, 2013), of witch only 2 are located in Mozambique, namely: Massingir (located in Elephant river, 30 km downstream of the South African border, with about 2,800 million m^3 capacity) and Macarretane (located in Limpopo river, about 20 km upstream Chokwè, with 15 million m^3 capacity). Both dams were built for irrigation proposes.

Water Use

In Mozambique, Limpopo river water is mostly used for irrigation proposes, from Massingir Dam. Other minor uses include: subsistence livestock (mainly by rural communities), urban supply (major cities are Xai-Xai and Chókwè, supplies from groundwater), rural communities supply (in rural areas population resort to water from boreholes, rivers and lagoons) and industry and mining.

Currently, the main irrigation areas are (Consultec *et al*, 2016): Eduardo Mondlane Irrigation (10,000 ha), Lower Limpopo irrigation scheme (12,500 ha) and Chokwè irrigation scheme (2,500 ha). For 2045 is estimated a total irrigation area of about 123,000 ha (Consultec *et al.*, 2016). Current irrigation demand is estimated to be about 364 million m^3/y (Consultec *et al.*, 2016).

Water supply requirements to urban areas are relatively low: 21 million m^3/y (Consultec *et al.*, 2016). Livestock has an actual estimated water use of 10 million m^3/year (Consultec *et al.*, 2016). Industry and mining activities have very low impact on water uses, representing 0.1 million m^3/year.

Water Quality

Water quality in the Limpopo Basin is affected by human activities. In the Mozambican sub-basin, the main sources of water pollution include:

- Human settlements – water contamination risk resulting from human settlements (wastewater) is dispersed throughout the basin, being higher in areas with greater population density. Generally, the basin presents a low population density. The main urban centers are Xai-Xai (920 inhabitants/km^2) and Chokwè (80 inhabitants/km^2). Domestic wastewaters contribute to the contamination of water with oxidizable organic matter, nitrates, phosphates, ammonia and infectious agents (bacteria, viruses and protozoa). Infectious agents are the major concern associated with domestic wastewater. Most population living in the basin resort to water from boreholes (59%, INE 2013) and rivers or lagoons (9%, INE 2013) without any formal treatment, increasing the risk of diseases such as cholera, infectious diarrhea, dysentery, intestinal worms and schistosomiasis (bilharziosis), common diseases in the region. Occasional water analyses carried out in Limpopo basin showed high concentration of bacteria (*E. coli*), confirming fecal contamination by human settlements. Analyses to Xai-Xai sewage discharge identified high levels of *E. coli*, low concentration of dissolved oxygen (an indicator of organic matter pollution) and high levels of ammonia, nitrates and total phosphorus (Chilundo, 2007). The sewage is directly discharge into Limpopo river, without any previous treatment;

1 A Large Dam is any dam with a height, from lowest Foundation level to highest structure crest, of more than 15m, or if the height is between 10 and 15 metres and one or more of the following conditions apply (Aurecon, 2013): dam length more than 500 m; storage capacity more than 3 million m^3, flood discharge more than 2 000 m^3/s or unusual characteristics in dam type or foundation.

- Livestock – carried out mainly by rural communities for subsistence. The presence of livestock along river banks for watering is common, being a relevant source of water contamination through excretes and urine;
- Agriculture – intense agricultural activities occur in Chókwè region. Large-scale (intensive) agriculture poses a serious threat to water pollution through the use of fertilizers (enrichment of water with nutrients such as nitrates and phosphates, can bring serious ecological problems to aquatic ecosystems by favoring excessive algae and aquatic plants growth and consequently eutrophication water bodies) and pesticides (toxic substances). Environmental concerns on small-scale farming are manly associated with deforestation and degradation of the riparian vegetation, exposing the river banks to erosion and promoting the increase of sedimentation and water turbidity. Occasional water analyses carried out in agriculture water discharges (Chokwe and Munhuana) revealed low concentrations of dissolved oxygen (below 5 mg/L), being an indicator of organic matter pollution; also high concentrations of phosphorus were determined;
- Salt intrusion, near the river mouth – is observed up to 55 km upstream the river mouth (downstream Xai-xai city), due to high tides (Chilundo, 2007). This may condition the water use for irrigation and human consumption;
- Seasonal flow changes - natural seasonal changes can significantly affect water quality. The flow rise in the rainy season increase sediment transportation and affect the turbidity and promote the dispersion of pollutants;
- Water management infrastructures (dams, artificial embankments) – these structures are a physical barrier to the rivers natural flow. The upstream reservoirs contribute to the deposition of suspended particles and other associated elements such as heavy metals. Also can lead to the accumulation of nutrients and organic matter. Occasional water analyses carried out in Limpopo basin showed higher concentration of some metals (Lead, Zinc, Cadmium, Copper and Iron) in the reservoir than downstream Massingir dam.
- Natural geology of the region - occasional water analyses carried out in the Changara River showed that the water is very hard (high concentration of Calcium and Magnesium) and present high levels of Chloride; which results from water contact with soil and rock formations. This type of water is not suitable for agriculture and human consumption.

Note that before entering Mozambique, the Limpopo River flows through urbanized, industrial, mining and agricultural development areas in Zimbabwe and South Africa, which may contribute to changes in water quality. The basin includes Pretoria and Johannesburg urban centers.

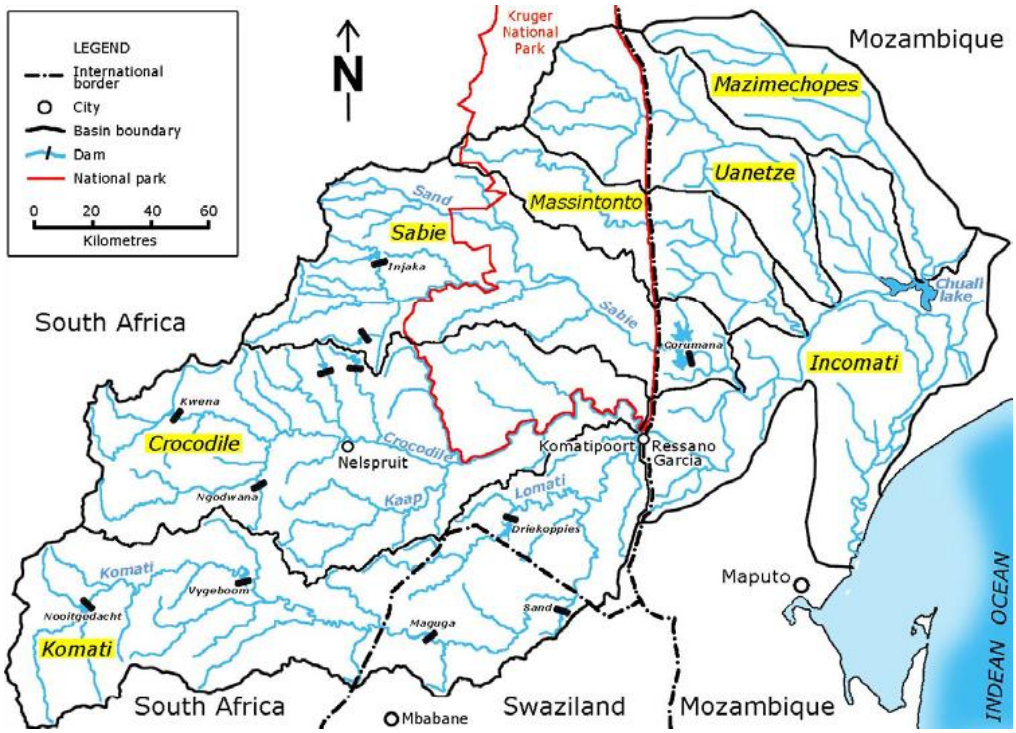
Water analyses carried out in Nuanedzi river presented high levels of iron (13 mg/L), affecting Limpopo river water quality downstream the rivers confluence. However, the concentration of this metal decreases drastically downstream to values 0.75 mg/L, probably due to sedimentation and adsorption onto sediment particles. Metals contamination can possibly result from mining activities in Zimbabwe. Elevated concentration of Sulfates were identified in Olifants river in South Africa and Mozambique (Aurecon, 2013), resulting from mining activities in South Africa.

6.1.6.4 Incomati Basin

Hydrological Framework

The Incomati basin is an international basin shared with South Africa (62%) and Swaziland (6%) (see **Figure 6.30**). The total catchment area is of about 46,400 km^2, of which 32% are located in Mozambique. The Incomati River has its origin in South Africa, at approximately 2,000 meter high (above sea level). Then it flows from the eastern part of South Africa, through the north of Swaziland and drops to the coastal plain to the east of the Lebombo Mountains at elevations below 150 m. In Mozambique, the river enters a rocky and enclosed valley, near Ressano Garcia border, and a few kilometres downstream presents a sandy riverbed with low banks that become floodable from Magude. From this village the river divides into several ramifications that separate and later join the main river, ending in meanders in the mouth. The Incomati River extends trough 714 km.

The Incomati River has 6 main tributaries, namely: Crocodile, Sabie, Massintonto, Uanetze and Mazimechopes (the only tributary rising in Mozambique, near the South Africa border).



Source: Khalili (2007).

Figure 6.30 – International Incomati basin

Water Availability

The Incomati River is marked with seasonal cyclical patterns, with floods in the rainy season and small flows in the dry season. It presents irregular flow, with consecutive dry years and floods with great magnitude. Sabié River is the tributary with less irregular regime.

In the last ten years, the flow of the Incomati River has become more irregular, with reduced flows in the dry season, due to intensive use upstream, including water transfer between basins.

In the wet season, the Incomati is very vulnerable to floods, especially downstream Magude. The Incomati basin is subject to cyclical floods, some of which with catastrophic effects (with cattle and crops losses, infrastructures destruction such as roads, railways, bridges and houses, among others). In Mozambique the major floods occurred in the years: 1937, 1955, 1972, 1975, 1976, 1984, 1985, 1996, 2000, 2012 and 2013 (Consultec, 2014). In general, floods occur between January and March. Moamba, Magude e Manhiça Districts are very vulnerable to floods.

Infra-structure

Incomati Basin has 8 major dams, with a total storage capacity of about 2,000 million m^3, of which only one is located in Mozambique, namely the Corumana Dam, located in Sabie river (storage capacity 879 million m^3), Moamba district. This dam was constructed for irrigation proposes and is predicted to reinforce the water supply to Maputo and Matola municipalities in the near future.

The catchment also contains some smaller farm dams and dikes. In Mozambique the Xinavane and Maragra farm dikes stand out, as well as the railway dike that runs along the river between Marracuene and Magude.

Water Use

The Incomati basin is of strategic importance, as it is located in an area of intense development pressure, which results in a considerably high demand for its water resources. Most of the abstracted water is used for irrigation. The Incomati basin in Mozambique presents large scale agricultural areas, in particular sugarcane. In total, about 25 000 ha of irrigation are accounted in Mozambique (Consultec, 2014).

Water Quality

Water quality in this basin is affected by human activities. The main sources of pollution include:

- Human settlements – Marracuene and Manhiça villages, near the mouth, Magude and Xinavane, and Moamba, Ressano Garcia and Sabié villages near the border. There is no wastewater treatment. Excreta and urine (domestic wastewater) contribute to the contamination of water with oxidizable organic matter, nitrates, phosphates, ammonia and infectious agents (bacteria, viruses and protozoa). Infectious agents are the major concern associated with domestic wastewater pollution;
- Agriculture – intense agricultural activities occur in Magude and Xinavane region, and in Manhiça. Large-scale (intensive) agriculture poses a serious threat to water pollution through the use of fertilizers (enrichment of water with nutrients such as nitrates and phosphates, can bring serious ecological problems to aquatic ecosystems by favoring excessive algae and aquatic plants growth and consequently eutrophication water bodies) and pesticides (toxic substances);
- Seasonal flow changes - natural seasonal changes can significantly affect water quality. The flow rise in the rainy season increase sediment transportation and affect the turbidity and promote the dispersion of pollutants;
- Salt intrusion, near the river mouth – felt up to about 50 km from the mouth.

6.1.6.5 Matola Basin

Hydrological Framework

The Matola River has its source in a swampy area in northeast Moamba District and develops in a North-South direction. The river has a total length of 58 km and its drainage basin has a total area of 2,362 km^2. The Matola River discharges into the Maputo Bay via the Espírito Santo Estuary, which also receives the discharges of three other rivers, namely the Umbeluzi, Infulene and Tembe rivers. The hydrographic basin, especially in the lower sector, mainly comprises urbanized areas.

Water Availability

Matola River has a relatively small annual flow (estimated at about 150 million m^3 per year), and is a seasonal river, with high flows during the wet season and very small, or even no flows, during the dry season. In the dry season the salinity of the river is solely determined by the waters of the Espírito Santo Estuary because of the absence of river flow at this time. Consequently, hydrological conditions in the Matola River are such that flushing of the river is determined primarily by river runoff during the rainy season, while during the dry season tidally-induced dispersion is the overwhelmingly dominant, if not the only, flushing mechanism.

In urbanized areas the river canal presents restrictions to flow, due to constructions in the banks.

Water Use

Water is used for small-scale agriculture. Water supply to Matola Municipality is sourced from the Pequenos Libombos Dam, located in the Umbeluzi River (Umbeluzi basin).

Water Quality

Water quality in Matola basin is affected by human activities. The main sources of pollution include:

- Human settlements – the lower sector of the basin mainly comprises Matola city, with high population density (2,000 inhabitants/km^2). In the urbanized and semi-urbanized zone of the city people use septic tanks. There is no wastewater treatment. Domestic wastewaters contribute to the contamination of water with oxidizable organic matter, nitrates, phosphates, ammonia and infectious agents (bacteria, viruses and protozoa). Infectious agents are the major concern associated with domestic wastewater pollution;
- Industry – the municipality of Matola has the largest industrial park in Mozambique that includes agro-industrial, metal-mechanical and construction materials. The municipality has about 50 industries, some located along Matola River including Aluminium Mozal, Textil Moztex and a tannery. The Mavoco industrial landfill is also located near the river;
- Agriculture – small scale agriculture occurs along the river. Environmental concerns on small-scale farming are manly associated with deforestation and degradation of the riparian vegetation, exposing the river banks to erosion and promoting the increase of sedimentation and water turbidity;
- Salt intrusion, near the river mouth – in the lower stretches of the river, the water is brackish, due to the marine influence, presenting high values of Electrical conductivity, Sodium and Chloride (Consultec & SRK, 2012).

6.1.7 Landscape

6.1.7.1 Approach and Methodology

Power transmission projects have the potential for landscape and visual impacts. Landscape can be defined as "*a part of the territory, as it is perceived by people, whose character results from the action and interaction of natural and human factors*" (EC, 2000). A landscape unit is understood to mean not only "*an area limited by relief or other elements, within which all points are seen mutually*" (Neuray, 1982), but also one in which the landscape presents a certain homogeneity in relation to the relief, geology, vegetation and humanization. The evaluation of the quality of the landscape stems from the scenic value attributed to it and from the landscape sensibility.

The landscape baseline was compiled from both secondary data and outputs of site visits. A desktop study has been carried out to gather all relevant data to inform the assessment. The desktop study information sources included the following documents:

- Mozambique Regional Transmission Backbone Project Environmental and Social Impact Assessment (2011);
- EPDA report, 2016;
- Findings from the specialists site visits (2017); and
- Google Earth aerial photography.

Site visits were made to key locations by ESIA team members. Site visit photos along the entire routing have been used to assist in the assessment of visual impact and landscape character. The parameters used to characterize landscape were based on the existing land uses, presence of natural and artificial vegetation, presence of elements of visual intrusion and scenic quality of the landscape. The classification of the value of the landscape is based on its quality, a subjective concept that stems from the scenic value, attributed by potential observers. Biophysical landscape components, such as relief, the presence of water lines, the diversity and landscape value of the vegetation cover, and the aesthetic components such as the singularity (characteristics that distinguish and make a "unique" landscape) determine the visual quality of the landscape.

6.1.7.2 Landscape Description

Landscape in the Project area presents mixed characteristics, with areas of natural landscape with some scenic value interspersed with areas of a more urban and industrial character. The major land use along the northern half of the proposed route corridor (**Figure 6.31**) is woodland/bush with some small clearings and cleared corridors, e.g. along main roads and the Limpopo railway line. Only south of Chokwe, in the southern half of the route, is the land systematically cleared, although some relatively large blocks of woodland still persist between the Incomati and Limpopo rivers.

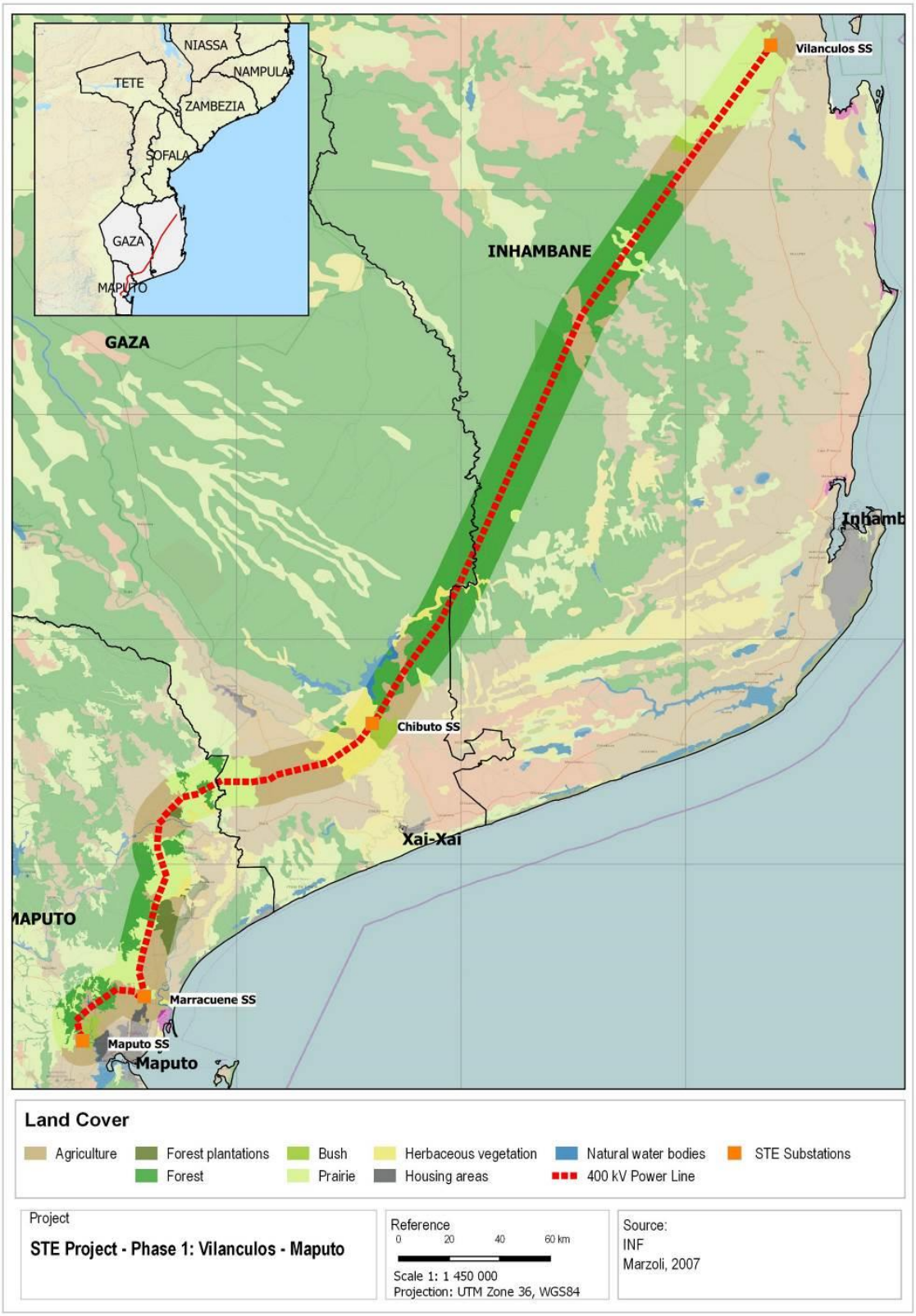


Figure 6.31 – Land cover along the power line alignment

The nature of the wooded vegetation which comprises the greater part of the study area is homogenous for large areas but overall is divided into three main vegetation types: miombo, mixed

riverine/coastal woodland and undifferentiated woodland. The large rivers that cross the corridor include the Limpopo and the Incomati, which are associated with distinct habitats. In addition there are many lakes formed by clay pans in the sandy terrain, especially in the lower Limpopo valley.

Along the Project area there are natural low disturbed areas, but near populated areas the dominant vegetation types include the degraded forms of native vegetation. In general, the degrees of human disturbance on vegetation range from moderately to largely anthropized. The main antropization factors include fragmentation of vegetation formations due to roads, collection of wood and timber, agriculture and housing.

As discussed in the biodiversity section, the Project alignment does not cross or approach any conservation or protected area. The 400 kV power line is subdivided in three sectors: Vilanculos SS to Chibuto SS, Chibuto SS to Matalane SS and Matalane SS to Maputo SS. The following sections describe the landscape's nature and character in these three sectors.

Vilanculos substation to Chibuto substation

In the surroundings of Vilanculos substation the land cover is predominantly good quality woodland with about 50 % woody cover, including patches of trees taller than 10 m and areas of open savannah. In this area landscape is considered to be of 'medium' sensitivity due to the undesignated but good quality landscape with relatively dense vegetation cover (**Photograph 6.1**).

Photograph 6.1 – Land cover in the surroundings of Vilanculos substation

From Vilanculos substation the line route runs southwest, crossing roads R481 and R484 west of Funhalouro, bends slightly to east passing east of Changanine Village before continuing almost straight to Chibuto substation. Total distance from Vilanculos to Chibuto is about 340km.

The line route is flat, forested and with few roads. The altitude varies from 38 m at Vilanculos substation to 76 m at Chibuto substation (**Figure 6.32**).

Figure 6.32 – Elevation profile between Vilanculos SS and Chibuto SS

In terms of the vegetation's character along the line route, in the northern part of this sector, in the Vilanculos, Massinga and Funhalouro districts, the woodland is still pretty intact. To the south, vegetation gradually changes to savannah or more mixed vegetation, as the human pressure intensifies. Close to larger settlements, such as Funhalouro and Chibuto, the human presence becomes more intense and persistent. In this sector, the route also crosses three rivers, the Changane, the Chigombe and the Sangutane before reaching the Limpopo valley. This landscape is considered to be of 'low' sensitivity due to the undesignated but medium quality landscape, sparse population and vegetation and some main roads.

Chibuto substation to Matalane substation

In the Chibuto substation area the land cover includes miombo woodland, which accounts for roughly 40 % of the substation area, with the remaining 60 % being made up by grassland and bare soil (**Photograph 6.2**). The area identified is surrounded by wetlands and a floodplain used for cultivation, cattle grazing and residential properties. The Chibuto SS is located on an elevation at the east side of the valley.

Photograph 6.2 – Land cover in the surroundings of Chibuto substation

This landscape is considered to be of 'medium' sensitivity due to the undesignated but good quality landscape with miombo cover. The altitude varies from 76 m at Chibuto substation to 46 m at Matalane substation (**Figure 6.33**).

The proposed line route passes through floodplain over the first 24 km from Chibuto substation, crossing road N221, passing Mazivila Village, Xinavane, Magude and Chinhanguanine Village, on its way to Matalane substation. The total distance from Chibuto to Matalane is about 180km.

The line route crosses an intensively cultivated landscape of the outskirts of the Limpopo River valley and entering into the Incomati River basin. The plains of the river basin is characterised with reeds and sand banks interrupted by areas of high land that are inhabited and have dry land cultivation. The road network follows these higher areas due to risk of flooding in the lower zones. The vegetation covering is low-lying and interrupted by human activities.

South of the Limpopo, the line crosses the lower Limpopo valley where land use and habitats are a mixture of machambas, rice growing and floodplains. The proposed route crosses the Incomati River Basin, which is substantial with reed beds and sandy cliffs. The Incomati River is part of a major river basin system linking to the Limpopo River Basin, although the major floodplain areas lie largely to the west of the proposed line.

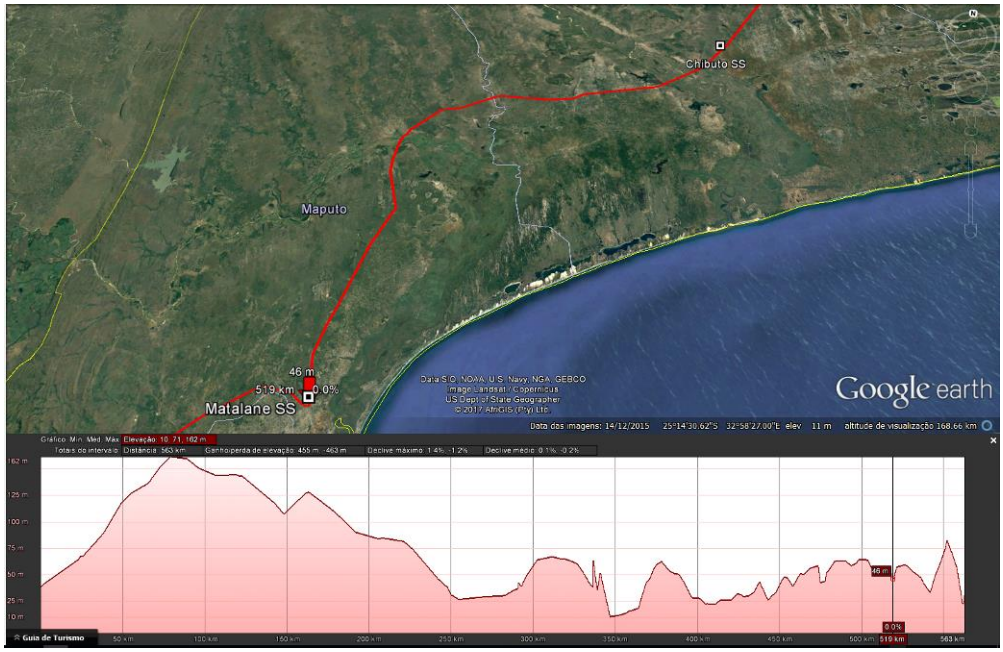


Figure 6.33 – Elevation profile between Chibuto SS and Matalane SS

This landscape is considered to have pockets of 'medium' sensitivity landscape with the majority classed as 'low' sensitivity. This is due to the coherent river landscape in the northern part changing to more developed and dominated by existing roads and relatively well developed areas located close to Matalane.

Matalane substation to Maputo (Boane) substation

From Matalane (**Photograph 6.3**) the line route turns eastwards and continues straight in the direction of Maputo substation. The line ends on the North-Western side of Maputo substation.

Photograph 6.3 – Land cover in the surroundings of Matalane substation

At the start of this sector, some woodland areas still exists. However, the level of development increases, as the route approaches Maputo, and the land becomes mostly occupied by farming and settlements. The total distance from Matalane to Maputo is about 40km. The altitude varies from 46 m to 27m (**Figure 6.34**).

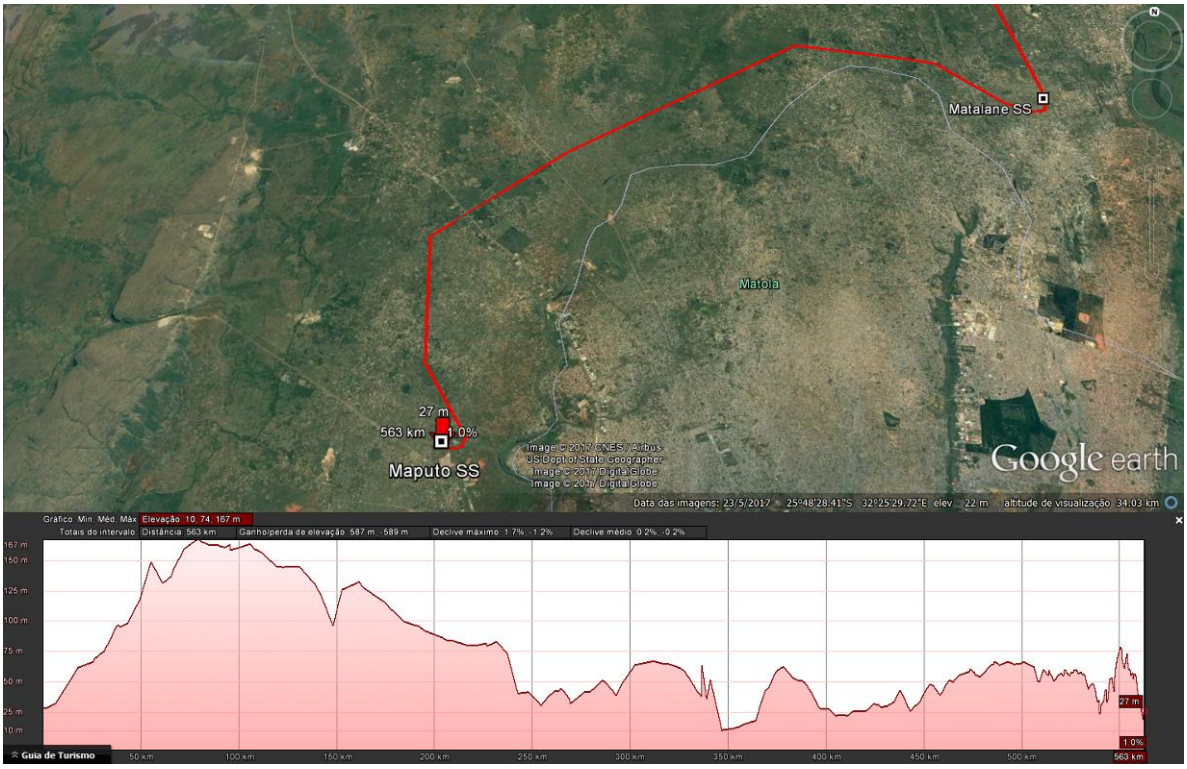


Figure 6.34 – Elevation profile between Matalane SS and Maputo SS

The route will end at Maputo substation, located near the Beluluane Industrial Park (BIP) (**Photograph 6.4**), close to the Mozal Aluminium Plant - a dominant feature on the landscape. In this area, the landscape presents mixed characteristics, with mostly an urban and industrial character, but punctuated with areas of natural character and high scenic value, namely the Espírito Santo Estuary and the Matola River. The MOZAL industrial complex is characterized by the volumetry of the building, the extension of the occupied area and the industrial characteristics of the infrastructure.

The area presents a mosaic of industrial, urban, residential occupation with a dense network of communication routes and dispersed buildings that give the surrounding landscape reduced scenic quality and visual confusion. Natural areas of higher visual quality are formed by patches of forest vegetation, shrubs, herbaceous vegetation, the Espírito Santo Estuary and the Matola River.

Overall, the landscape along the alignment from Matalane to Maputo substations is considered to be of 'medium' sensitivity due to the flat coherent landscape and flatness of the area resulting in a large zone of visual influence. Furthermore, to the south, near Maputo, the industrial development and increased development contributes to the categorisation.

Photograph 6.4 – Various industrial, urban and residential aspects near Maputo substation

Near Maputo (Boane) substation (**Photograph 6.5**) there are some residental areas nearby but generally the area appears to be dominated by scrub and small areas of cultivation. Here the landscape is considered to be of 'low' sensitivity due to the relatively well developed landscape with the Mozal Aluminium factory close by.

Photograph 6.5 – Aspects of the landscaping in the Maputo (Boane) substation

6.2 Biotic Environment

6.2.1 Methodology

The biodiversity baseline was based on secondary data collection and field work. A field survey was conducted between 13 and 22 June 2017 to allow primary data collection on flora, vegetation and terrestrial vertebrates. The specific methodological approach for each biodiversity group is provided in the following sections.

Flora and vegetation

For flora, sampling sites with 30 minutes duration were defined to sample all the full vegetation strata. A total of 35 sampling sites were sampled mainly along the most natural areas (see **Figure 6.35**). Areas more disturbed were visited and species presence registered as *ah-doc* observations. When there was uncertainty regarding species identification during the fieldwork, specimens were collected, labelled, and taken to the Eduardo Mondlane University botanical laboratory in Maputo for identification using herbarium samples and the Flora Zambesiaca (Kew, 2014) as references.

All primary data on vegetation units and habitats were processed through GIS to help refine the mapping of vegetation units and habitats within the study area. A vegetation units map was generated for a 200 m buffer around the transmission line and a 50 m buffer around the substations, which is where potential impacts on habitats can be expected. This map was first drafted during secondary data analysis, through photo-interpretation of aerial photographs, and then refined with the primary data collected in the field.

Mammals

The sampling methodology for large mammals was based on direct and indirect observations (e.g., footprints, tracks, droppings, carcasses) during diurnal transects. Transects had a duration of 30 minutes and variable length. A total of 35 sampling sites were sampled mainly along the most natural areas (**Figure 6.35**).

Bats were sampled through two different methodologies: acoustic nocturnal surveys and roost inspections. Acoustic surveys were conducted using an ultrasound detector (EM3+ Wildlife Acoustics) with a frequency range between 8 and 192 kHz. At each of the 8 sampling locations (**Figure 6.35**), bat calls were recorded for 10 minutes at dusk. The calls recorded in the field were analysed using audio software. Bat species identification was done by comparison with the reference call values used in Monadjem *et al*. (2010), Hauge (2010), and Kopsinis *et al*. (2009). Whenever possible, the calls were identified to the species level, or alternatively, to a phonic group of species that have similar calls.

Roost inspections involved active daytime search of potential structures for bats to roost, such as abandoned buildings, bridges, tunnels, caves, mines, gaps in the rock, and mature trees. Whenever possible, the interior of the structure was visited to verify the presence or traces of bats.

Herpetofauna

Amphibians were sampled at selected water bodies or wetlands and by dusk active searches in trees and wetlands. Sampling in water bodies was done by dip-netting, mainly on the banks. Active searches were done by lifting tree barks. Dip-netting allowed the sampling of larvae and adult stages, while active visual searches allowed the identification of some frog species that can be found on the banks. A total of 8 sampling sites were sampled through active search and 3 points were sampled specifically with dip-netting (**Figure 6.35**).

Sampling of reptiles was based on visual encounter surveys, through walking transects, with 30 minutes duration. During transect sampling, cover objects (e.g., rock and logs) were turned. Cover objects were carefully turned towards the field technician and with work gloves. A small hand-torch was used to look into cracks and holes in search of reptiles. The individuals encountered were captured by hand or using appropriate devices (dip-nets, a noose with a sliding knot for lizards, and a snake-catcher stick for venomous snakes) to allow an accurate identification of species. After data collection, specimens were released onsite. A total of 35 sampling sites were sampled mainly along the most natural areas (**Figure 6.35**).

Birds

Bird sampling targeted raptors, passerines, nocturnal birds and water birds. Raptors and passerines sampling was undertaken through walking transects, with 30 minutes duration. A total of 35 sampling sites were sampled mainly along the most natural areas (**Figure 6.35**).

Point counts targeting water birds were undertaken at water bodies and rivers for a variable amount of time, according to the water body size. The water bodies sampled were both inside the study area and in its surrounding, because of possible waterbirds movements crossing the study area. All birds seen or heard were identified and counted. The observations were undertaken using binoculars. A total of 15 water bodies and/or rivers were sampled (**Figure 6.35**).

Nocturnal birds were sampled by playback counts at dusk, using vocalization of the species potentially occurring in the study area. The playback conditions were standard at all locations, and 30 seconds of playback (repeated for a maximum of 6 times) followed by 15 seconds of waiting time was applied for each species, with the maximum time of playback for each species being 3 minutes. A silent period of 2 minutes was established between species playbacks. If a species answered before 3 minutes of emission, then the next species was played. A total of 8 nocturnal birds sampling sites were performed (**Figure 6.35**).

For all fauna groups *ad-hoc* observations within the study area or its surroundings were registered, and interviews with local people were undertaken to collect data on emblematic species and humans-fauna conflicts.

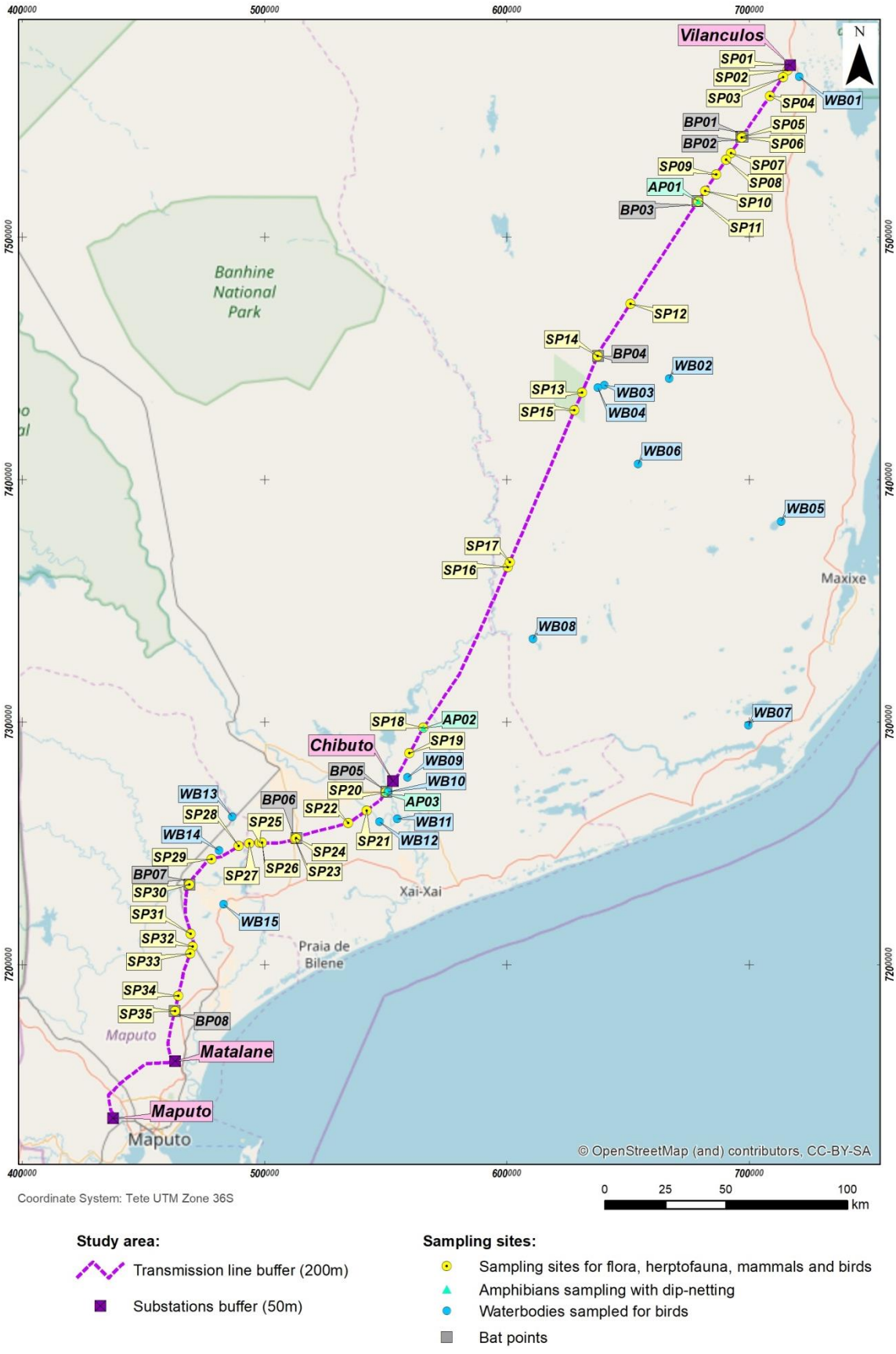


Figure 6.35 – Sampling sites for flora and fauna

6.2.2 Flora and Vegetation

6.2.2.1 Regional Context

Vegetation types with similar characteristics are grouped as habitats, and the broadest global habitat category is biomes. WWF developed a system that identified 14 global biomes, nine of which occur in Africa. The study area encompasses three biomes: the Tropical and Subtropical Moist Broadleaf Forests biome, the Tropical and Subtropical Grasslands, Savannas, Shrublands and Woodlands biome and the Flooded Grasslands and Savannas biome (**Figure 6.36**).

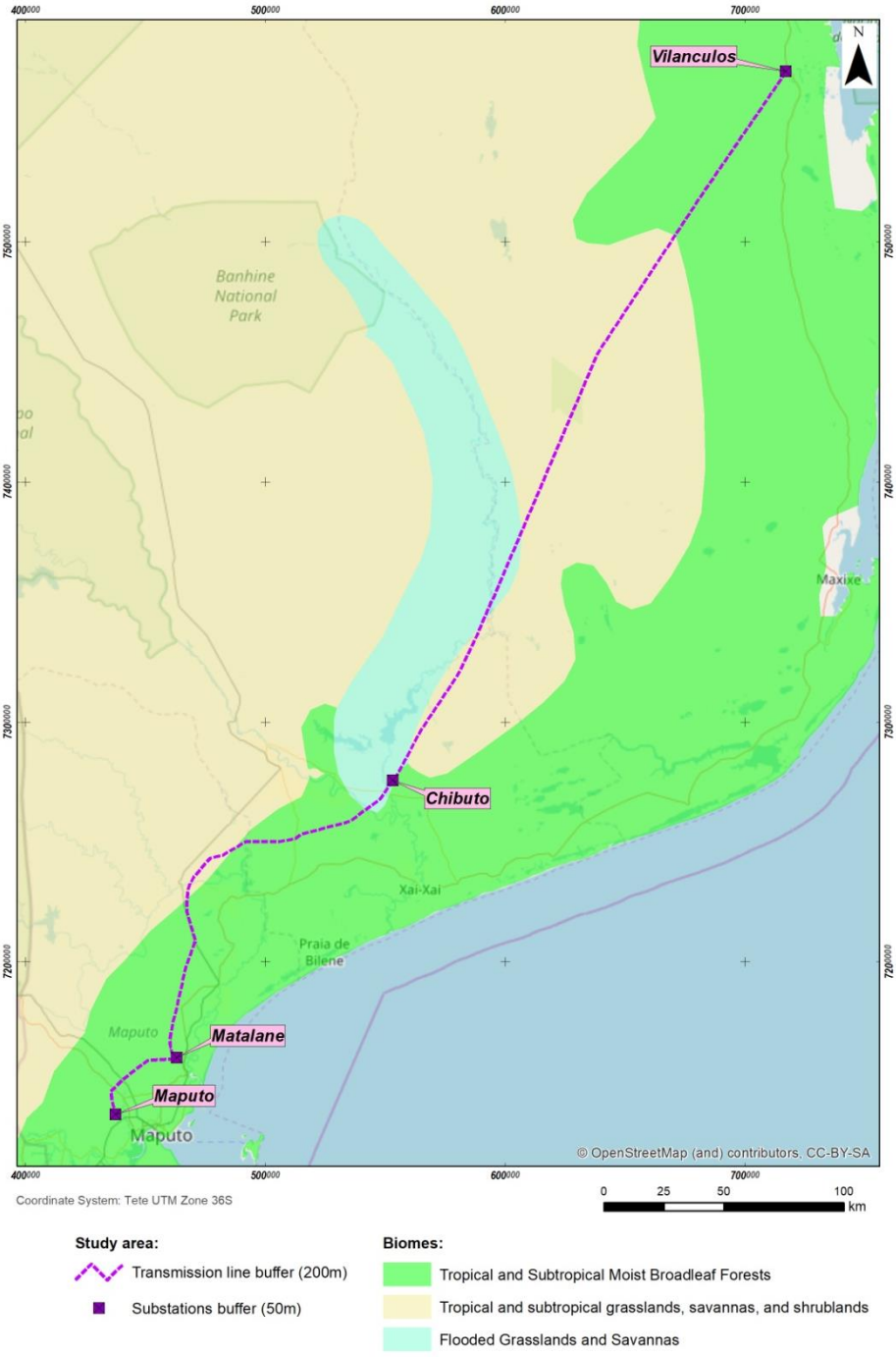


Figure 6.36 – Biomes in the study area

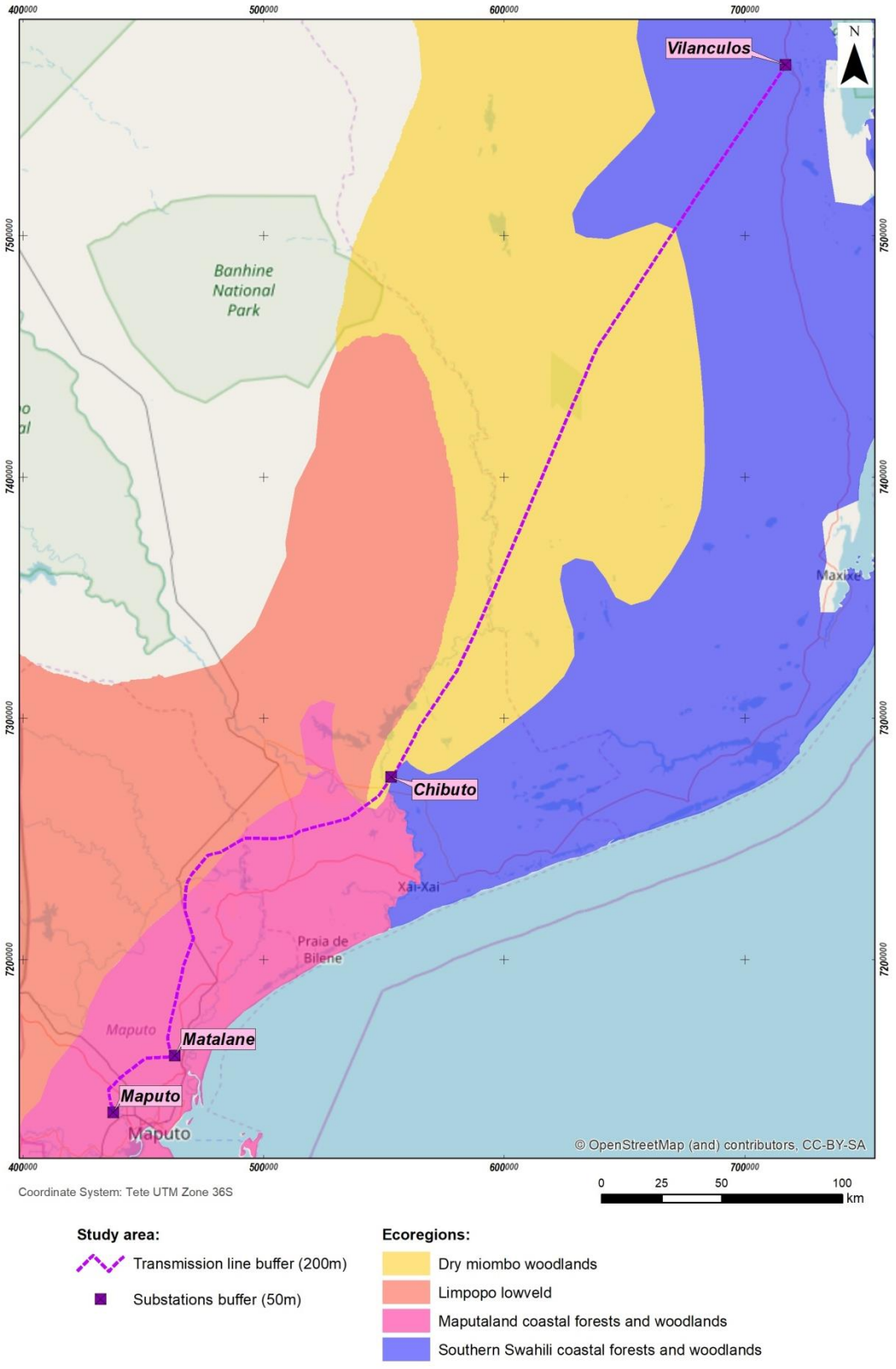
The Tropical and Subtropical Moist Broadleaf Forests biome encompasses rainforests or rainforest mosaics, forests that are mostly evergreen or semi-evergreen, and are located in areas where rain is more seasonal. The Tropical and Subtropical Moist Broadleaf Forests biome is mostly found in the tropical belt of Africa and a smaller area extends to southern Africa (Burgess *et al*., 2004). The Tropical and Subtropical Grasslands, Savannas, Shrublands and Woodlands is the largest biome in Africa, it supports grasslands, savanna-woodlands, forest, wet savanna mosaics and thickets (Burgess *et al*., 2004). Flooded Grasslands and Savannas biomes encompasses flooded grasslands, swamps and shallow lakes; and is divided in 2 subdivisions: freshwater swamp systems and slightly brackish to hypersaline swamp systems (Burgess *et al*., 2004).

The study area encompasses a total of four ecoregions: Southern Swahili Coastal Forests and Woodlands, Dry Miombo Woodlands, Maputaland Coastal Forests and Woodlands and a small part of Limpopo Lowveld (RESOLVE, 2017) (**Figure 6.37**).

The Southern Swahili Coastal Forests and Woodlands ecoregion is characterized by low variability in annual temperature and high levels of rainfall and forests are dominated by semi-evergreen and evergreen tree species. The Dry Miombo Woodlands have seasonal tropical climate with little rain fall in the dry season and nutrient-poor soil. *Brachystegia* and *Julbernardia* are the characteristic dominant species, specially adapted with ectomycorrhizal that help obtaining essential nutrients in a low nutrient soil. Maputaland Coastal Forests and Woodlands contains extensive areas of wetland and vegetation is complex and very diverse with more than 15 vegetation types described for the ecoregion. Coastal dunes support dense forests, including short forests and thickets specially adapted for salt and wind. In this forest the most common species are *Strychnos* sp., *Celtis africana* and *Ziziphus mucronata*. The Limpopo Lowveld ecoregion is seasonally flooded and vegetation encompasses lightly wooded savanna, dominated by *Hyphaene coriacea* and *Acacia* sp. Secondary grasslands may occur in more disturbed areas, as well as small patches of swamp forests (Burgess *et al*., 2004).

In ecological terms and according to White (1983), the nature of the wooded vegetation which comprises the greater part of the study area is homogenous for many large areas and can be classified into four main vegetation types: Coastal forest mosaic (encompasses savanna and thicket areas), Miombo woodland, Halophytic vegetation and Undifferentiated woodland. During field work three of the four vegetation types were confirmed as present in the study area (Coastal forest mosaic, Miombo woodland, and Undifferentiated woodland), being the Undifferentiated woodland the most common and frequently associated with more disturbed areas.

Halophytic vegetation has not been found in the study area, only the lower part of the Changane River encompasses the study area so conditions for the occurrence of this type of vegetation are not the best, since it is known that halophytic vegetation is typically present in upper parts of the Changane River.



Source: Adapted from RESOLVE (2017).

Figure 6.37 – Ecoregions in the study area

6.2.2.2 Flora Species

A total of 370 species are referenced as of potential occurence in the study area (IUCN, 2017). During field work, 233 flora species were confirmed to be present. The full list of potential and confirmed flora species is provided in **Annex II** (**Volume IV**).

The most representative family in the study area is Fabaceae with 50 species followed by Poaceae with 21 species and Asteraceae with 18 species (**Figure 6.38**).

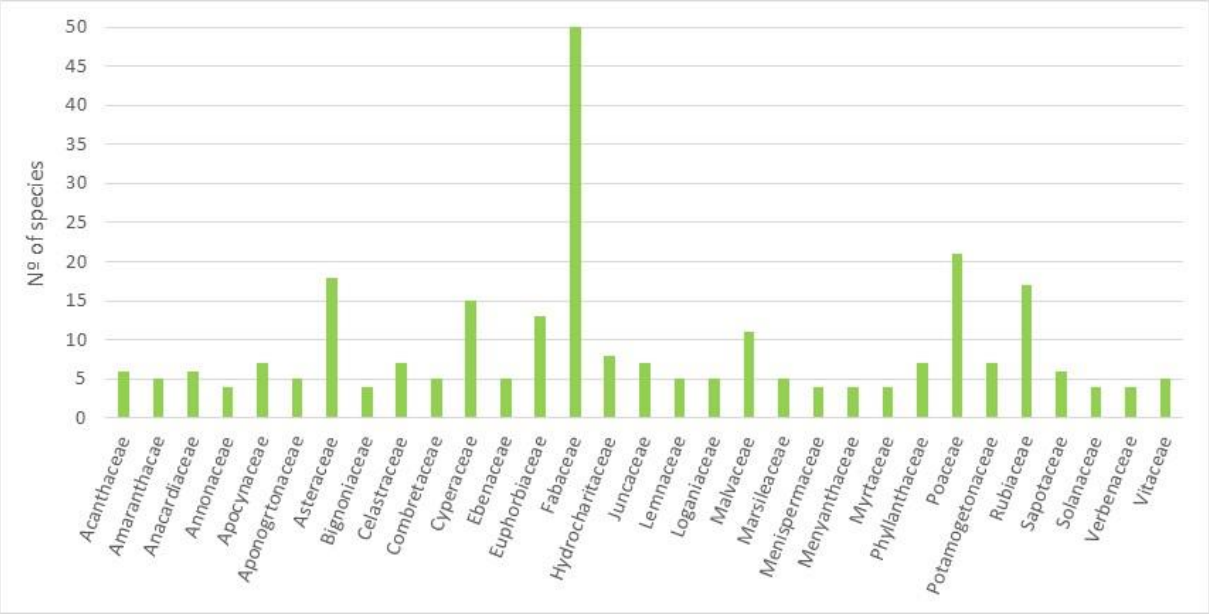


Figure 6.38 – Most representative families of flora potentially present in the study area

From the species potentially present in the study area 3 species (*Spirostachys africana, Guibourtia conjugata* and *Berchemia zeyheri*) are classified as precious wood by the Forestry and Wildlife Regulation (Decree 12/2002, from 6 June), meaning that those species cannot be explored for other purposes rather than legal wood exploration. According to the same regulation, 11 of the potential species in the study area are classified as first class wood; 5 species are classified as second class wood; 12 species are classified as third class wood; and 14 species are classified as fourth class wood (see **Table AII.1**; **Annex II**; **Volume IV**).

None of the species potential or confirmed in the study area are classified as threatened[2] by IUCN Red List (IUCN, 2017). Only three of the species confirmed in the study area are classified as Near Threatened: *Dalbergia melanoxylon, Pterocarpus angolensis* and *Encephalartos ferox* (IUCN, 2017). Four of the species confirmed in the field are endemic, namely: *Carissa praetermissa* is endemic of central Mozambique (Zambezia, Manica, Sofala, Gaza and Inhambane); *Dolichandrone alba* is endemic of southern Mozambique (Gaza, Inhambane and Maputo); *Bauhinia burrowsii* is endemic of southern Mozambique (Gaza and Inhambane); and *Croton inhambanensis* is endemic to the province of Inhambane (Hyde *et al*., 2017).

[2] Threatened species include those classified by IUCN as Vulnerable, Endangered or Critically Endangered.

It's also relevant to refer the presence of baobab trees (*Adansonia digitata*) in the study area as an important species from a symbolic and cultural point of view for local communities.

A total of 26 non-native species are potential in the study area and 22 of those species were confirmed during field work (**Table 6.14**).

Table 6.14 – Non-native flora species potential and confirmed in the study area

Family	Species	Habitat	Confirmed in the study area
Agavaceae	*Agave sisalana*	Agriculture areas	Yes
Aloaceae	*Aloe marlothii marlothii*	Agriculture areas	Yes
Amaranthacae	*Achyranthes aspera*	Urban areas	No
	Amaranthus curentus	Agriculture areas	No
Anacardiaceae	*Anacardium occidentale*	Agriculture areas	Yes
	Mangifera indica	Agriculture areas	Yes
Apocynaceae	*Catharanthus roseus*	Gardens	Yes
Asteraceae	*Sonchus oleraceus*	Urban areas	No
	Xanthium strumarium	Urban areas	Yes
Cactaceae	*Opuntia ficus-indica*	Urban areas	Yes
Caricaceae	*Carica papaya*	Agriculture areas	Yes
Convolvulaceae	*Ipomoea batatas*	Agriculture areas	Yes
Euphorbiaceae	*Manihot esculenta*	Agriculture areas	Yes
	Ricinus communis	Urban areas	Yes
Fabaceae	*Arachis hypogaea*	Agriculture areas	Yes
	Senna occidentalis	Urban areas	No
	Tamarindus indica	Agriculture areas	Yes
	Vignia unguiculata	Agriculture areas	Yes
Myrtaceae	*Psidium guajava*	Agriculture areas	Yes
Musaceae	*Musa sp.*	Agriculture areas	Yes
Poaceae	*Bambusa vulgaris*	Forest	Yes
	Oryza sp.	Agriculture areas	Yes
	Saccharum officinarum	Agriculture areas	Yes
	Zea mays	Agriculture areas	Yes
Solanaceae	*Capsicum sp.*	Agriculture areas	Yes
Verbenaceae	*Lantana camara*	Urban areas	Yes

Most of the non-native species (20 species) were introduced for food, wood or other type of use. 16 of the non-native species are used as a food source and some of them are of great importance, such as cassava (*Manihot esculenta*), mango (*Mangifera indica*), cashew (*Anacardium occidentale*), maize (*Zea mays*), peanuts (*Arachis hypogaea*) or "nhemba" beans (*Vignia unguiculata*). Besides the use of the fruit as food, tamarind trees (*Tamarindus indica*) are also used as wood (fourth class wood). Non-native species are also used for medicinal uses, such as *Catharanthus roseus* and *Aloe*

marlothii marlothii; for construction and crafts, such as the bamboo (*Bambusa vulgaris*); and for rope production like the sisal (*Agave sisalana*) (**Photograph 6.6**).

Photograph 6.6 – Non-native species of interest as food (cassava and maize) and medicine (*Aloe marlothii marlothii*)

From the non-native species, 4 species are considered invasive or potentially invasive: *Achyranthes aspera, Ricinus communis, Lantana camara* and *Xanthium strumarium*. The presence of 3 of these species was confirmed, but this distribution is restricted to areas where vegetation is disturbed and human presence is more pronounced. *Xanthium strumarium* was detected in two places: close to Chibuto and to Magude; *Lantana camara* was observed in only one location west of Xai-Xai; and *Ricinus communis* was observed close and south of Mapelane (**Photograph 6.7**). North of Xai-Xai, where the vegetation is less disturbed, no invasive species was observed.

Photograph 6.7 – *Ricinus communis* in the study area

The main threats for flora in the study area are related with the conversion of natural vegetation areas into agriculture, through vegetation clearing, tree ringing (**Photograph 6.8**) and fires, all local common practices for the creation of subsistence agriculture areas. In some areas, especially in the south of the study area, vegetation is also cleared for the expansion of residential areas, in a non-managed way. These actions lead to degradation of vegetation with a high risk of non-native and ruderal species spread and degradation of soil quality.

Photograph 6.8 – Cut and ringed trees

6.2.2.3 Vegetation Units and Habitats

As noted in the methodology section, the study area for vegetation units and habitats was a 200 m buffer around the transmission line and a 50 m buffer around the substations. Overall, 10 vegetation units were identified in this study area. The vegetation units map is provided in **Annex III** (see **Volume IV**).

The most representative vegetation unit in the study area and line corridor is undifferentiated woodland, which corresponds to 62% of the study area, followed by subsistence agriculture, which occupies almost 16% of the study area (**Figure 6.39**). The less representative vegetation units in the study area and line corridor are miombo forest and waterbodies, occupying only 0.2% of the area each; followed by thicket, which corresponds only to 0.4% of the area. Of the 4 substations, Maputo is the largest, affecting disturbed areas and subsistence agriculture. Vilanculos substation's area is half subsistence agriculture and half undifferentiated woodland. Matalene substation affects slightly more subsistence agriculture than undifferentiated woodland, and a few dispersed houses. Chibuto substation is the smallest and will only affect undifferentiated woodland (**Table 6.15**).

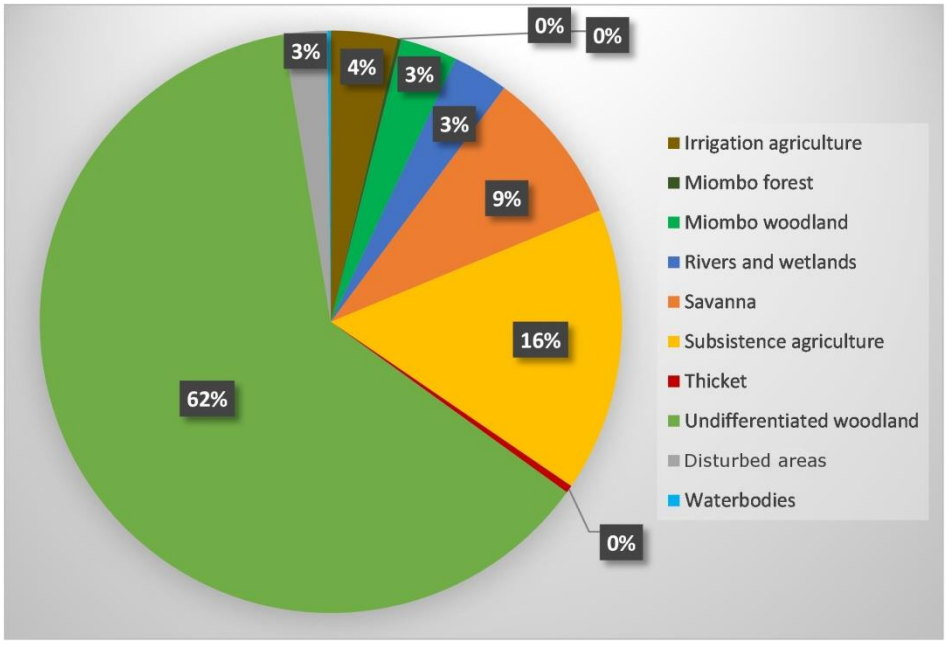


Figure 6.39 – Percentage of the study area occupied by each vegetation unit

Table 6.15 – Area occupied by each vegetation unit in the study area, in the transmission line corridor and in each substation (hectares)

Vegetation units	Study area		Line corridor		Substations				
	Area	%	Area	%	Chibuto	Maputo	Matalane	Vilankulos	Total
Irrigation agriculture	840.4	3.7	836.6	3.8	0	0	0	0	0
Miombo forest	50.8	0.2	50.5	0.2	0	0	0	0	0
Miombo woodland	721.5	3.1	718.3	3.2	0	0	0	0	0
Rivers and wetlands	706.4	3.1	703.2	3.2	0	0	0	0	0
Savanna	1962.5	8.5	1953.7	8.8	0	0	0	0	0
Subsistence agriculture	3711.2	16.1	3407.6	15.3	0	133.8	107.2	47.3	181.1
Thicket	94.9	0.4	94.5	0.4	0	0	0	0	0
Undifferentiated woodland	14313.5	62.2	14107.2	63.4	34.4	0	61.2	47.3	81.7
Disturbed areas	560.8	2.4	331.8	1.5	0	223	4.5	0	223
Waterbodies	43.6	0.2	43.4	0.2	0	0	0	0	0
Total	**22832**	**100**	**22246.7**	**100**	**34.4**	**356.8**	**173.0**	**94.5**	**485.7**

Miombo Forest

Miombo forest is mostly deciduous, although some are almost evergreen. The percentage of coverage of these forests varies from medium to high. In the study area only small patches of miombo forest were observed, close to Vilanculos (**Photograph 6.9**). This habitat is characterized by *Brachystegia torrei* and *Brachystegia spiciformis*. Miombo forest occupies only 50.8 ha in the study area (0.2% of the study area), and occurs only in the north of the study area (**Table 6.15**).

Photograph 6.9 – Miombo forest in the study area

Miombo Woodland

Most miombo woodlands are semi-deciduous (Kindt *et al*., 2011). A large spectrum of woodland structure was observed, from open to very dense woodland (**Photograph 6.10**). The species composition of these woodlands is similar to the miombo forest, although *Julbernardia globiflora* and *Afzelia quanzensis* also occurs as dominant or co-dominant; the tree coverage is the main difference between miombo woodlands and forests. Miombo woodland occupies 721.5 ha of the study area (3.2% of the study area), located mostly in the north of the study area (**Table 6.15**).


Photograph 6.10 – Miombo woodland in the study area

Undifferentiated woodland

This type of woodland, sometimes dense, is characterized by a mix of vegetation, without a clear dominant species. The species composition varies along the study area; some of the co-dominant species are *Terminalia sericea*, *Acacia nigrescens*, *Dichrostachys cinerea* and *Sclerocarya birrea* (**Photograph 6.11**). This undifferentiated vegetation occurs along all the study area and closer to urban areas it is clear that vegetation is disturbed and less conserved. It includes open to close woodland cover and also very dense secondary vegetation. Undifferentiated woodland is the most abundant vegetation unit in the study area, being present from north to south and also in Chibuto and Vilankulos substations, and occupying 14 313.5 ha (62.2% of the area) (**Table 6.15**).


Photograph 6.11 – Undifferentiated woodland in the study area

Savannah

In the study area two types of savanna were observed: palm savanna and acacia dominated savanna (**Photograph 6.12**). This vegetation type is part of the coastal forest mosaic. Palm savanna occurs mainly in Panda area and is dominated by *Hyphaene coriacea* and *Phoenix reclinata*, in association with *Olax dissitiflora* and *Smilax anceps*. Acacia dominated savanna occurs mainly in Macia area and is dominated by *Acacia* sp., *Sclerocarya birrea* and *Sthrychnos madagascariesis*. Savanna is the third most abundant vegetation unit in the study area and occupies 1 962.6 ha (8.6% of the area) (**Table 6.15**).

Photograph 6.12 – Savanna in the study area

Thicket

Thicket occurs in mosaic with agriculture areas or with open areas (**Photograph 6.13**). This vegetation type is part of the coastal forest mosaic, along with savanna. Only small and much localized patches of ticket vegetation were observed in the study area. The dominant species in thicket vegetation are *Monodora junodii, Sthrychnos madagascariensis* and *Psydrax locupes*. Thicket is one of the less representative vegetation units in the study area, located only in the north of the study area, occupying only 94.9 ha (0.4% of the area) (**Table 6.15**).

Photograph 6.13 – Thicket in the study area

Waterbodies

Most of these are waterholes in the study area that are typically of circular shape and shallow margins (**Photograph 6.14**). The marginal vegetation is dominated by *Cyperus* sp. These water bodies are, generally, isolated from the hydrographic network, not having connection with rivers or streams. These waterbodies are located mostly in the north of the study area. Waterbodies represent only 0.2% of the study area, corresponding to 43.5 ha (**Table 6.15**).

Photograph 6.14 – Waterbodies in the study area

Rivers and wetlands

This habitat includes all the rivers, tributaries and streams found in the study area and associated wetlands (**Photograph 6.15**). The main rivers in the study area are the Limpopo, Changane and Incomati. Limpopo and Changane wetlands are dominated by agriculture activities, with very little natural vegetation left. Incomati river wetlands are also used for agricultural purposes, but areas of natural vegetation dominated by *Phragmites mauritianus, Ficus sycomorus* and *Sesbania sesban* are also still present. Rivers and wetlands represent 706.4 ha of the study area (3.1% of the area) (**Table 6.15**).

Photograph 6.15 – Main rivers in the study area

Subsistence agriculture

Most subsistence agriculture areas use the traditional 'bush fallowing' system of agriculture (**Photograph 6.16**). The first stage is field clearance and involves cutting the bush and then leaving the dead branches and saplings in the ground to dry, sometimes for a year. Larger trees are usually left untouched or ringed, so they will die later.

Generally, plantations are mainly cassava (*Manihot esculenta*), millet (*Pennisetum glaucum*) and maize (*Zea mays*) in small subsistence farms. Other types of plantations are sorghum (*Sorghum bicolor*), sugar cane (*Saccharum officinarum*), sweet potato (*Ipomoea batatas*), coconut (*Cocus nucifera*), mango (*Mangifera indica*), cashew (*Anacardium occidentale*), tangerine (*Citrus tangerina*), guava (*Psidium guajava*), papaya (*Carica papaya*), pineapple (*Ananas comosus*); less commonly are found banana (*Musa* sp.), peanut (*Arachis hypogaea*), lemon (*Citrus limon*), cucumber (*Cucumis sativus*), water melon (*Cucurbita melo*) and more diverse plantations (with eggplants (*Solanum*

melongena), tomatoes (*Solanum lycopersicum*), chillies and peppers (*Capsicum* sp.), cabbages (*Brassica* sp.), lettuce (*Lactuca sativa*), okra (*Abelmoschus esculentus*)) and "nhemba" beans (*Vignia unguiculata*) plantations.

After the plantations the natural vegetation quickly begins to regenerate. The farmed areas ("machambas") are very common indicating that a large part of the study area is under the influence of human action and consequently the natural vegetation is very disturbed. Subsistence agriculture is the second most representative vegetation unit, occupying 3 711.2 ha, and is distributed all over the study area (16.1% of the area) (**Table 6.15**).

Photograph 6.16 – Subsistence agriculture areas in the study area

Irrigation agriculture

This vegetation type encompasses agriculture areas that are irrigated by nearby rivers or wetlands. This vegetation occurs mainly close to Limpopo, Changane and Incomati rivers and is dominated by maize and sugar cane (*Saccharum officinarum*) cultures (**Photograph 6.17**). In small waterbodies, rice (*Oryza* sp.) plantations were also observed. Irrigation agriculture occupies 840.3 ha of the study area (3.7% of the area) (**Table 6.15**).

Photograph 6.17 – Irrigation agriculture areas in the study area

Disturbed areas

This habitat class refers to human settlements or exposed soil. It includes areas with very low to medium density of houses (villages), areas with complete deforestation, roads and all the disturbed areas around (**Photograph 6.18**). In the villages, natural vegetation generally does not exist, but planted species such as mangos, coconuts, guavas and tangerines trees can be found. Disturbed

areas occur in small patches within the Project corridor, are distributed mainly in the south of the study area and occupy a total of 560.8 ha (2.4% of the study area) (**Table 6.15**).

Photograph 6.18 – Disturbed areas in the study area

6.2.3 Fauna

6.2.3.1 Mammals

A total of 112 mammal's species are potential in the study area according to bibliographic sources (IUCN, 2017) (see **Table AII.2**, **Annex II**, **Volume IV**). The most represented families are Bovidae and Muridae both with 15 species, followed by Vespertilionidae with 9 species (**Figure 6.40**).

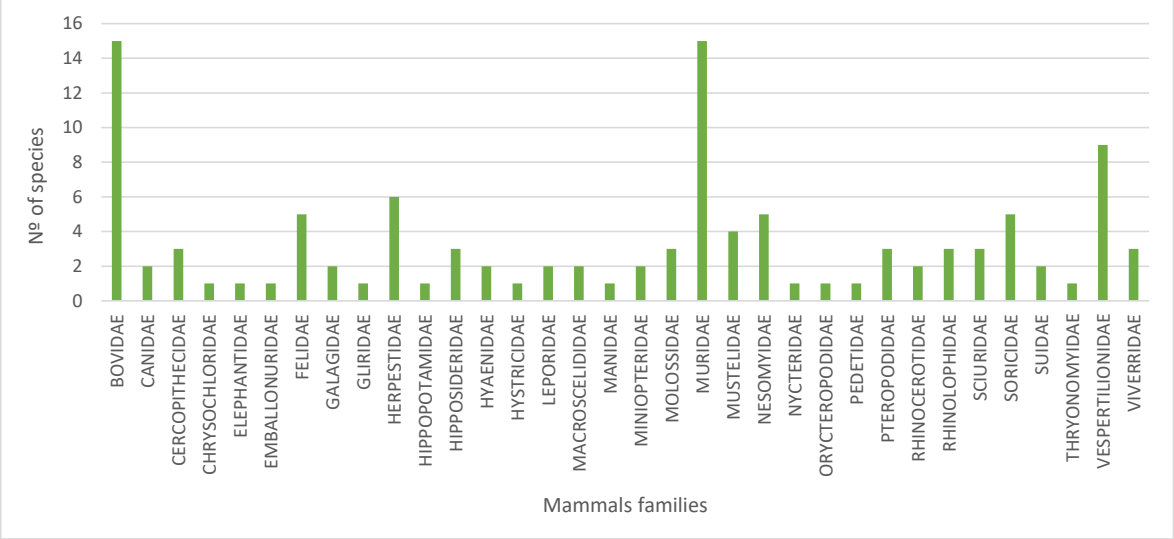


Figure 6.40 – Number of potential mammal's species per family

During field work 18 species were confirmed as present in the study area (see **Table AII.2**, **Annex II**, **Volume IV**); including 3 bat species. Three bat roosts were also identified (**Figure 6.41**):

- Roost01 (**Photograph 6.19**): a tree with one individual (species not possible to confirm);
- Roost02 and Rooost03: a pile of wood and a pile of bricks, both with multiple individuals (some of them identified as Cape bat (*Neoromicia capensis*) through recorded calls).

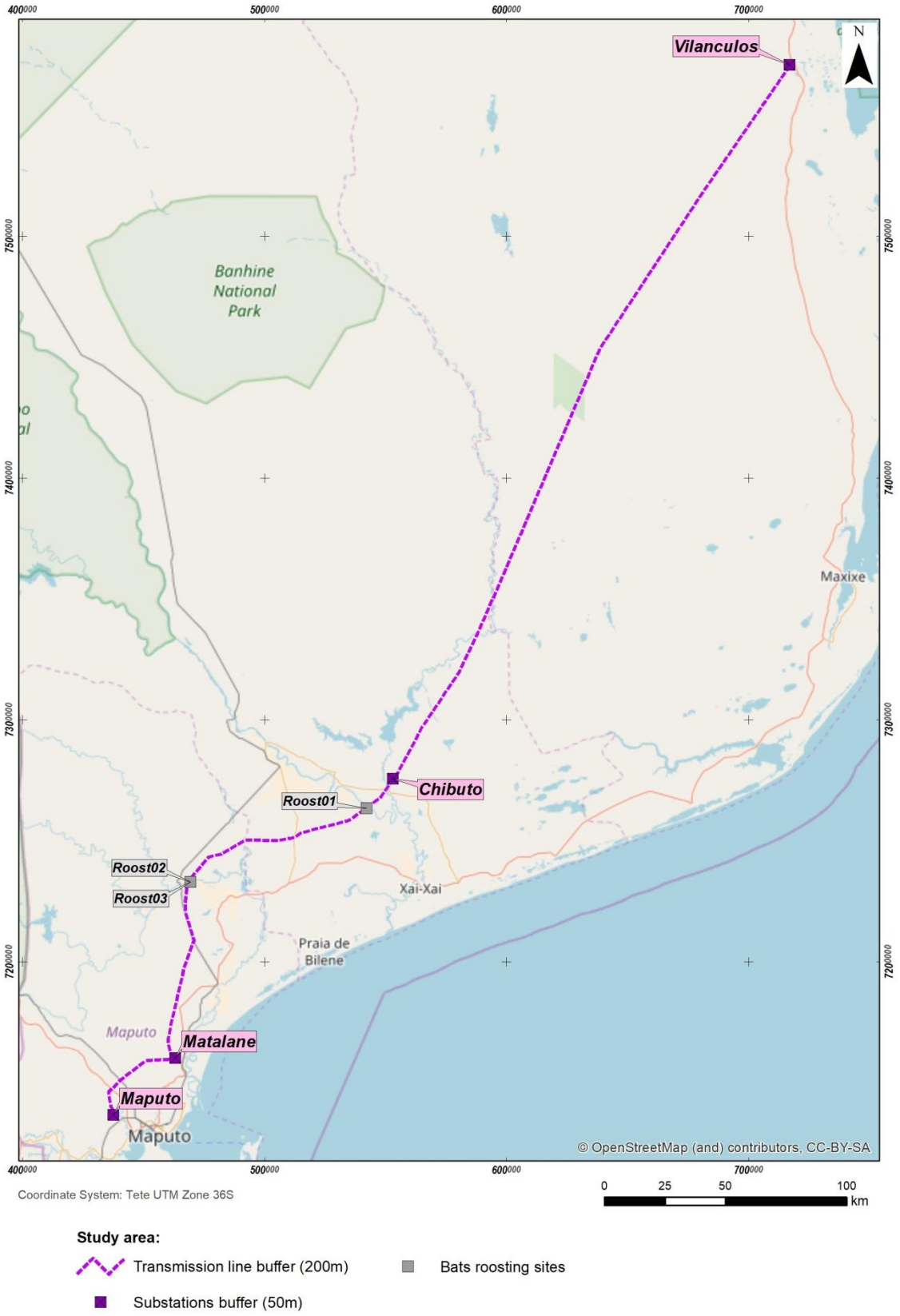


Figure 6.41 – Bat roosts found in the study area

Photograph 6.19 – Roost01, in the Limpopo floodplain

From the 112 potential species in the area, 6 species are threatened:

- One classified as Critically Endangered: the black rhinoceros (*Diceros bicornis*);
- Five classified as Vulnerable: leopard (*Panthera pardus*), Temminck's ground pangolin (*Smutsia temminckii*), lion (*Panthera leo*), hippopotamus (*Hippopotamus amphibious*) and African elephant (*Loxodonta africana*) (IUCN, 2017).

Three of these threatened species were confirmed in the field: hippopotamus, through interviews with local people, and leopard and African elephant, through signs and footprints. The leopard was identified close to Macia and the African elephant about 40 km north of Funhalouro. Hippopotamus occur in the main 3 rivers that cross the study area: Limpopo, Changane and Incomati.

From the potential list of mammals present in the study area, 28 species are listed in the Forestry and Wildlife Regulation, meaning that hunting those species is forbidden. 31 species are congregatory, including 21 bat species, and 4 species are migratory. Some of the mammals that can occur in the study area are listed in CITES, the convention for animal trade: 4 species in appendix I, 13 species in appendix II and 3 species in appendix III (see **Table AII.2**, **Annex II**, **Volume IV**). Hippopotamus is considered an EDGE[3] species.

6.2.3.2 Herpetofauna

In total, 38 amphibian species have the potential to occur in the study area, according to bibliographic sources (IUCN, 2017) (see **Table AII.3**, **Annex II**, **Volume IV**). The most represented families are the Hyperoliidae, mostly composed of arboreal genus, with 9 potential species, followed by the Pyxicephalidae, with 7 species (**Figure 6.42**).

[3] Evolutionary Distinct and Globally Endangered Species.

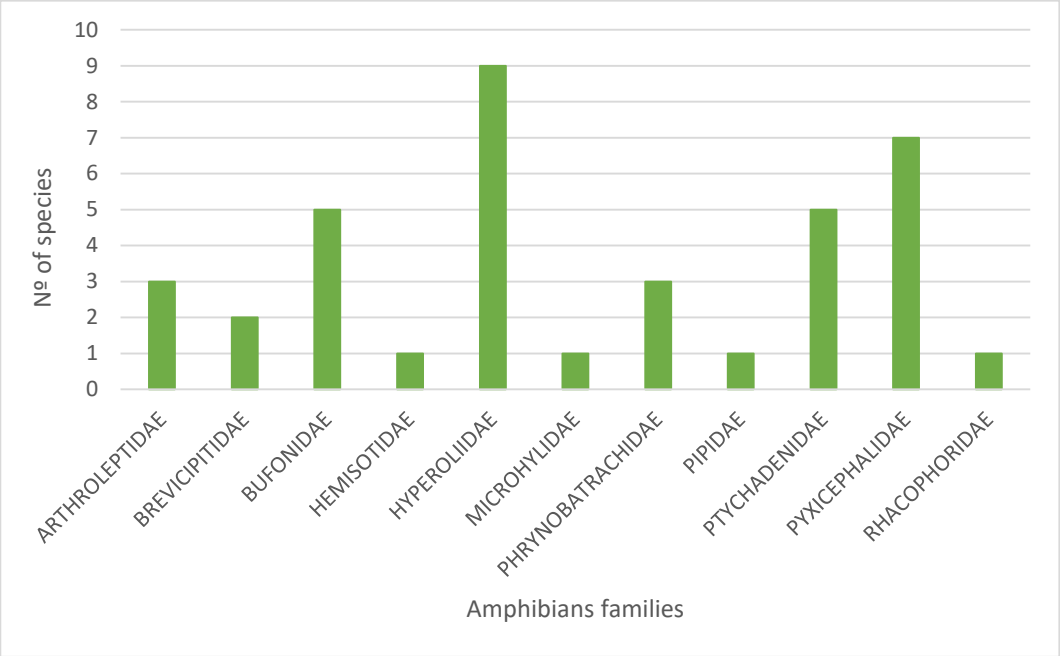


Figure 6.42 – Number of potential amphibian's species per family

During field work, a total of 9 species of amphibians were confirmed as present in the study area (see **Table AII.3**, **Annex II**, **Volume IV**). *Phrynobatrachus mababiensis* (**Photograph 6.20**) and *Phrynobatrachus acridoides* are the most abundant; more than 80 individuals of each species were observed in on waterbody in the study area.

Photograph 6.20 – Amphibian species *Phrynobatrachus mababiensis* (inside red circle)

None of the listed species for the study area (both potential and confirmed) are threatened, as they are classified as Low Concern, according to IUCN (IUCN, 2017). There are also no endemic, restricted range, migratory or congregatory amphibian species in the study area.

A total of 23 reptile species are potential in the study area, including 3 freshwater turtles, according to bibliographic sources (IUCN, 2017) (see **Table AII.4**, **Annex II**, **Volume IV**). The most represented families are Gekkonidae and Scincidae, each with 6 species (**Figure 6.43**).

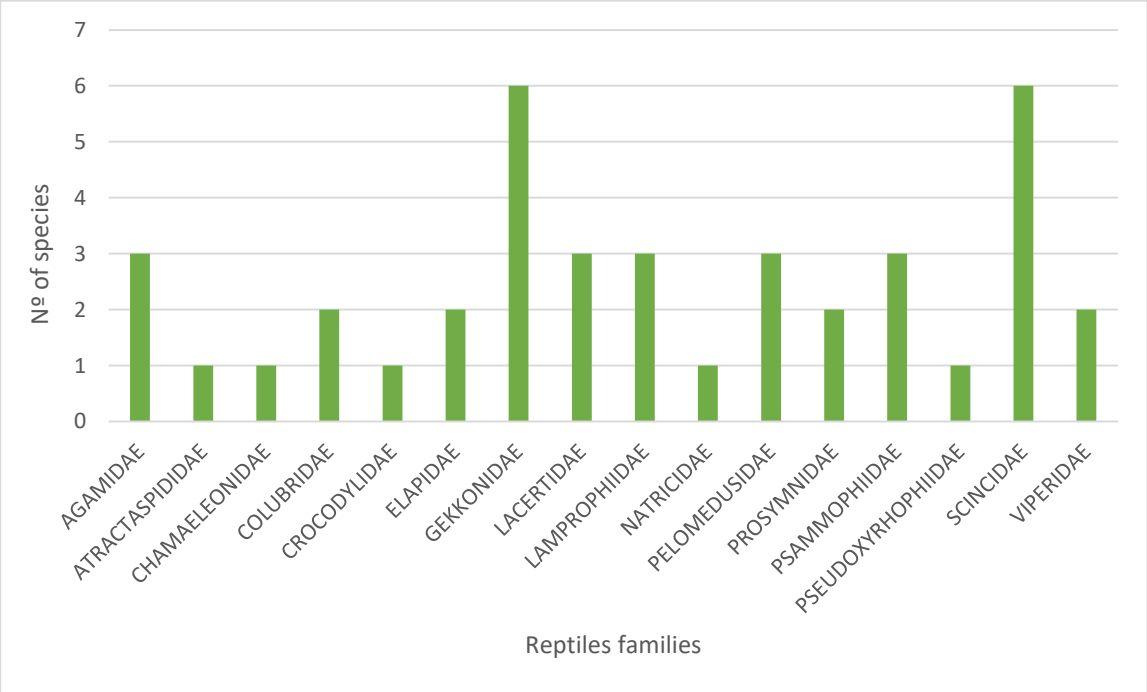


Figure 6.43 – Number of potential reptile's species per family

During field work, it was possible to confirm the presence of 18 species (see **Table AII.4**, **Annex II**, **Volume IV**), including crocodiles, though interviews with locals, and 2 Viperidae species: puff adder (*Bitis arietans*) and lowland swamp viper (*Proatheris superciliaris*) (**Photograph 6.21**).

Photograph 6.21 – Lowland swamp viper (left) and puff adder (right) observed during the field survey

None of the listed species for the study area (both potential and confirmed) are threatened, as they are classified as Low Concern or Not Evaluated, according to IUCN (IUCN, 2017). There are also no endemic, restricted range, migratory or congregatory reptile species in the study area.

Two of the reptile species that can occur in the study area are listed in CITES appendix II, the convention for animal trade: *Chamaeleo dilepis* and Nile crocodile (*Crocodylus niloticus*).

6.2.3.3 Birds

Overall, a total of 457 bird species can occur in the study area, according to bibliographic sources (IUCN, 2017) (see **Table AII.5**, **Annex II**, **Volume IV**). The most representative family of birds in the

study area is Accipitridae with 39 species, followed by Cuculidae and Ploceidae, each with 17 species (**Figure 6.44**).

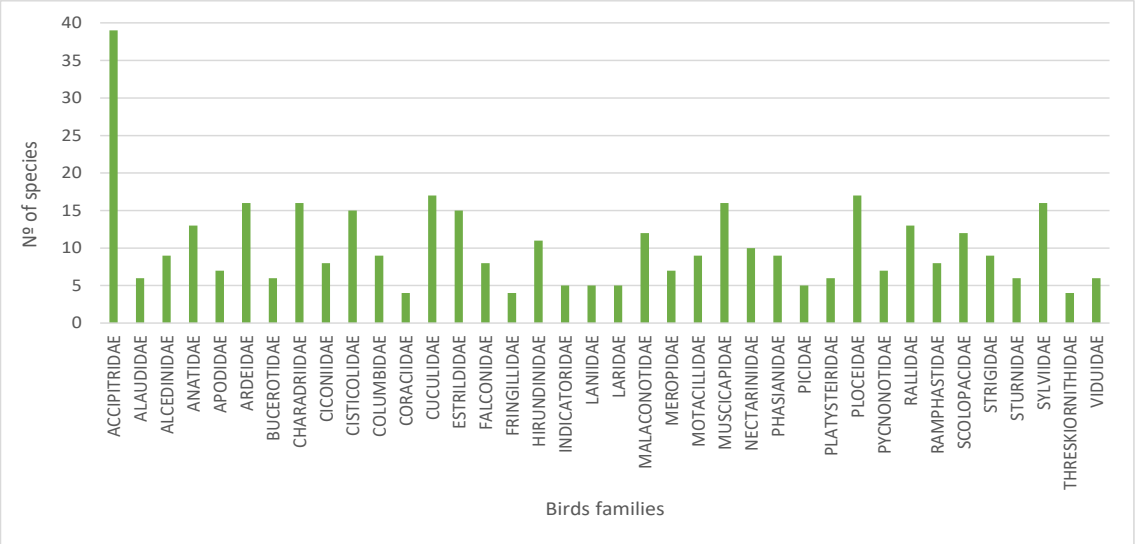


Figure 6.44 – Number of potential bird's species for the most representative families

During field work, a total of 119 species were confirmed as present (see **Table AII.5**, **Annex II**, **Volume IV**). Although the number of species identified in the field is high, it's important to refer that field work was done in a period when most of the migratory species that can occur in the study area (150 migratory bird species) already left.

Rivers, wetlands and waterbodies were the places where a higher concentration of birds was observed. In the Changane mouth and Limpopo floodplain a group of more than 200 cattle egrets (*Bubulcus ibis*) and more than a dozen African sacred ibis (*Threskiornis aethiopicus*) were observed at dusk. Also on the banks of Limpopo a roost with more than a dozen yellow-billed storks (*Mycteria ibis*) was identified (**Photograph 6.22**). In the Incomati River basin, more than a dozen cattle egrets and more than 50 great white pelicans (*Pelecanus onocrotalus*) were observed.

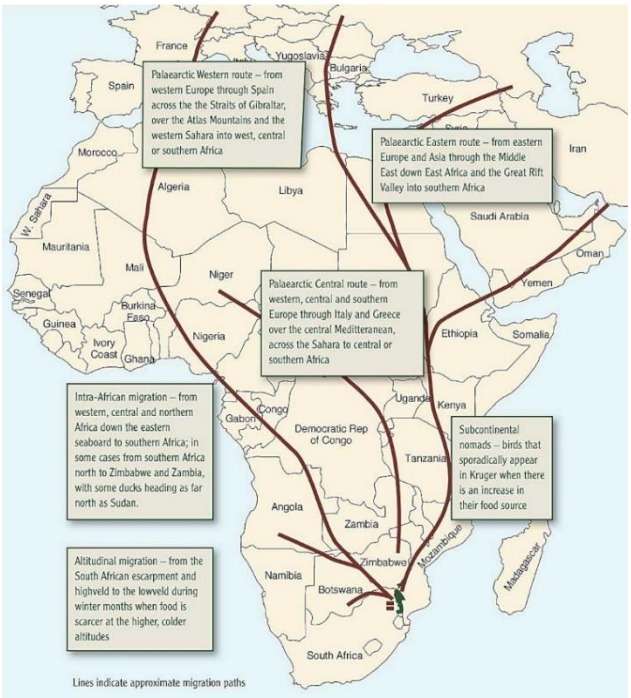
Photograph 6.22 – Yellow-billed storks (*Mycteria ibis*) roost on the Limpopo River bank

Further to the high number of birds observed in the referred areas, it's also important to refer the possible movements of birds between waterbodies, rivers and wetlands in both sides of the line corridor, as well as movements related to close by Important Bird Areas (IBA) (see **Figure 6.47**), especially important in the north. As previously mentioned, the only wetlands that are directly

interfered by the Project are the floodplains of the major rivers in the study area, namely the Limpopo, Changane and Incomati Rivers. These interferences are shown in **Figure 6.25** above (see page 95). The floodplain of these rivers are interfered by the middle segment of the transmission line, between Chibuto and Matalane substations. The crossing of the floodplains of the Limpopo, Changane and Incomati rivers are unavoidable, given the start and end points of the line, and the location of the substations: the regional river network develops in a NW-SE direction, while the transmission line develops in a NE-SW direction, which makes the interference unavoidable.

The Limpopo and Changane wetlands are dominated by agriculture activities, with very little natural vegetation left, which limits their importance for aquatic birds. Incomati river wetlands are also used for agricultural purposes, but areas of natural vegetation dominated by *Phragmites mauritianus, Ficus sycomorus* and *Sesbania sesban* are also still present.

As mentioned above, of the 457 bird species that are listed as occurring in the Project region, 150 species are migratory (see **Table AII.5**, **Annex II**, **Volume IV**). There is no specific information regarding bird migration routes in Mozambique. Most of these 150 migratory species are Palearctic migrants, with known migration patterns. These long-distance migrant birds, mainly insect-eaters and waders, follow set migration patterns between Europe and Southern Africa in a broad North-South direction, as illustrated in **Figure 6.45** below. However, more specific information on these migration routes in Mozambique is not available, i.e., it is not known if birds use one or more specific routes, or if they use the entire territory of Mozambique to perform their North-South migration. Given that Palearctic birds migrate in a broad North-South direction and that the STE Project develops in a NE-SW direction along 560 km, it is likely that the proposed transmission line will cross the migration pathway of some Palearctic birds, although no major migration routes are known for the Project area.



Source: Kruger Park (birding.krugerpark.co.za).

Figure 6.45 – General Palearctic bird migration routes

Eight of the species listed for the study area are threatened, according to IUCN (IUCN, 2017). Four species are classified as Vulnerable: martial eagle (*Polemaetus bellicosus*), secretarybird (*Sagittarius serpentarius*), Southern ground-hornbill (*Bucorvus cafer*) and wattled crane (*Grus carunculatus*); two as Endangered: steppe eagle (*Aquila nipalensis*) and Cape vulture (*Gyps coprotheres*); and two as Critically Endangered: white-backed vulture (*Gyps africanus*) and hooded vulture (*Necrosyrtes monachus*). During field work none of the threatened species were observed.

In total there are 65 species that can occur in the study area that are listed in CITES: one in appendix I and 64 in appendix II. In CMS, 69 species are listed: one in appendix I, 67 in appendix II and one in appendix III. From the potential list of birds present in the study area, 95 species are listed in Decree 12/2002, from 6 June, meaning their hunting is forbidden. There are also 130 species potentially present in the study area that are congregatory.

6.2.3.4 Human-Wildlife Conflicts

Conflicts between humans and wildlife tend to occur in communities where humans and wildlife still coexist and share the same habitat. On average, 118 people are killed by wildlife per year in Mozambique; the majority of them by crocodiles (Dunham *et al*., 2010). The numbers are especially high in Maputo and Gaza provinces, mostly due to the presence of major rivers like Limpopo, Changane and Incomati. Curiously the number of crocodiles killed by people due to human-wildlife conflicts (HWC) is very small.

In the three provinces encompassed by the study area, deaths or injuries to people from hippopotamus were also registered, with the higher number in Inhambane province, but mainly in the north. Deaths or injuries caused by elephants were only registered in Maputo and Inhambane provinces. In the three provinces there are also records of elephants being killed, although the opportunity to obtain ivory, and not HWC, may be the real reason for those kills. In the three provinces in question no deaths or injuries to humans by lions were registered (Dunham *et al*., 2010) (**Table 6.16**).

Regarding livestock, damages are mainly caused by lions and crocodiles, with higher number of animals being killed by lions, in Maputo and Gaza provinces. On the destruction of crops, problems come mainly from elephants and hippopotamus, in similar proportions, in the three provinces (Dunham *et al*., 2010) (**Table 6.16**). Conflicts with buffalos were also reported in the three provinces. Overall, in Mozambique one death and seven injured were recorded, some cases of damages on crops and 11 buffalos killed (Dunham *et al*., 2010).

In the last decades, no conflicts with leopards were recorded but there are records of leopards being killed. There are records of HWC with hyaenas in Maputo and Gaza provinces, especially close to the border with Kruger National Park and Gonarezhou National Parks (Dunham *et al*., 2010). HWC also occur with warthog, bushpigs, vervet monkeys, baboons and small rodents, mainly due to damages in agricultural crops. Snakes are also frequently involved in HWC due to death or injuries caused to humans that frequently end in the animal death as well.

During the interviews undertaken, local people were asked about HWC and none referred recent incidents in the study area.

Table 6.16 – Human-wildlife conflicts in the three provinces encompassed by the study area

Species/HWC	Provinces		
	Maputo	Gaza	Inhambane
Crocodiles			
People killed or injured	1-10	1-10	1
Domestic livestock killed	9-18	1-8	0
Crocodiles killed	1-5	1-2	1
Hippopotamus			
People killed or injured	1-2	1-2	1-4
Months with crop damage	1-4	1-5	1-5
Hippopotamus killed	1-5	1-5	1-4
Lions			
People killed or injured	0	0	0
Domestic livestock killed	1-30	1-30	0
Lions killed	1-8	1	0
Elephants			
People killed or injured	2	0	1
Months with crop damage	1-3	1-6	1-9
Elephants killed	1-3	1-3	1-2

Source: Adapted from Dunham *et al.* (2010).

6.2.4 Conservation Areas

6.2.4.1 Legally Protected Areas

There are no officially designated protected areas within the study area. However, there are some legally protected areas in the study area surroundings (**Figure 6.46**), namely:

- Bazaruto National Park – 30 km northeast of the study area;
- Maputo Special Reserve – 50 km south of the study area;
- Chirindzene Natural Reserve – 53 km east of the study area;
- Licuati Forest Reserve – 53 km south of the study area;
- Inhaca and Portuguese Island Faunal Reserve – 53 km southeast of the study area;
- REM Vigilance Zone – 82 km south of the study area;
- Limpopo National Park – 95 km west of the study area;
- Pomene Game Reserve – 95 km east of the study area;
- Banhine National Park – 102 km west of the study area;
- Zinave National Park – 116 km northwest of the study area.

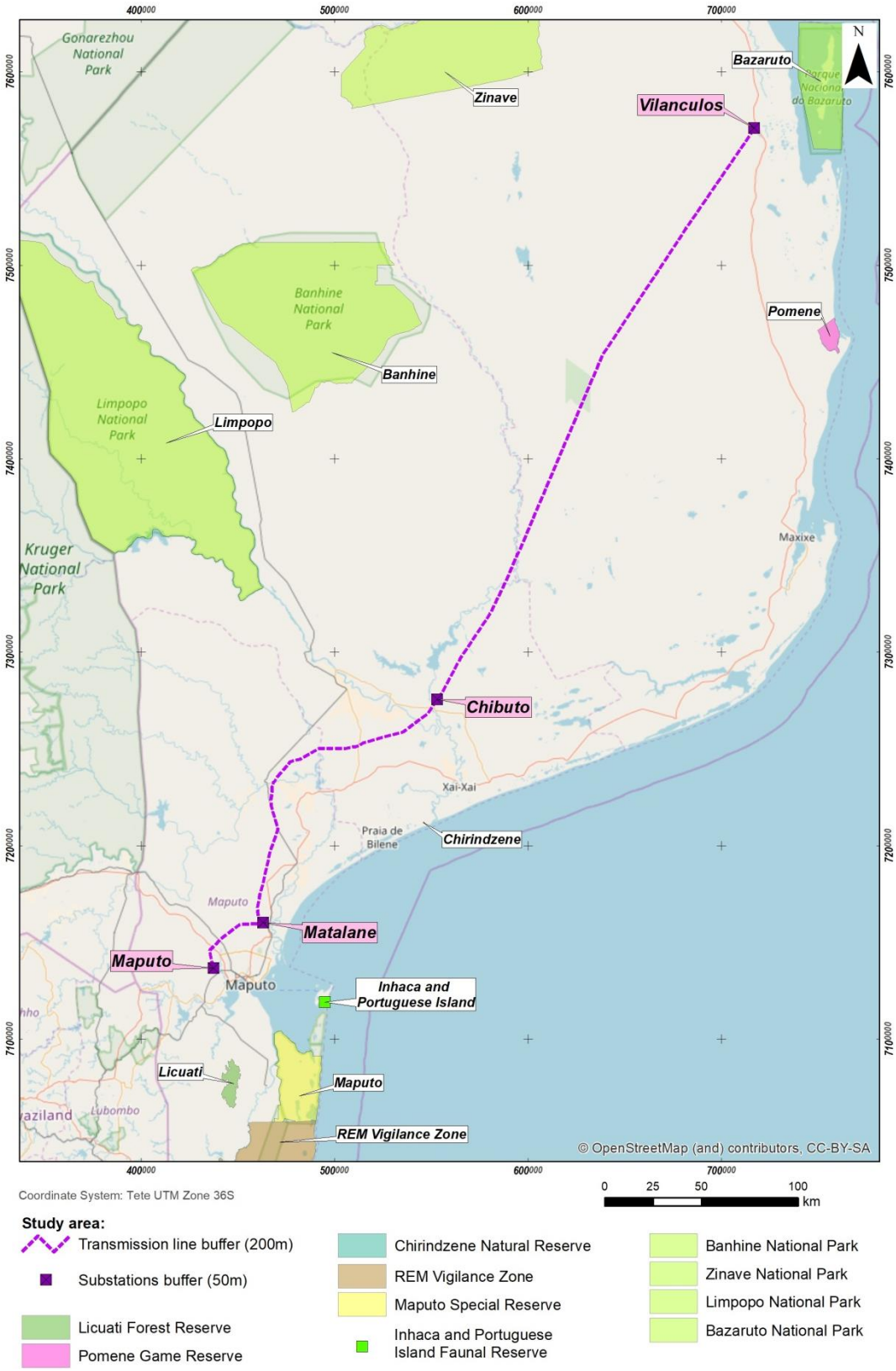


Figure 6.46 – Legally protected areas in the study area surroundings

6.2.4.2 Important Areas for Biodiversity

The study area does not cross any IBA or other key biodiversity areas[4]. However there are some IBA's in the study area surroundings (**Figure 6.47**):

- Bazaruto Archipelago (MZ004) – 30 km northeast of the study area;
- Panda *Brachystegia* woodlands (MZ003) – 48 km southeast of the study area;
- Changelane river gorge (MZ002) – 50 km south of the study area;
- Maputo Special Reserve (MZ001) – 50 km south of the study area;
- Pomene (MZ005) – 95 km east of the study area;

The north and south parts of the study area encompasses the Endemic Bird Area (EBA) South-east African coast (EBA092). This EBA corresponds to a broad coastal plain of southern Mozambique, northern Natal, the south-eastern extreme of Transvaal in South Africa and eastern Swaziland. There restricted-range birds, such as Rudd's Apalis (*Apalis ruddi*), Neergaard's Sunbird (*Cinnyris neergaardi*), Pink-throated Twinspot (*Hypargos margaritatus*) and Lemon-breasted Canary (*Crithagra citrinipectus*), occur in a variety of wooded and open habitats, but not in evergreen forest (BirdLife International, 2017).

The north part of the study area encompasses Coastal Forests of Eastern Africa Biodiversity hotspot (Conservation International, 2011). In this biodiversity hotspot there are approximately 4050 vascular plant species, of which approximately 1750 are endemic, 70% of them are found in forest habitats. The hotspot also hosts at least 28 endemic plant genera, 90% of which are found in forest habitats. The south part of the study area crosses the Maputaland-Pondoland-Albany Africa Biodiversity hotspot. This biodiversity hotspot is characterized by subtropical thicket that is maintained by elephants, rhinos and buffalos that crash open paths and disperse seeds through their digestive tracts and it's a refuge for the critically endangered black rhino. The biodiversity hotspot hosts nearly 600 tree species it has the highest tree diversity of any temperate forest in the world (Conservation International, 2011).

East African Mangroves, which is a WWF Global 200 Ecoregion, is located 30km northeast of the study area (**Figure 6.47**). The Global 200 Ecoregions are large-scale priority areas of uniform ecological features, chosen for the conservation of the most outstanding and representative of the world's habitats (Olson & Dinerstein, 2002). The East African Mangroves Global 200 Ecoregion as comprises mangroves within the tropical latitudes in East Africa. This critical / endangered ecoregion hosts highly productive fish and prawns nurseries, enhancing the biodiversity of surrounding marine habitats while providing vital habitat for migratory birds, marine turtles, dugongs, and porpoises. However, Eastern African mangroves are threatened in many areas by overuse and conversion by a growing human population that utilises the mangroves for rice farming, shrimp aquaculture, and for construction materials and the timber trade (WWF, 2014).

There are no RAMSAR or UNESCO heritage sites crossing the study area or in its surroundings (within 100 km of the study area).

[4] All IBA are considered key biodiversity areas, in the context of IFC performance standards.

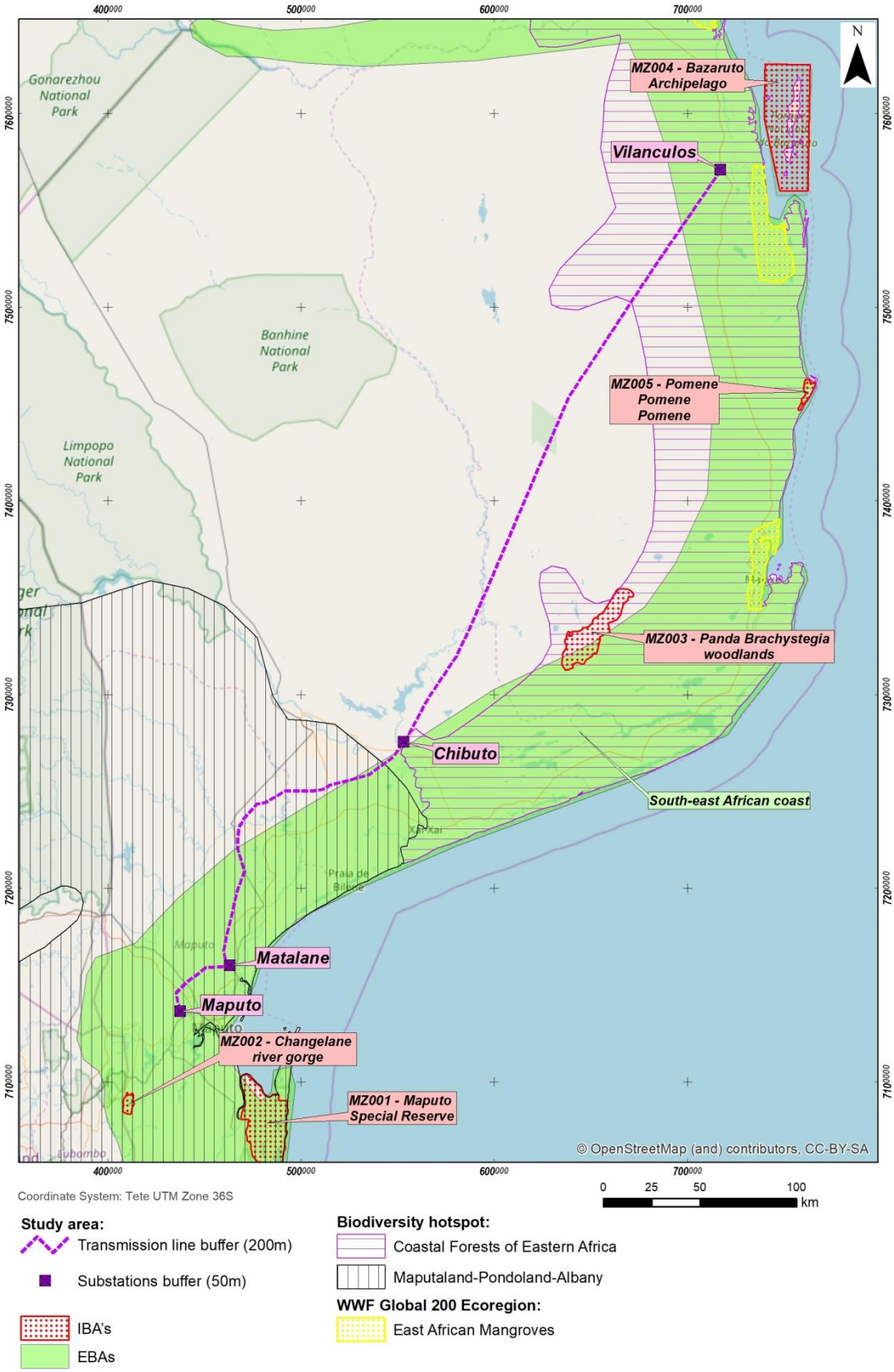


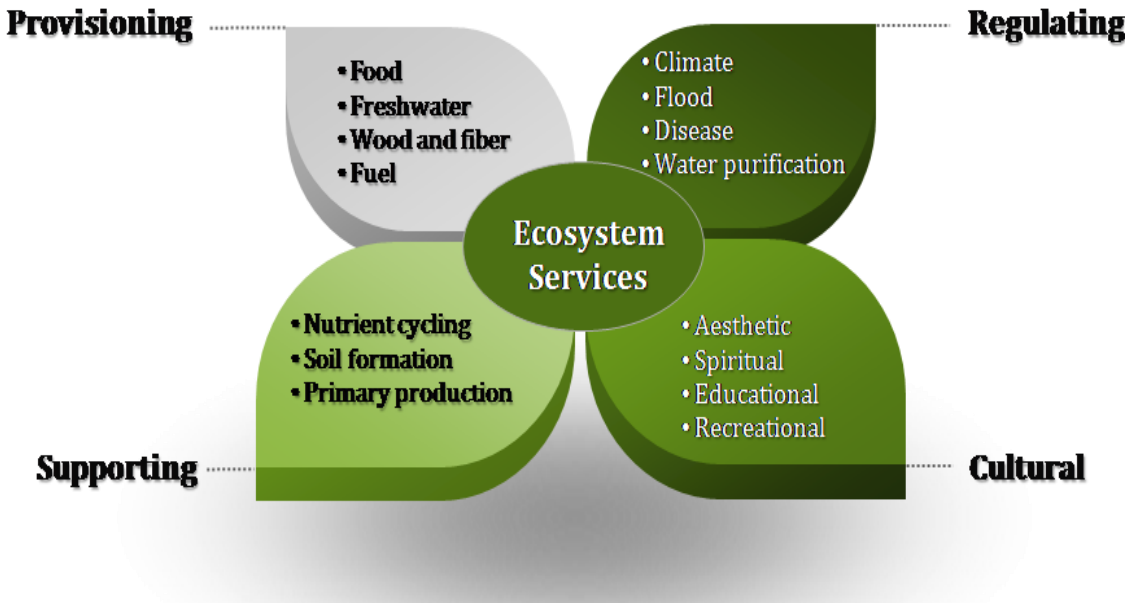
Figure 6.47 – Important areas for biodiversity in the study area surroundings

6.2.5 Ecosystem Services

6.2.5.1 General Considerations

Secondary data was used to identify and characterise the ecosystem services provided by the existing habitats within the study area to people. The 4 categories of ecosystem services are presented graphically in **Figure 6.48** and summarised as follows (MEA, 2005; de Groot, 2006; IPIECA & OGP, 2011):

- Supporting (or base) Services: Include services such as primary productivity, nutrient cycling, carbon cycling, water cycling, production of atmospheric oxygen and soil formation, which are necessary for ecosystem functioning and for supporting the delivery of all other categories of ecosystem services. The effect of supporting services on human well-being is only perceived in the long-term through impacts on the provision of other ecosystems goods and services;
- Provisioning Services: tangible goods, such as food, water, fuels, fibres, biochemical, ornamental resources and genetic resources, which are directly obtained from ecosystems; due to their direct use, most of the services have a market value and are traded;
- Regulating Services: Include services such as water purification, air quality maintenance, climate regulation, pollination, soil protection from erosion, regulation of disturbances (floods, drought, fire) and diseases, which are related to ecosystem functions and their contribution to regulating essential ecological processes and life support systems;
- Cultural Services: services such as spiritual enrichment, cognitive development, religious values, cultural heritage, recreation, and aesthetic enjoyment, which humans obtain from ecosystems through knowledge, experience, and the sense of relationship with the natural environment. These services are closely related to human values, identity, and behaviour.



Source: Adapted from MEA (2005).

Figure 6.48 – A conceptual model of connection types regarding ecosystem structure, processes, services and benefits

6.2.5.2 Supporting Ecosystem Services

Supporting ecosystem services are the ones necessary for the production of all other ecosystem services, including soil formation, photosynthesis, primary production, nutrient cycling and water cycling. All other ecosystem services depend on and develop on supporting ecosystem services (ES). All habitats except the urban areas (these areas cannot be considered relevant sinks of ES) are related to these services, as presented in **Table 6.17**. The relative importance of each habitat for the ES was assessed by the ESIA team and is ranked in **Table 6.17** as H - High importance; M - Medium importance; L - Low importance; and NA – Non Applicable.

Table 6.17 – General appraisal on the relative importance of each supporting service at the vegetation unit level

Vegetation Units	Primary production and photosynthesis	Soil Formation	Nutrient and water cycling
Miombo forest	H	H	H
Miombo woodland	H	H	H
Undifferentiated woodland	M	M	M
Savanna	H	H	H
Thicket	H	M	H
Rivers and wetlands	H	H	H
Waterbodies	H	H	H
Subsistence agriculture	H	L	H
Irrigation agriculture	H	L	H
Disturbed areas	NA	NA	NA

6.2.5.3 Provisioning Ecosystem Services

Provisioning services include the products that are obtained from ecosystems, such as food, fiber, fuel, genetic resources, biochemicals, natural medicines, pharmaceuticals, ornamental resources, and fresh water. The most relevant habitats for these services are: miombo forest, miombo woodland, undifferentiated woodland and subsistence agriculture (**Table 6.18**). The relative importance of each vegetation unit for provisioning ecosystem services is classified in **Table 6.18** . A brief description of the relevant provisioning ecosystem services follows.

Table 6.18 – General appraisal on the relative importance of each provisioning service at the vegetation unit level.

Vegetation Units	Food Production						Endogenous Natural Resources	Endogenous Forest Products			Plant and Animal Resources	
	Hunting	Natural food foraging	Fishing	Livestock and husbandry	Agriculture	Honey production	Freshwater	Wood	Other Forest non-woody materials	Resins	Genetic Resources	Medicinal and well-being
Miombo forest	H	M	NA	M	NA	H	L	H	M	M	M	M
Miombo woodland	H	M	NA	M	NA	H	L	H	M	M	M	M
Undifferentiated woodland	L	L	NA	L	NA	H	L	H	H	H	M	M
Savanna	H	H	NA	M	M	L	L	H	M	L	M	L
Thicket	M	M	NA	NA	NA	M	NA	M	L	M	L	L
Rivers and wetlands	L	L	H	NA	M	L	H	NA	NA	NA	M	M
Water bodies	NA	NA	H	NA	M	L	H	NA	NA	NA	M	M
Subsistence agriculture	M	M	NA	H	H	M	M	H	M	M	L	H
Irrigation agriculture	L	L	NA	L	H	L	H	L	L	L	L	M
Disturbed areas	NA	NA	NA	M	M	M	L	NA	NA	NA	L	L

Food production

Hunting is a common practice in rural areas, with people hunting antelopes in general, monkeys, warthogs/bush pigs and hares. Mostly people hunt for food, although it is normal to sell the surpluses (**Photograph 6.23**).

Photograph 6.23 – Hunted hare for sale in Panda District

Most people eat wild fruits in villages, but only a restricted number of them, such as masala (*Strychnos spinosa*), malambe (*Adansonia digitata*) and tamarind (*Tamarindus indica*) (**Photograph 6.24**).

Photograph 6.24 – Massala fruit (*Strychnos spinosa*)

Although the number of large freshwater sources in the study area is relatively limited, subsistence fishing is done in major rivers, such as Limpopo, Changane and Incomati; the main captured freshwater species is tilapia (*Oreochromis* sp./*Tilapia* sp.). Freshwater mussels are also collected as a complementary food source (**Photograph 6.25**).

Photograph 6.25 – Boat and mussel shells in the Incomati bank

In the study area all villages have livestock, mostly cows, goats (**Photograph 6.26**) and chicken, normally in small numbers, although there are a few larger cattle production farms. More rarely pig, sheep and duck are also kept. Donkeys are frequently used as working animals.

Photograph 6.26 – Cattle in the study area

The main agriculture products in the study area are cassava, millet and maize. Other common products are rice, sugar cane, sorghum, sweet potato, coconut, mango, cashew, tangerine, guava, papaya, pineapple, banana, peanut, lemon, cucumber, water melon, eggplants, tomatoes, chillies, peppers, cabbages, lettuce, okra and "nhemba" beans. Besides food, ecosystems provide also drinks and beverages, such as *Hyphaene coriacea* sap[5] (**Photograph 6.27**), coconut and cashew.

Photograph 6.27 – *Hyphaene coriacea*

Endogenous Natural Resources

The main freshwater sources are rivers and waterbodies, but in some villages also boreholes were observed.

Endogenous Forest Products

In the study area, wood is an important resource considering the species present: 3 species of precious wood, 11 species of first class wood, 5 species of second class wood, 12 species of third class wood and 14 species of fourth class wood. Wood is also an energy source (fire), used in house and other structures as construction material (**Photograph 6.28**). Charcoal is also an important

[5] During the EPDA public meetings, one of the participants indicated that the sap of this small palm tree is used in the Xai-xai area to produce a local alcoholic beverage, both for own consumption and for sale.

resource for local people since for many in the only energy source available and it's also sold commonly.

Photograph 6.28 – Fire wood (left; Funhalouro District) and construction wood (right; Chokwe District) for sale

Other forest non-woody materials are used, such as palm tree fronds, grass and sisal. The sisal is usually used in production of ropes. Tendrils from grasses and palm trees can be found in the villages; they are sometimes use for roof covering, doors and windows. The grasses and bamboo are sometimes used for crafts, mainly to make baskets.

6.2.5.4 Regulating Ecosystem Services

Regulating services correspond to the benefits obtained from the regulation of ecosystem processes, including air quality regulation, climate regulation, water regulation, erosion regulation, water purification, disease regulation, pest regulation, pollination, and natural hazard regulation. The most relevant habitats for these services are: miombo forest, miombo woodland, rivers, wetlands and waterbodies (**Table 6.19** and **Table 6.20**). The relative importance of each vegetation unit for provisioning regulating services is classified in the following tables.

Table 6.19 – General appraisal on the relative importance of regulating services (prevention and habitats) at the vegetation unit level

Vegetation Units	Prevention				Habitats	
	Flood prevention/ control	Wildfire prevention/ control	Pest and disease prevention / control	Invasive species control	Habitats Maintenance	High Conservation Value Areas
Miombo forest	M	L	M	L	M	M
Miombo woodland	M	L	M	L	M	M
Undifferentiated woodland	M	L	L	L	M	L
Savanna	M	L	L	L	M	L
Thicket	H	L	L	L	H	H
Rivers and wetlands	H	H	M	M	H	H
Waterbodies	H	H	M	M	H	M
Subsistence agriculture	M	M	L	H	L	L
Irrigation agriculture	M	M	M	M	L	L
Disturbed areas	L	H	L	L	L	NA

Table 6.20 – General appraisal on the relative importance of regulating services (cycles and depuration) at the vegetation unit level

Vegetation Units	Cycles (processes)					Depuration			
	Soil protection and formation	Water Regulation	Nutrient Regulation	Pollination	Local climate regulation	Soil bioremediation	Pollution and contaminant treatment	Water Purification	Air quality
Miombo forest	H	M	M	H	H	M	M	M	H
Miombo woodland	H	M	M	H	H	M	M	M	H
Undifferentiated woodland	M	L	L	M	L	L	L	L	M
Savanna	M	M	M	M	M	L	L	M	M
Thicket	M	L	L	M	L	L	L	L	L
Rivers and wetlands	H	H	H	L	H	H	H	H	H
Waterbodies	M	H	M	L	H	L	H	H	M
Subsistence agriculture	H	M	H	H	M	M	M	M	M
Irrigation agriculture	H	M	H	L	M	M	M	M	M
Disturbed areas	NA	L	L	L	NA	L	L	L	L

6.2.5.5 Cultural Ecosystem Services

Cultural services refer to the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences – thereby taking account of landscape values (MEA, 2005). The most relevant habitats for these services are: the rivers, wetlands and waterbodies (**Table 6.21**). The relative importance is ranked as H - High importance; M - Medium importance; L - Low importance; and NA – Non Applicable.

Table 6.21 – General appraisal on the relative importance of each cultural service at the vegetation unit level

Cultural ecosystem services	Human Well-Being		Educational	
	Recreation Activities	Tourism	Education	Scientific Research
Miombo forest	M	M	M	H
Miombo woodland	M	M	M	H
Undifferentiated woodland	L	L	M	L
Savanna	M	M	M	L
Thicket	L	L	M	M
Rivers and wetlands	H	H	H	M
Waterbodies	H	H	M	M
Subsistence agriculture	M	L	M	L
Irrigation agriculture	M	L	M	L
Urban areas	L	L	L	L

6.2.6 Natural, Modified and Critical Habitat Assessment

6.2.6.1 Methodology for Habitat Assessment

WB operational policy on natural habitats (WB O.P. 4.04) states that WB financed projects should not result in the significant conversion of natural habitats. To assess the presence of natural habitats in the Project's area of influence, habitats in the study area were classified according to the guidelines of IFC PS6 (IFC, 2012a), as modified, natural, or critical. IFC PS6 guidelines were used, as they provide more specific criteria for the classification of habitats than O.P. 4.04.

Modified habitats are areas that may contain a large proportion of plant or animal species of non-native origin, or where human activity has substantially modified an area's primary ecological functions and species composition (e.g., agriculture areas, forest plantations, reclaimed coastal zones, and reclaimed wetlands).

Natural habitats are areas composed of supposedly viable assemblages of plant or animal species of largely native origin, or where human activity has not essentially modified an area's primary ecological functions and species composition.

Critical habitats are areas with high biodiversity value. These are natural or modified habitats that meet at least 1 of the following criteria:

- Habitat of significant importance to CR (Critically endangered) or EN (endangered) species;
- Habitat of significant importance to endemic or restricted-range species;
- Habitat supporting globally significant concentrations of migratory species or congregatory species;
- Highly threatened or unique ecosystems; and
- Areas associated with key evolutionary processes.

Each of the first 3 criteria is further divided into 2 quantitative sub-criteria (tiers). A habitat is defined as critical if the habitat complies with one of the tiers. A description of tiers for each criterion is presented in **Table 6.22**.

Table 6.22 – Description of the IFC PS 6 Tiers for Each Criteria (IFC, 2012b).

Criteria	Tier 1	Tier 2
1. Critically Endangered / Endangered Species	- Habitat that sustains ≥ 10 percent of the global population of a CR or EN species / subspecies where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species. - Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species.	- Habitat that supports the regular occurrence of a single individual of a CR species and / or habitat containing regionally - important concentrations of a Red-listed EN species where that habitat could be considered a discrete management unit for that species / subspecies. - Habitat of significant importance to CR or EN species that are wide ranging and / or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species. - As appropriate, habitat containing nationally / regionally important concentrations of an EN, CR or equivalent national / regional listing.
2. Endemic / Restricted Range Species	- Habitat known to sustain ≥ 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species (e.g. a single-site endemic).	- Habitat known to sustain ≥ 1 percent but < 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where data are available and / or based on expert judgment.
3. Migratory/ Congregatory Species	- Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle where that habitat could be considered a discrete management unit for that species.	- Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent but < 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle and where that habitat could be considered a discrete management unit for that species, where adequate data are available and / or based on expert judgment. - For birds, habitat that meets BirdLife International's Criterion A4 (BirdLife International, 2014) for congregations and / or Ramsar Criteria 5 or 6 for Identifying Wetlands of International Importance (RAMSAR, 2014). - For species with large, but clumped distributions, a provisional threshold is set at ≥5 percent of the global population for both terrestrial and marine species. - Source sites that contribute ≥ 1 percent of the global population of recruits.

Besides the principal criteria mentioned above, IFC PS6 considers other secondary criteria that comply with recognized high biodiversity values and that might also support a critical habitat

designation. Secondary criteria must be evaluated on a case-by-case basis and include the following examples:

A. Areas required for the reintroduction of CR and EN species and refuge sites for these species, and habitat used during periods of stress (e.g., flood, drought or fire);
B. Ecosystems of known special significance to CR or EN species for climate adaptation purposes;
C. Concentrations of VU (Vulnerable) species in cases where there is uncertainty regarding the listing, and the actual status of the species may be EN or CR;
D. Areas of primary / old-growth / pristine forests or other areas with especially high levels of species diversity;
E. Landscape and ecological processes (e.g., water catchments, areas critical to erosion control, and disturbance regimes such as fire or flooding) required for maintaining critical habitat;
F. Habitat necessary for the survival of keystone species; and
G. Areas of high scientific value, such as those containing concentrations of species new or little known to science (IFC, 2012b).

Secondary criteria C to G were taken into consideration specifically for the purpose of this baseline study. Criteria A is not considered because currently there are no areas for reintroduction known in the study area; and Criteria B is not considered because there are no known ecosystems especially significant for climate adaptation in the study area.

6.2.6.2 Natural and Modified Habitat Determination

The classification of Natural and Modified habitats, as defined in IFC PS6, has been developed based on the identified and mapped vegetation units and habitats. Within the Natural habitat category, the following vegetation units and habitats were included: miombo forest, miombo woodland, undifferentiated woodland, savanna, thicket, rivers and wetlands and waterbodies.

The Modified habitats include subsistence agriculture, irrigation agriculture and urban areas (**Figure 6.49**).

As shown in **Figure 6.49**, there is an evident predominance of Natural habitats in the study area (77.7%; 17 893.0 ha), in particular in the northern half of the alignment (from Chibuto up to Vilanculos). Modified habitats (22.2%; 5111.8 ha) are mostly concentrated in the southern part of the study area, near the more heavily populated cities and regions (from Chibuto down to Maputo).

Figure 6.49 – Natural and modified habitat mapping

6.2.6.3 Critical Habitat Determination

An analysis of critical habitat determination was undertaken for the study area, following IFC's Criteria 1-3, as well as the secondary criteria, as described above. This assessment is provided below, by type of criteria.

Overall, a total of 239 species (4 flora, 32 mammals and 203 birds) were identified that fitted the IFC 1-3 criteria, but none of the species triggered the Tiers, as described in **Table 6.22** above, in order to consider the critical habitat classification process. Specifically:

- **Criteria 1** – 5 species classified as CR or EN are referenced in the literature as having the potential to occur, namely black rhinoceros (*Diceros bicornis*), steppe eagle (*Aquila nipalensis*), white-backed vulture (*Gyps africanus*), Cape vulture (*Gyps coprotheres*) and hooded vulture (*Necrosyrtes monachus*). However, their presence in the study area was not confirmed during field work and comparing their global distribution area with the suitable area available for the species in the study area it does not comply with *tier* 1. Also the study area is not considered relevant at regional level for those species;
- **Criteria 2 –** a total of 4 endemic and restricted range species, all flora species, have been identified as occuring in the study area, as listed in the tables in **Annex II** (**Volume IV**). However, the suitable habitat present in the study area corresponds to less than 1% of it's distribution area, so none of the species comply with *tiers* 1 or 2;
- **Criteria 3 –** 233 migratory and/or congregatory species are listed as potentially present in the study area, from which 33 of them were confirmed during field work. However, the study area does not sustain ≥95% of the global population, therefore does not comply with *tier* 1; the area also does not sustain 1% of the population regularly or cyclicaly, does not sustain large parts of clumped distribution and also is not an important area for recruiting, therefore does not comply with *tier* 2.

In what regards the secondary criteria, Criterion D (Areas of primary / old-growth / pristine forests or other with especially high levels of species diversity) is applicable to a small patch of miombo forest identified in the northern part of the alignment, which is thus considered to be critical habitat.

Miombo forest patches represent near-pristine vegetation that offers clues about the original nature of the vegetation, prior to the massive disturbance caused by human activities over the last many thousand years. Dry coastal forests, that include miombo forest, are part of the 'Coastal Forests of Eastern Africa' biodiversity hotspot that hosts most of the rare species found in this area and a high flora and fauna diversity (Timberlake *et al*., 2010; Timberlake & Chidumayo, 2011).

The location of this patch of miombo forest, considered to be Critical habitat, is illustrated in **Figure 6.50**.

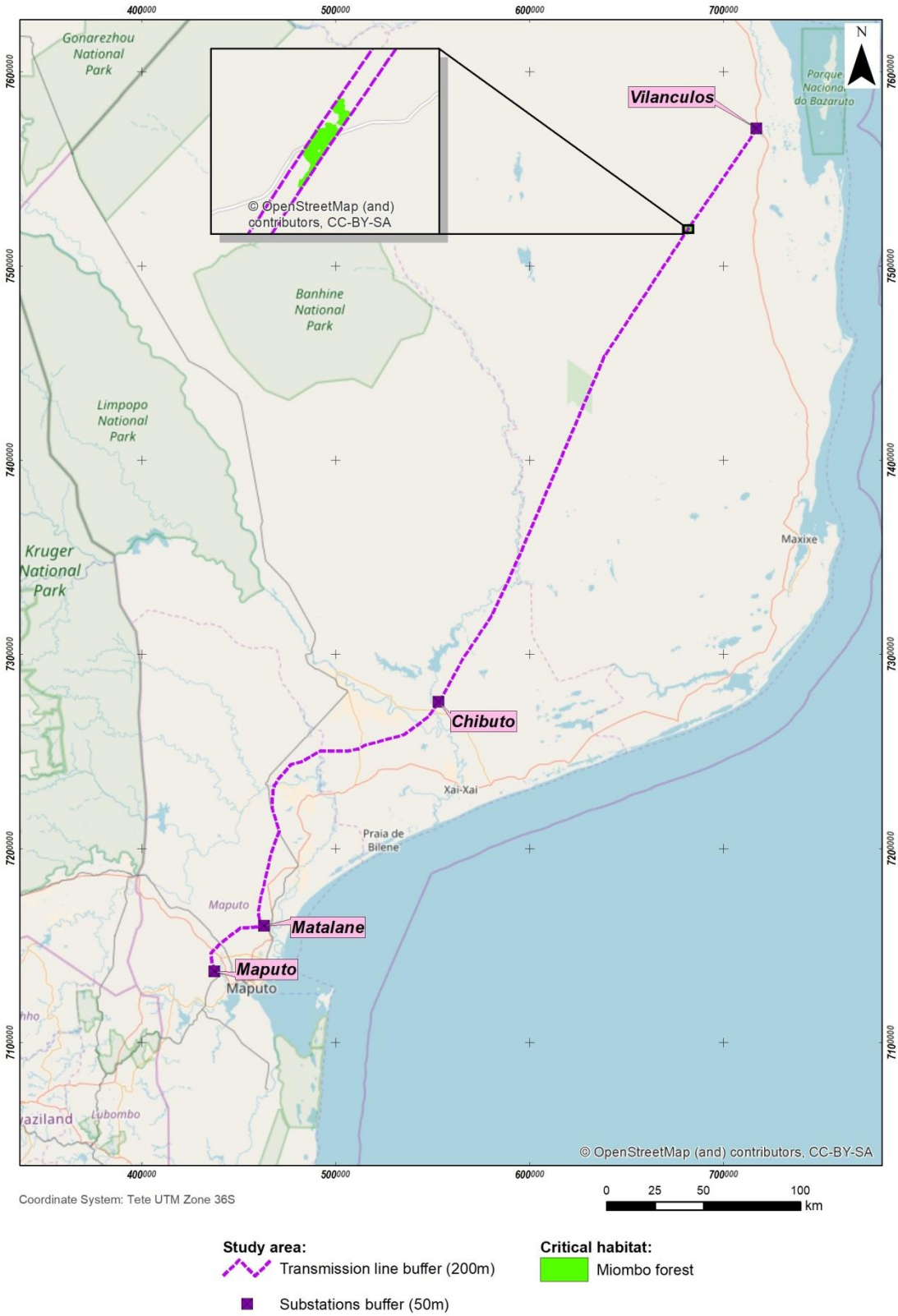


Figure 6.50 – Critical habitat mapping

6.3 Socio-economic Environment

6.3.1 Approach and Methodology

The methodological procedure to describe the socioeconomic environment included the collection and interpretation of both secondary and primary data. Firstly, the available secondary information for the Provinces of Maputo, Gaza and Inhambane, and districts crossed by the Project was collected and analysed. This included a desktop research of the available documentation on the Province and Districts, including information from the National Institute of Statistics (INE), other ESIA's conducted in the region and other freely available official reports.

This desktop review was then complemented with primary information, collected during field work conducted in July 2017 and August / September 2018. Two data collection methods were used:

- Qualitative participative methodology processes were used, through semi-structured interviews with traditional and government authorities that represented all the communities affected by the Project;
- Quantitative methodology was used, through a census survey with all affected people with houses within the Project's RoW (100 m corridor, centered in the alignment, of which the inner 50 m corridor was surveyed in 2017 and the outer 50 m in 2018).

6.3.2 Administrative Division

The STE Project will cross the Provinces of Maputo, Gaza and Inhambane and 13 Districts. This subsection presents the administrative division of the provinces that will be crossed by the Project.

6.3.2.1 Administrative Division of Inhambane Province

Inhambane Province is located on the Southern region of Mozambique, and is bounded to the North by Sofala and Manica Province, to the West and South by Gaza Province and to the East by the Indian Ocean. The Province is divided into twelve Districts and two municipalities. The Provincial Capital is Inhambane City. **Table 6.23** below shows the administrative division of Inhambane Province (the districts crossed by the Project are highlighted in bold).

Table 6.23 – Administrative division of Inhambane Province

Province	Districts	Municipalities
Inhambane	**Funhalouro**, Govuro, Homoine, Jangamo, Inharrime, Inhassoro, Mabote, **Massinga**, Morrumbene, **Panda**, **Vilanculos** and Zavala	Cities of Inhambane and Maxixe

Source: INE (2017a).

The districts crossed by the Project (see **Figure 6.51**) include, from North to South:

- **Vilanculos District,** located in the central region of Inhambane Province. The Project's length in Vilanculos is 52 km, through Mapinhane Administrative Post and Pambara and Quwene locality. The Vilanculos Substation is also located in this district;

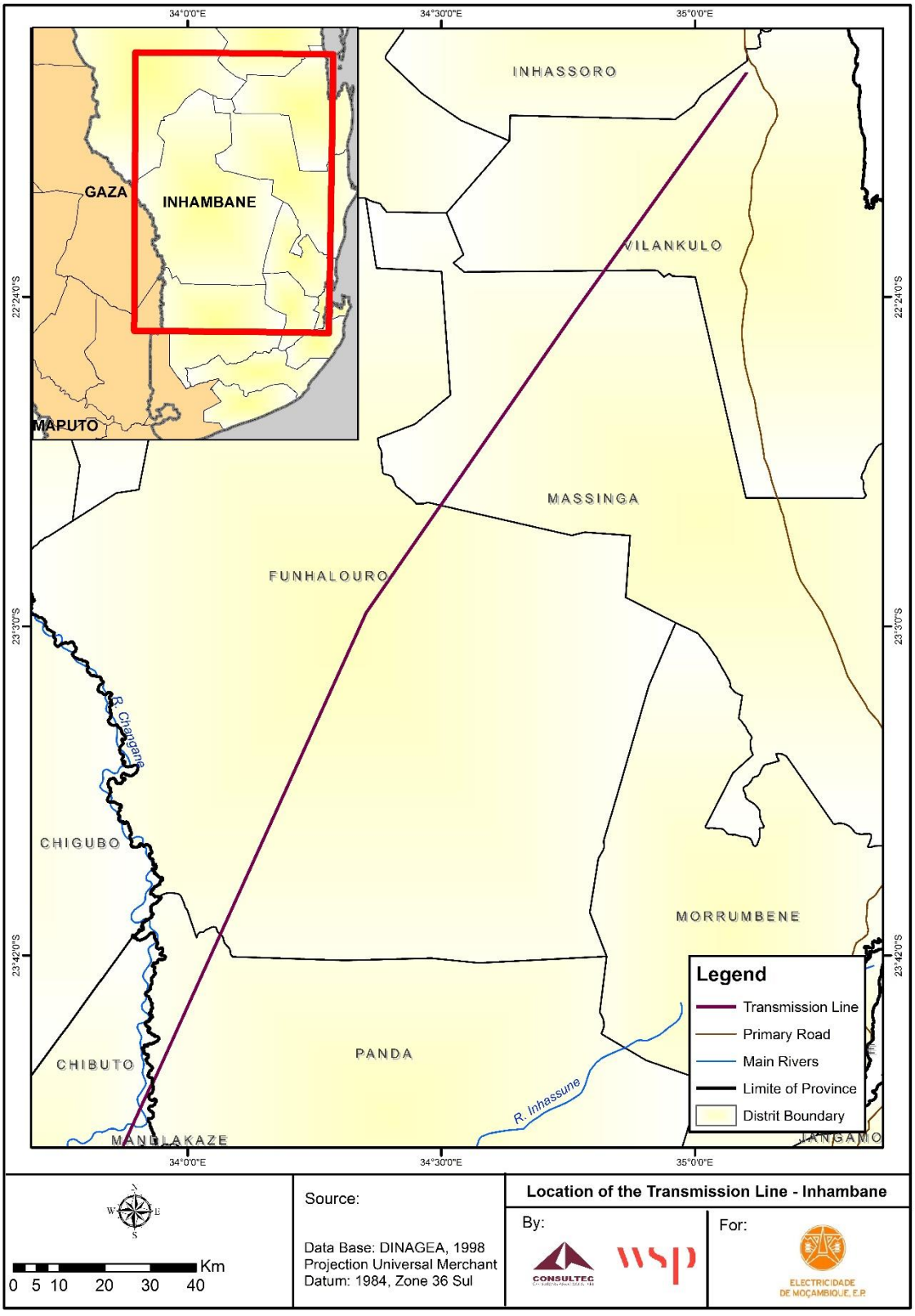


Figure 6.51 – Project alignment in Inhambane Province

- **Massinga District**, located in the central region of Inhambane Province. The Project's length in Massing is 62 km, through Chicomo Administrative Post;
- **Funhalouro District**, located in the South of Inhambane Province. The Project's length in Funhalouro is 104 km, through Funhalouro Sede Administrative Post and Mavume Locality;
- **Panda District**, also located in the South of Inhambane Province. The Project's length in Panda is 35 km, through Mawayela Administrative post and Macavalena locality.

6.3.2.2 Administrative Division of Gaza Province

Gaza Province is also located on the Southern region of Mozambique and is bounded to the North by Manica Province, to the South by Maputo Province, to the West by the South Africa and Zimbabwe and to the East by Inhambane Province and the Indian Ocean. The Province is divided into fourteen Districts and five municipalities; the Provincial Capital is Xai-Xai City. **Table 6.24** below shows the administrative division of Gaza Province.

Table 6.24 – Administrative division of Gaza Province

Province	Districts	Municipalities
Gaza	**Bilene**, **Chibuto**, Chicualacuala, Chigubo, **Chokwe**, Chongoene, Guijá, Limpopo, Mabalane, **Mandlakaze**, Mapai, Massangena, Massingir e Xai-xai	City of Xai-xai and Vilas of Chibuto, Macia and Mandlakaze

Source: INE (2017b).

The districts crossed by the Project (marked in bold in **Table 6.24**) include, from North to South:

- **Chibuto District**, located in the West region of Gaza Province. The Project's length in this district is 96 km, through Alto Changane and Godide Administrative Posts and Alto Changane, Godide and Chipadje localities;
- **Mandlakaze District**, also located in the Western region of Gaza Province. The Project's length in this district is 5 km, trough Macuacua Administrative Post;
- **Chokwe District**, also located in the Western region of Gaza Province. The Project's length in this district is 22 km, trough Xilembene and Lionde Administrative Posts and Zilemebne and Conhane localities;
- **Bilene District**, located in the South of Gaza Province. The Project's length in this district is 32 km, through Mazivila Administrative Post and Mazivila Locality.

Figure 6.52 shows the alignment through Gaza Province.

6.3.2.3 Administrative Division of Maputo Province

Maputo Province is the southernmost Province of Mozambique and it is bounded to the North by the Province of Gaza, to the West by South Africa and Kingdom of Swaziland, to the South by the South Africa and to the East by the Indian Ocean. The province is divided into eight Districts and four municipalities. The Provincial Capital is Matola City.

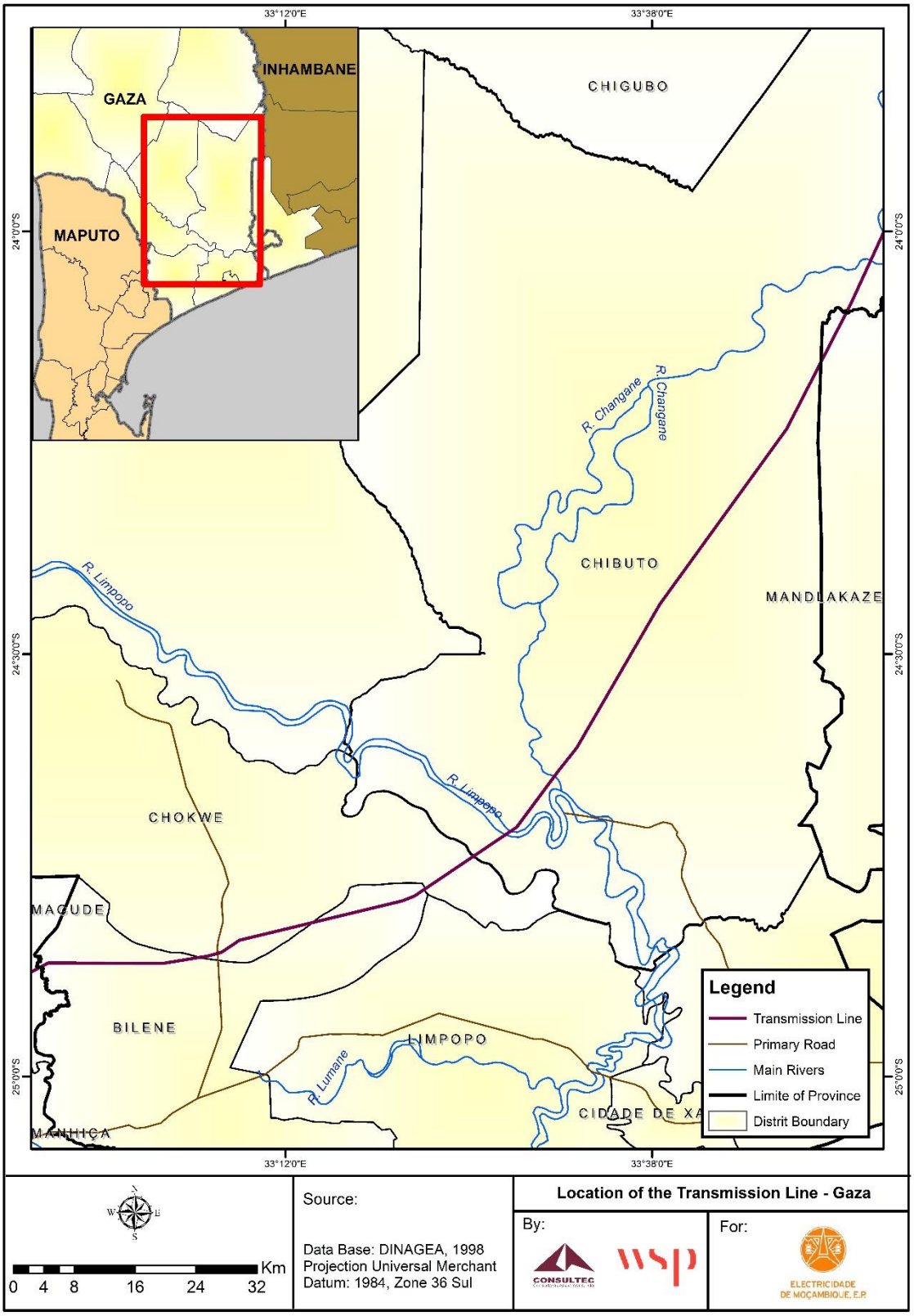


Figure 6.52 – Project alignment in Gaza Province

Table 6.25 below shows the administrative division of Maputo Provinces. The administrative units crossed by the Project are highlighted in bold.

Table 6.25 – Administrative division of Maputo Province

Province	Districts	Municipalities
Maputo	**Boane**, **Magude**, **Manhiça**, **Marracuene**, Matola, Matutuine, **Moamba** and Namaacha	City of Matola and Vilas of Boane, Manhiça and Namaacha

Source: INE (2017c).

The Project will cross the following districts in Maputo Province:

- **Magude District**, located in the North of Maputo Province. The Project's length in this district is 46 km, going through Magude Administrative Post and Maguiguana Locality;
- **Manhiça District**, also located in the northern region of Maputo Province. The Project's length in this district is 49 km, through Maluana Administrative Post and Maluana Locality;
- **Marracuene District**, located in the western region of Maputo Province. The Project's length in this district is 16 km, going through Marracuene Administrative Post and Marracuene Sede Locality. Matalane Substation is located in this district;
- **Moamba District**, also located in the central region of Maputo Province. The Project's length in this district is 27 km, crossing Pesane and Tenga Administrative Posts and Tenga, Mahulane and Pessane-Sede Localities;
- **Boane District**, located in the central region of Maputo Province. The Project's length in this district is 13 km, crossing the Boane Sede and Matola Rio Administrative Posts and Matoloa Rio and Mulatona Localities. The Maputo Substation is located in this district.

Figure 6.53 illustrates the alignment going through Maputo Province.

6.3.3 Political Organization

6.3.3.1 Provincial Government

The Provincial Government of Maputo, Gaza and Inhambane is led by the Governor, supported by the Permanent Secretary, and is structured into management and coordination areas (the Provincial Directorates) that reflect the central level ministries. Further to these directorates, there are also, at the provincial level, the Provincial Attorney-General, the Provincial Commander of the Police of the Republic of Mozambique, the Provincial Disaster Management Delegate, the AIDS Council and Social Security, amongst other provincial representatives.

The Provinces are divided into Districts and Municipalities. The Municipal Councils are governed by the Mayor, Councilors and Chairperson and respective members of the Municipal Assembly. In some areas of the municipality the power of the traditional structures continues to be felt, through the Community Authorities that work in close partnership with the governmental structures and participate in social, economic, political and cultural dynamics.

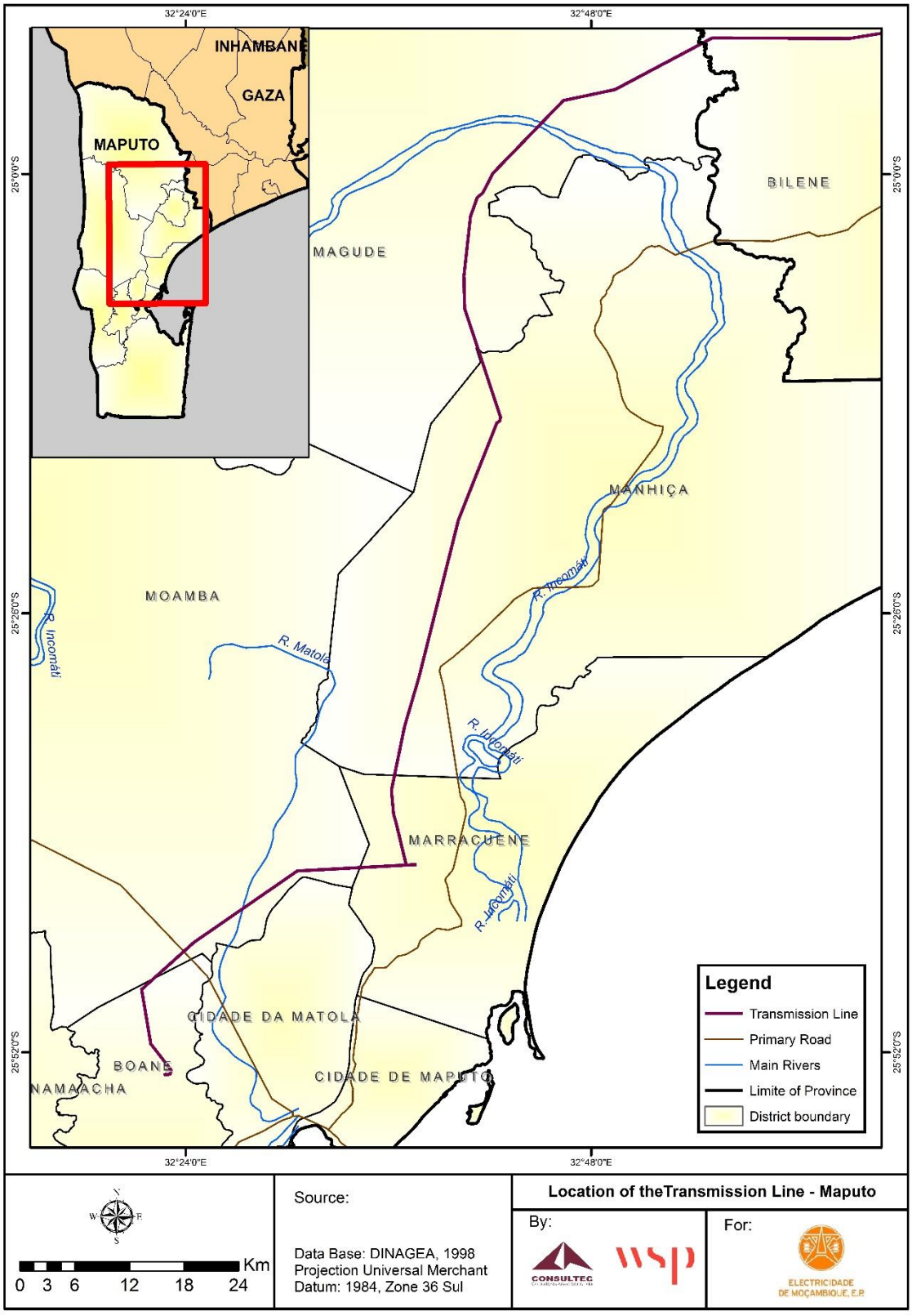


Figure 6.53 – Project alignment in Maputo Province

Districts, on the other hand, are governed by the District Administrators, supported by the Heads of Administrative Posts and Localities. **Table 6.26** below shows the organisational structure of the Province's Districts and Municipalities.

Table 6.26 – Structure of the Administrative and Traditional Authorities

Districts	District Administrator; Chief of Administrative Post; Chief of Locality; Traditional Leaders of: 1st Rank (Community Leader); 2nd Rank (Village Secretary); and 3rd Rank (Head of Block).
Municipalities	Mayor Councillors *Régulos* (traditional chiefs) Neighbourhood Secretaries Unit Secretaries Head of Block.

6.3.3.2 District Government

The District Government is led by the District Administrator, appointed by the Governor, and is comprised of the following functional areas of management and co-ordination: Administrator, Office of the Administrator and Permanent Secretary, Economic Activities, Planning and Infrastructure, Education, Youth and Technology, District Health, Women's and Social Welfare Service, District Directorate of the National Institute of Social Security, Public Civil Registry and Notary Office, and District Post of the Police. In addition to these institutions, State Information Services, Public Telecommunications Company, Civil Registry, Court and Administration of State Real Estate Assets fall under the District government.

In turn, the Administrator answers to the Provincial and Central Government for the District's various sectors and activities (District-level services). In terms of governance structure, the relevant formal leaderships include the Chief of the Administrative Post and the Chief of the Locality.

The communities' participation in government (traditional authorities) happens at a local level and is headed by local community leaders. These traditional authority structures are recognized by the state administration by Decree No. 15/2000, of 20 June, and Decree No. 11/2005, of 10 June. These decrees recognize the role of community leaders as the legitimate authorities within their respective communities. Thus, the village/community and locality chiefs are appointed by the government, whereas the traditional leaders "*Anciãos and Rainhas*" (Elders and Queens) are chosen by members of the clan, and the "*Régulo/Lider Comunitário*" (Senior Clan Ruler) traditionally inherits the position.

To allow the community to be more involved in decision making, the government introduced participatory district planning, based on the idea that local development decisions should be taken from the base. To facilitate this principle, Consultative Councils were created in the Administrative Posts and at the Locality level. These councils are involved in the annual planning process.

Figure 6.54 shows the District Authority hierarch, where the community chief reports to the community secretary, who reports to the *lider comunitário/régulo*, who reports to the Locality Chief, who reports to the Chief of the Administrative Post and this latter to the District Administrator.

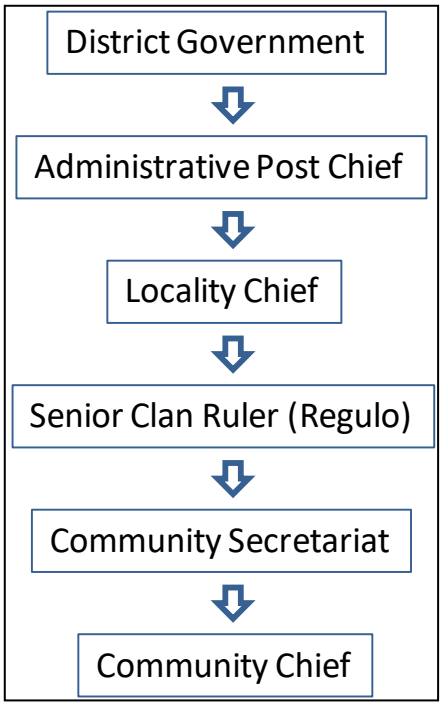


Figure 6.54 – District authority hierarchy

The Locality is comprised of communities and villages. The term "community" is used to define a village or, sometimes, groups of villages. At the community level, authority is exercised by various "community" authorities who can be the *bairro* (neighbourhood) secretaries, unit chiefs or *quarteirão* (block) chiefs, who in the peri-urban neighbourhoods are also assisted by community leaders. There are other structures that support both the secretaries and the traditional leaders in governing the neighbourhoods and these include the community police, the traditional doctors, community judges and community advisors who help the village leader solve conflicts which arises in the community. Nevertheless, these structures report directly to the *secretário da aldeia.*

The role of local authorities is to maintain social order and resolve community level social conflicts. The community leader is also responsible in attributing land to new community members, disseminating information to the community members, informing higher government authority about any conflict or issues in their community and implementing any project required by the government.

Participation of women in local government is generally low, especially at traditional authority levels. When the consultants asked local authorities why there were no women in government roles they said that women usually occupy different roles, like nurses, school teachers or secretaries at the administrative posts. This low level of women in government role may be linked to their level of education and to cultural practices.

6.3.3.3 Social Organizations

The social organization of the study area is basically routed on the political organization, as the community leaders are the most relevant focus of social organization at community level. Beyond that, the presence of other social organizations is residual. Of relevance, it is important to note only that all of the localities in the Project corridor claimed to have a member of the *Organização da Mulher Moçambicana* (Mozambicans Women's Organisation), which seeks the emancipation of the Mozambican women and promote gender equality. It should be noted that this organization is a branch of the Frelimo Party, although of a social nature.

6.3.4 Demographics

6.3.4.1 Province and Districts of Interest

According to INE (INE, 2017a, b, c), the projected population for Inhambane, Gaza and Maputo Provinces for 2016 was of 1 523 635, 1 467 951 and 1 782 380, respectively. **Table 6.27** below shows the projected population for the provinces and districts crossed by the alignment, including population density and gender distribution.

Table 6.27 – Projected population for 2016 for the provinces and districts of interest

Province / District	Total surface area (km^2)	Total Population	Population Density (inhabitant/km^2)	Female (%)
Inhambane	**68,775**	**1,523,635**	**22.2**	**55.5**
Vilanculos	5,867	164,264	28.0	54.5
Massinga	7,458	205,108	27.5	55.8
Funhalouro	15,678	48,735	3.1	54.9
Panda	6,857	52,446	7.6	56.2
Gaza	**75,334**	**1,467,951**	**17.5**	**54.5**
Chibuto	5,602	30,678	5.4	54.6
Mandlakaze	3,685	184,180	50.0	54.8
Chokwe	2,443	208,767	85.5	55.7
Bilene	2 719	173,276	63.7	54.5
Maputo	**22,693**	**1,782,380**	**78.5**	**52.0**
Magude	6,961	62,924	9.0	53.7
Manhiça	1,798	286,376	159	54.0
Marracuene	697	149,833	214	51.8
Moamba	4,577	69,612	15.2	51.6
Boane	804	160,789	199	51,6

Source: INE (2013).

As can be observed in **Table 6.27** above, Maputo Province has the highest population density of the three provinces of interest. The more densely populated district is Boane.

In terms of the population age structure, all three provinces and 13 districts follow a typical age pyramid structure for developing countries, with a large young population and low elderly population. **Table 6.28** below shows the age structures in the three provinces.

Table 6.28 – Age distribution in the Provinces of Inhambane, Gaza and Maputo

Province	Age in Years			
	0-4 (%)	5-14 (%)	15-64 (%)	>65 (%)
Inhambane	17	29.8	47.9	5.3
Gaza	17.1	29.9	48.7	4.3
Maputo	15.1	27.7	53.8	3.4

Source: INE (2017a, b, c).

6.3.4.2 Project RoW

As mentioned, the Project will cross 13 districts, of which 10 will have Project Affected People (PAP), i.e., people with houses or other buildings within the Project's RoW (100 m corridor centered in the line). A total of 415 households (HH) were identified within the RoW, of which it was possible to interview 310[6]. The table below shows the number of interviewed HH, per administrative unit. **Photograph 6.29** shows the heads of some of the interviewed HH, while **Photograph 6.30** illustrates the main dwellings of some of the interviewed HH.

Table 6.29 – Number of interviewed HH within the RoW, per administrative units

District	Administrative Post	Locality	Number of affected HH 0-25 meters Row	Number of affected HH 25-50 Row	Total Number of Affected HH
Bilene	Mazivila	Mazivila	3	7	10
Chokwe	Xilembene	Xilembene	5	4	9
	Lionde	Conhane	7	4	11
Chibuto	Changanine	Hate-Hate	2	-	2
	Godide	Chipadje	2	-	2
		Godide Sede	6	17	23
	Alto Changane	Alto Changane	1	-	1
Panda	Mawayela	Macavelane	2	2	4
Funhalouro	Funhalouro Sede	Mavume	4	3	7
Boane	Boane Sede	Boane Sede	1	-	1
	Matola Rio	Matola Rio Sede	35	10	45
		Mulotana	28	47	75
Moamba	Pessene	Pessene Sede	9	28	37
		Mahulane	20	-	20
	Tenga	Tenga	8	-	8
Marracuene	Marracuene Sede	Marracuene sede	19	11	30
Manhica	Maluana	Muluana	3	8	11
Magude	Magude	Maguiguana	3	11	14
Total			158	152	310

[6] Please note that this census will be confirmed and updated during the preparation of the final RAP, after the approval of the ESIA.

Photograph 6.29 – Heads of some of the HH interviewed along the Project route

Photograph 6.30 – Main dwellings of some of the HH interviewed along the Project route

The field work showed that a total of 1312 people reside in the houses that are within the Project RoW, this gives an average of 4.23 people per HH. This is lower than the national average, which is 4.3 people per HH (INE, 2009). It is important to point out that the majority of these HH are located in Maputo Province (see **Table 6.29**), where the alignment crosses areas with higher population density.

Even though the general population distribution by gender is relatively homogeneous, with 48.5% men and 51.5% women, the majority of interviewed HH are headed by men (66%). It was also found that 62% of the heads of HH are married and live with their spouses and respective children.

According to the census survey, out of the HH headed by women only 16% are married and the rest is widowed, separated, divorced or single. HH headed by a single parent of the female gender should be considered as vulnerable, due to local circumstances where women are usually economically disadvantaged.

Out of the HH headed by men, 5% mentioned having polygamous relationships. During the semi-structured interviews, it was reported that polygamy is accepted. In many occasions, polygamy is related to wealth, as men can only marry a second wife if he can afford to take care of both. Polygamy happens in all religions, and while it isn't possible to be legally married to more than one spouse (as per the Family Law, Law 10/2004), this practice is culturally accepted in Mozambique and it is not punishable by law. Polygamous weddings are performed following traditional ceremonies only, as they are not recognized by the state.

With regards to age structure, the census survey found that one head of HH was under 15 years of age (a 14-year old girl). It was verified that 83% of the head of HH are between 15 - 65 years old (economic active age) and 17% are above 65 years old. A head of HH over 65 years old is regarded as vulnerable as, in principle, they are no longer economically active and are therefore dependent on family members.

The census survey also showed that the age distribution of the people living with the RoW is very similar to that of the districts and province, where the majority of the population is young. This is to be expected, given the low life expectancy of Mozambique's population, which is below 45 years (INE, 2007). **Figure 6.55** below shows the age structure of the population living within the RoW.

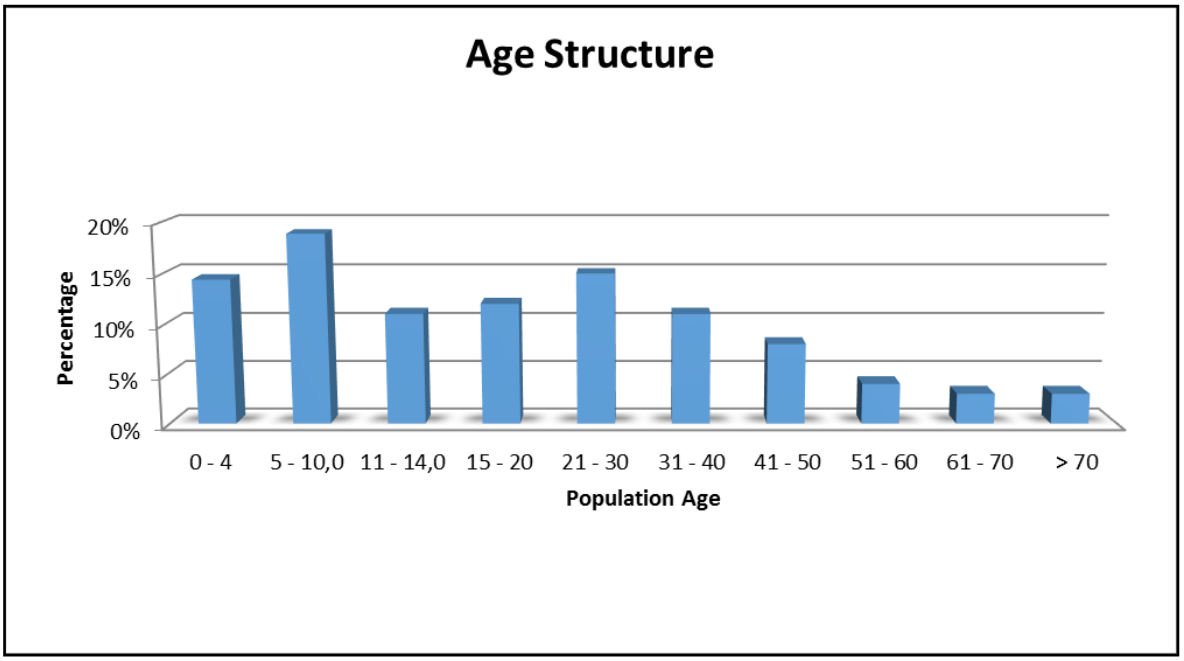


Figure 6.55 – Age structure of the population living with the RoW

According to the census survey, 46.2% of the PAPs are under 15 years of age and 5.1% are above 65, which means that 51.3% of the affected population (young and aged) are economically dependent of the other 48.7% (aged 15 – 65, considered as economically active).

6.3.5 Heritage and Culture

6.3.5.1 Province and Districts

The three main ethnic groups[7] in Inhambane Province are the Bitongas, Chopi and Chitsuas, although other ethnic groups are also present, in lesser numbers, as migrants from other regions of Mozambique. The main languages spoken locally are: Chopi, Bitonga and Chitsua (INE, 2013).

The four main ethnic groups in Gaza Province are the Changane, Tsonga, Chopi and Ronga. Gaza Province also has other ethnic groups due to the proximity with South Africa and Zimbabwe. The main languages spoken locally are Changane, Tsonga, Chopi and Ronga.

The main ethnic group in Maputo Province is the Tsonga. As Maputo Province is the main economic and financial centre of Mozambique, it has become an attractive centre for people seeking employment and better opportunities. Thus, there is a great diversity of ethnic groups such as Changane, Chope, Bitonga, and nationalities, such as Portuguese and South Africans, among many others. The main languages spoken in Maputo are the Tsonga, Changane and Portuguese. Other spoken languages include Chopi, Bitonga and Xitswa, reflecting the multi-ethnic diversity.

The districts of interest follow the same trend of their province. **Table 6.30** below shows the main language spoken in each district, apart from Portuguese.

Table 6.30 – Main languages spoken in the Provinces and Districts of interest

Province and District	Languages
Inhambane	**Bitonga, Chopi and Chitsua**
Vilanculos	Chopi
Funhalouro	Chopi
Massinga	Chopi
Panda	Chopi
Gaza	**Changane, Chopi and Tsonga**
Bilene	Tsonga
Chokwe	Tsonga and Changane
Chibuto	Tsonga
Mandlakaze	Tsonga
Maputo	**Tsonga, Changane, Chope, Bitonga and Chitsua**
Boane	Changane
Moamba	Changane
Marracuene	Ronga

[7] Note that Mozambican ethnolinguist groups do not qualify as Indigenous Peoples, as understood under WB OP 4.10, as they do not meet the defining criteria stated in OP 4.10. Namely, Mozambican ethnolinguistic groups do not possess a collective attachment to geographically distinct areas nor do they have customary cultural, economic, social or political institutions that are separate from a mainstream society.

Province and District	Languages
Manhica	Changane
Magude	Changane

Source: INE (2013).

This multi-ethnicity is also manifested in the great diversity of religious affiliations in the three provinces and 13 districts. Christianity (including several different traditions) and Islam are the two major religions. **Table 6.31** below shows the main religions practiced in the three provinces.

Table 6.31 – Main religions practiced in the provinces of interest

Religion	Inhambane Province (%)	Gaza Province (%)	Maputo Province (%)
Christianity (Catholic)	35.8	35.8	39.8
Christianity (Anglican)	24	24	16.5
Islam	9.8	9.8	16.9
Christianity (Zion)	15	15	13.8
Christianity (Evangelic)	11.7	11.7	8.5
No religion	1.7	1.2	2.5
Other religions	1.9	1.9	1.2
Unknown	0	0.6	0.7
Total	100	100	100

Source: INE (2013).

6.3.5.2 Project RoW

Most HH living within the Project's RoW belong to the Changane ethno-linguistic group (64%). This reflects the fact that the majority of these HHs are located in Maputo Province. Only 28% of interviewees mentioned Portuguese as the main language spoken in the HH. Other languages spoken are Chopi and Chitsua. During the semi-structured interviews with local leaders, it was revealed that the most spoken language among the communities was Changane. The only exception was the locality of Mavume, where it was reported that the main language was Chitsua.

With regards to daily activities, the management of HH property and assets is usually under the responsibility of the man, even though they also participate in agriculture, cattle breeding, house construction and marketing activities such as the sale of traditional beverages.

Women are generally responsible for HH chores (cooking, fetching water, washing and caring for the children) and most agriculture activities (land clearing, sowing, weeding, harvesting and processing of agriculture commodities). Women are also responsible for HH organization.

The elders are, in general, responsible for teaching the new generations about cultural habits, social practices, traditions, stories, and for conducting initiation rites, with men dealing with boys and women dealing with girls.

In terms of religion, the HH living within the Project RoW differ from the pattern described for the rest of the districts and provinces, with a greater number of evangelic practitioners (34%), followed by

Zionist (33%) and Catholics (12%). The semi-structured interviews showed the same trend as the census: local leaders stated that the most practiced religion in their localities was Zionism. Five religious temples were identified within the RoW. **Photograph 6.31** shows two Zion churches located within the Project RoW, both located in Moamba District, Maputo Province.

Photograph 6.31 – Zion churches located within the Project RoW (Moamba District)

In what regards traditional practices, ceremonies to ask for rain and for the protection of the family are good examples of current traditional practices. These rites are performed by community leaders, secretaries of neighbourhoods, religious leaders, elders and traditional healers.

In the semi-structured interviews, it was stated that all localities crossed by the Project have a traditional sacred place. None of these sacred places are located within the RoW.

In what regards to cemeteries, during the field work, it was reported that is common for families to bury their dead within the house plot or in family cemeteries. The field work shows that in total 18 cemeteries are within or very near the Project RoW, of which 16 are family cemeteries or graves and two are communal cemeteries. **Figure 6.56** shows the location of these cemeteries.

6.3.6 Education

6.3.6.1 Provinces and Districts of Interest

The Education system in Mozambique follows the structure below:

- Primary Education Stage 1 (EP1), which includes 1st to 4th grade;
- Primary Education Stage 2 (EP2), which includes 5th to 7th grade;
- Secondary Education Level 1 (ESG1), which includes 8th to 10th grade;
- Secondary Education Level 2 (ESG2), which includes 11th to 12th grade;
- Technical or professional education, taught at technical schools and institutes, offering courses covering three major areas (industrial, commercial and agricultural education) at elementary, basic and medium levels; and
- Tertiary Education – University and higher degrees.

Table 6.32 shows the education facilities in the provinces and district of interest. The education system in the Provinces of Inhambane, Gaza and Maputo and the 13 districts of interest follows the same trend as the rest of the country, with a focus on Primary Education as illustrated by the significantly larger number of primary education facilities in comparison with secondary.

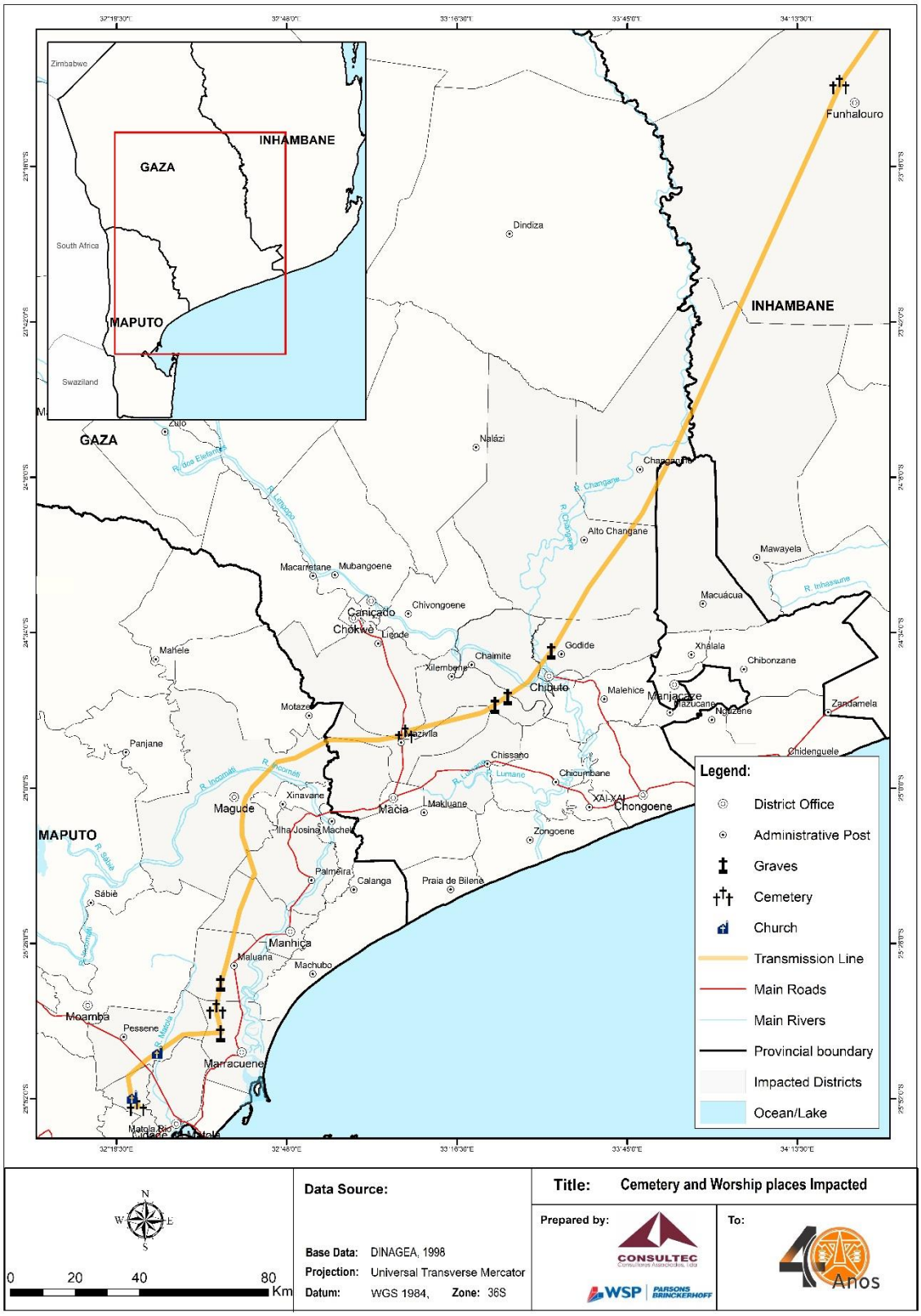


Figure 6.56 – Cemeteries, graves and churches located within or near the Project RoW

Table 6.32 – Education facilities in the provinces and districts of interest

Province / District	EP 1	EP 2	ESG 1	ESG 2
Inhambane	**777**	**555**	**55**	**29**
Vilanculos	73	46	5	3
Funhalouro	38	23	2	0
Massinga	114	94	6	2
Panda	43	24	2	0
Gaza	**720**	**347**	**73**	**36**
Bilene	85	33	9	2
Chokwe	85	47	12	4
Chibuto	116	36	7	3
Mandlakaze	106	60	10	6
Maputo	**438**	**338**	**97**	**50**
Boane	57	53	13	7
Moamba	68	30	4	4
Marracuene	42	31	7	5
Manhica	92	59	9	6
Magude	64	33	2	2

Source: INE (2013).

As it can be observed from the table above, the Province of Maputo has the largest number of ESG 2, having an average of one school per 453 km^2. By comparison, Inhambane and Gaza Provinces have much lower numbers of ESG 2 schools, with averages of one school per 2 371 km^2 and one school per 2 092 km^2, respectively. This means that pupils in the Provinces of Inhambane and Gaza have to travel long distances to be able to access secondary level education. As a result, it should be expected that the population in these provinces has a lower education level, when compared with Maputo Province.

6.3.6.2 Project RoW

When looking at education facilities near the Project RoW, all the localities crossed by the Project stated having at least one primary school. Only the locality of Tenga, in Moamba District, mentioned having a secondary school. **Photograph 6.32** illustrates schools located in localities crossed by the Project. No school is located within the Project RoW.

Photograph 6.32 – Zilinga Primary School (left) and Nhambi Primary School (right)

During the semi-structured interviews with local leaders, it was mentioned that usually the pupil have to walk to the district capital to access secondary education. **Table 6.33** below lists the names of the secondary schools which are attended by the people residing within the Project RoW.

Table 6.33 – Secondary Schools attended by the people living within the RoW

Name of Secondary School	District	Province
Mazivila Sede Secondary School	Bilene	Gaza
Mahulane Secondary School	Moamba	Maputo
ChilembeneSecondary School	Chokwe	Gaza
Mazivila Secondary School	Bilene	Gaza
Vila da Manhiça Secondary School	Manhiça	Maputo
Tenga Secondary School	Moamba	Maputo
Tenga Sede Secondary School	Moamba	Maputo
Mulotana Bile Secondary School	Boane	Maputo
Moamba Technical School	Moamba	Maputo
Djuba Secondary School and Djuba Technical School	Boane	Maputo
Mavume and Funhalouro Secondary School	Funhalouro	Inhambane
Malhapsene Secondary School	Município da Matola	Maputo

Secondary schools can be a good source of labour for the Project, as many students seek for employment once they finish high school.

In general, it was found that the education level of the population potentially affected by the Project is quite low, as shown in the following **Table 6.34**. This fact makes the population potentially more vulnerable to Project induced negative impacts.

Table 6.34 – Education level of the people living within the RoW

Age	Primary	Secondary	Technical	University	None	Minor	Other
0 - 4	2%	0%	0%	0%	34%	63%	2%
5-10	33%	0%	0%	0%	42%	24%	1%
11-14	66%	0%	0%	0%	27%	7%	0%
15-20	77%	8%	0%	0%	11%	4%	0%
21-30	59%	20%	3%	1%	12%	1%	1%
31-40	45%	15%	3%	1%	30%	3%	3%
41-50	35%	5%	5%	1%	50%	3%	1%
51-60	39%	0%	6%	4%	43%	6%	2%
61-70	39%	4%	2%	0%	53%	2%	0%
> 71	57%	0%	4%	0%	39%	0%	0%

When analysing the education levels of the heads of HH, it was found that a high percentage are illiterate (32%); 51% attended the 1st level primary education, 9% said they attended secondary education and only 0.7% mentioned they attended university. From the data analysis, it was concluded that the female heads of HH had, in average, a lower level of education, when compared against male heads of HH. Looking at **Figure 6.57** below, it can be concluded that this leads to HH

led by women being more vulnerable, given that with a low education level, women will face difficulties in finding formal employment.

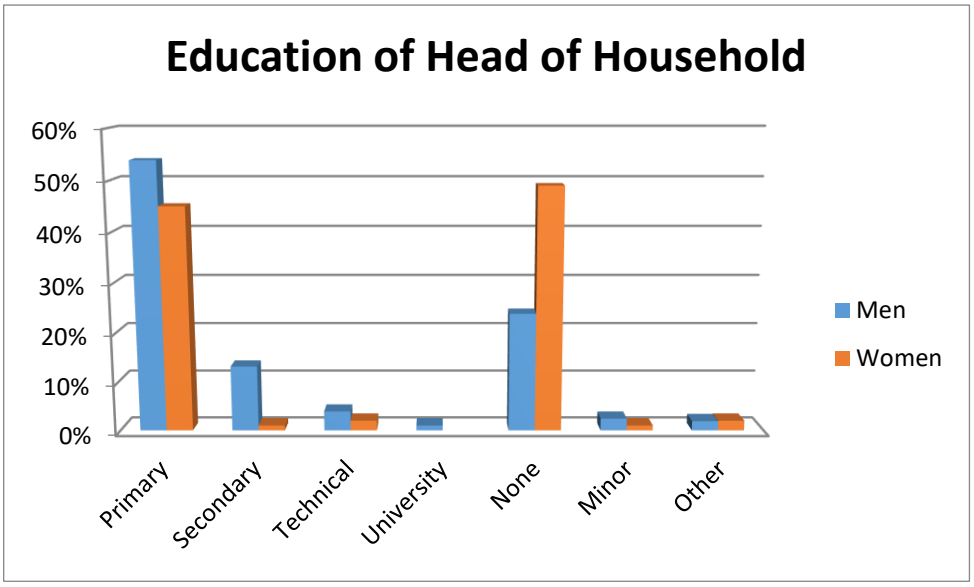


Figure 6.57 – Education level of the head of HH, by gender

6.3.7 Health

6.3.7.1 Provinces and Districts of Interest

The health sector in Mozambique focuses on primary healthcare services, and is characterized by various types of health facilities including community health facilities, health posts, health centers (urban and rural) and hospitals (district, rural, provincial and central), each offering different types of services. It is important to note that some facilities are better equipped than others, depending on location and the number of people served.

According to INE (2013), in 2012 Inhambane Province had a total of 125 sanitary facilities, of which one was a Provincial Hospital, four were Rural Hospitals, 10 were health posts and 110 were health centers. This equals one health facility per 602 km^2 and 12 189 inhabitants. In terms of number of beds, Inhambane province has 1.1 beds per 1 000 inhabitants. Within the district of interests which are located in Inhambane Province, only Vilanculos is equipped with a Rural Hospital, the rest of the districts are equipped with health posts and health centers.

The province of Gaza had 128 health facilities in 2012 (INE, 2013), namely one Provincial Hospital, four Rural Hospitals, 29 health posts and 94 health centers. This equals one health facility per 288 km^2 and 11 468 habitants. Gaza province has 1.4 beds per 1 000 inhabitants. Within the districts of interest which are located in Gaza Province, only Chokwe is equipped with a Rural Hospital, the rest of the districts are equipped with health posts and health centers.

Still according to INE (2013), Maputo Province has a total of 85 health facilities, namely one provincial hospital, one general hospital, one rural hospital, one district hospital and 73 health centers. This represents that there is one health facility per 266 km^2 and 20 969 inhabitants. In terms of number of

beds, Maputo province has an average of 0.8 bed per 1000 inhabitants. Within the districts of interest which are located in Maputo Province, only Manhiça is equipped with a Rural Hospital, the rest of the districts are equipped with health posts and health centers. It is important to note that due to the proximity of the districts of interest, many people access the health facilities in Matola and Maputo city, where the hospitals are better.

6.3.7.2 Project RoW

Health Units

When looking at the health facilities near the Project RoW, eight localities stated having a health centre, meaning that population do not have to walk long distances to access health services. No health centre is located within the RoW. **Photograph 6.33** shows the health centre in Tenga.

Photograph 6.33 – Tenga Health Centre

During the census survey, 97% of the PAP stated that they go to the nearest health centre when someone in the HH is sick. 3% said they prefer using traditional medicine. **Table 6.35** below lists some of health centres used by the population living within the RoW.

Table 6.35 – Health Unit used by the Population residing within the RoW

Name of Health Unit	District	Province
Chiaquelane Health Center	Chokwe	Gaza
Alto Changane Health Center	Chibuto	Maputo
Boquisso Health Center	Marracuene	Maputo
Marracuene Sede Health Center	Marracuene	Maputo
Chamankulo Health Center	Maputo Municipality	City of Maputo
Mulotana Health Center	Boane	Maputo
Mavume Health Center	Funhalouro	Inhambane
Chalacuane Health Center	Chokwe	Gaza
Changanine Health Center	Chibuto	Maputo
Chibuto Health Center	Chibuto	Maputo
Chokwe Rural Hospital	Chokwe	Gaza

Name of Health Unit	District	Province
Matola Provincial Hospital	Matola Municipality	Maputo
Funhalouro Health Center	Funhalouro	Inhambane
Maputo Central Hospital	Maputo Municipality	Maputo City
Mahulane Health Center	Moamba	Maputo
Marracuene Health Center	Marracuene	Maputo
Mazivila Health Center	Bilene	Gaza
Tenga Health Center	Moamba	Maputo
Zimpeto Health Center	Maputo Municipality	Maputo City
Malhangalene Health Center	Maputo Municipality	Maputo City
Matalane Health Center	Marracuene	Maputo
ICOR	Maputo Municipality	Maputo City
Magude Health Center	Magude	Maputo
Matola Unidade D Health Center	Matola Municipality	Maputo
Moamba Health Center	Moamba	Maputo
Mozal Health Center	Boane	Maputo
Beleluane Health Post	Boane	Maputo

Household Health

The census survey showed that the most common diseases among the HH living within the RoW in the last 12 months were: malaria, tuberculosis, asthma, diarrhoea, cholera, STD, HIV/AIDS. All affected communities show the same pattern, with no significant deviation. The survey showed that 23% of the head of HH stated having a HH member with a chronic illness. Chronic illness usually is a taboo subject among the population, but during the survey some people revealed that they had a HH member with HIV.

Figure 6.58 below shows the social infra-structure located within or near the Project RoW.

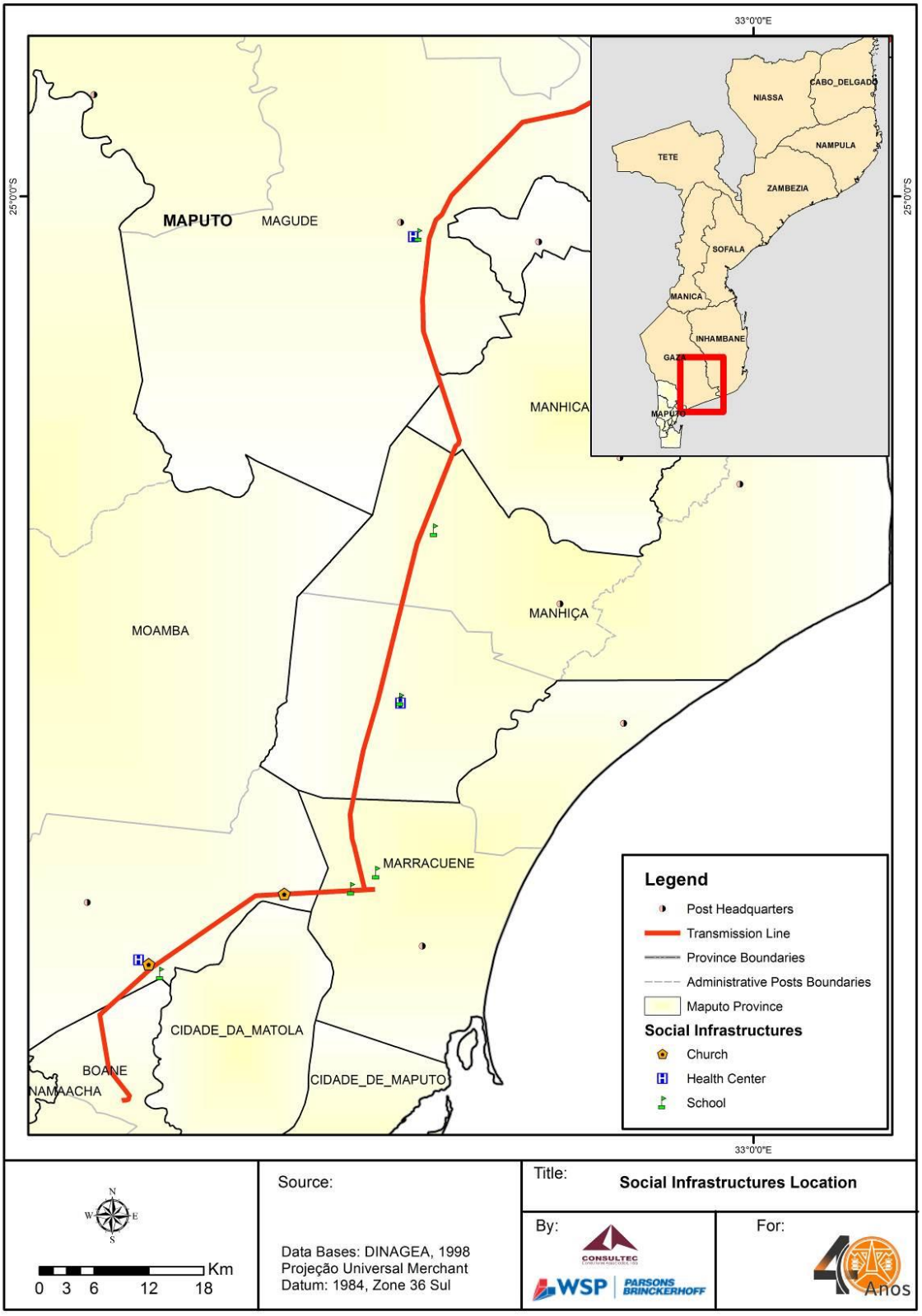


Figure 6.58 – Social infrastructure near the Project RoW

6.3.8 Basic Services and Infrastructure

6.3.8.1 Province and Districts of Interest

Energy, Water and Sanitation

In urban and peri-urban areas in the Provinces of Inhambane, Gaza and Maputo and the districts of interest, electricity is the main source of energy and is supplied by *Electricidade de Moçambique, E.P.* (EDM), whilst water is supplied by *Águas de Moçambique* (AdeM). In the rural areas, the main source of water is usually from public taps/standpipes (*fontanários*) that are connected to the general water supply network, as well as boreholes, open wells and rivers and lagoons.

With regards to sanitation, the urban and peri-urban areas have a system of individual family septic tanks. In more rural areas, the majority of the population uses latrines or open air defecation. **Table 6.36** below summarizes basic water, sanitation and energy services in the provinces of interest.

Table 6.36 – Basic Services in Inhambane, Gaza and Maputo Province in 2007

Basic Services	Inhambane Province (% HH)	Gaza Province (% HH)	Maputo Province (% HH)
Water			
Tap water inside the house	1.0	1.7	5.5
Tap water outside the house	3.9	10.7	32.1
Public taps	6.7	20.4	19.1
Protected wells	23.1	22.5	13.4
Non protected wells	49.0	31.4	20.8
River/Lake/Lagoon	9.0	10.4	7.1
Rain	6.5	2.0	0.2
Mineral	0	0	0
Other	0.7	0.9	1.8
Sanitation			
Septic tank	1.2	2.2	10.6
Improved Latrine	4.6	10.3	18.8
Traditional improved latrine	10.1	11.2	14.4
Traditional latrine	51.2	47.0	43.7
None	32.8	29.2	12.5
Energy			
Electricity	4.9	12.3	29.3
Generator	0.8	0.5	0.4
Gas	0	0.1	0
Petroleum/Paraffin	76.0	65.6	59.9
Candles	6.2	14.1	8.1
Battery	1.2	0.4	0.3
Wood	10.0	6.4	1.6
Other	1.0	0.7	0.3

Source: INE (2013).

It is important to note that the districts of interest follow the same trend as their respective provinces.

Solid waste management (collection, treatment and disposal) is inadequate and is mainly concentrated in the municipalities. This is particularly evident outside the more urban areas and contributes to the prevalence of malaria, diarrhea and cholera in the area.

Transport, Access Roads and Communication

The Provinces of Inhambane, Gaza and Maputo present an adequate road network. Inhambane and Maputo also have air and maritime transport infrastructure. According to the National Administration of Roads (ANE), the road networks of the Provinces of Inhambane, Gaza and Maputo have a total length of 2 877 km, 2 711 km and 2 415 km, respectively. **Table 6.37** below shows the road network in the provinces crossed by the Project alignment.

Table 6.37 – Road network of Inhambane, Gaza and Maputo Provinces

Road	Length (km)		
	Inhambane Province	Gaza Province	Maputo Province
Primary	558	280	322
Secondary	266	752	170.7
Tertiary	1,168	1101	1 383
Vicinal	885	578	539
Total	2 877	2711	2 415

Source: ANE (2014).

The road network provides the link between towns and the interior of the Provinces, thereby facilitating the flow of goods and products from production areas to markets, and also the movement of people and transport to/between tourist areas. Public transport is mainly provided by minibus taxis (*chapas*) and buses. Most of the population uses these means of transport. There are also a few boats that provide the same services via sea and fluvial navigation.

In terms of telecommunications, all districts are serviced by both landline and mobile networks. The landline and mobile network also provide internet services. These provinces also have access to radio and the main urban areas are also covered by open access and cable television services.

6.3.8.2 Project RoW

Energy, Water and Sanitation

Water supply in the Project RoW is precarious, following the same trend as the district and province, with 31% of the PAP getting their water from boreholes. The field work showed that 12% of the HH have boreholes within their plots and 13% get water from rivers. During the semi-structured interviews, it was reported that all localities have boreholes, but many of them are not in working conditions. During the field work, three boreholes which are within the Project RoW were identified. **Figure 6.59** below shows the main sources of water used by the population living within the RoW.

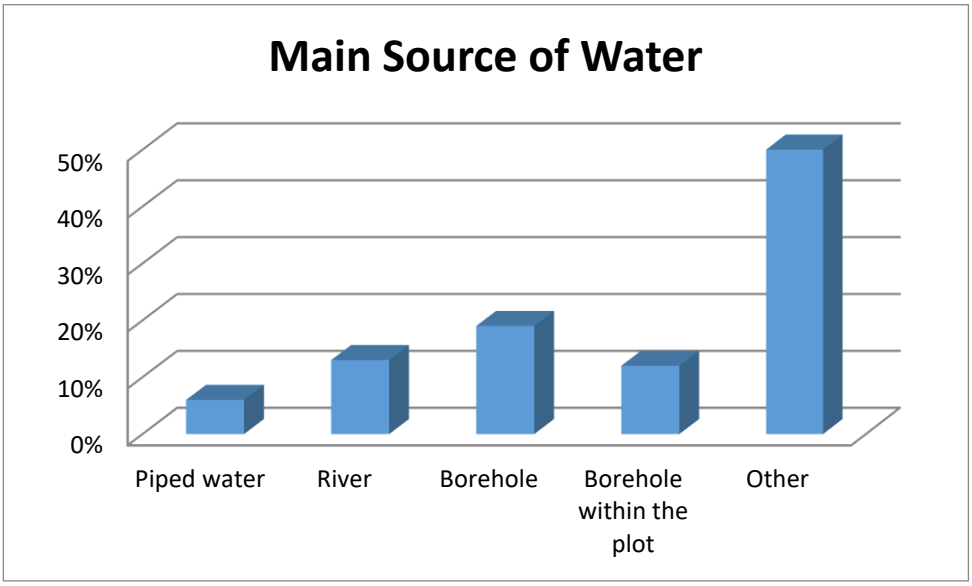


Figure 6.59 – Main sources of water used by the people living within the Project RoW

In what regards water quality, 75% of the interviewees do not treat water prior to using it, 18% boil water, 7% use chlorine (*certeza*). Poor water quality is associated with some diseases like diarrhea and cholera. **Photograph 6.34** shows water sources used by the population.

Photograph 6.34 – Protected borehole (left) and public tap (right)

With regards to sanitation, the fieldwork revealed the 26% of the HH within the RoW do not have any type of sanitation facilities, 52% have traditional latrines and 17% have improved latrines within their plot. This means that 26% of the population practice open air defecation, which is also a contributor to diseases like the ones mentioned above. **Photograph 6.35** shows the type of sanitation found in the houses within the Project RoW.

With regards to waste collection, the surveyed localities do not benefit from any formal waste collection system. Most HH burn (57%), bury or throw (41%) the waste on the yard. Currently, this situation is not of much concern as the waste produced in the communities is reduced and the type of waste generated is mostly organic (i.e. food waste, agriculture commodities waste, fruit peel, grass, among others). However, non-organic waste from consumption of commercial products in packages and containers (bottles, packages, plastics) was observed. Generally, these packages and containers are re-utilized.


Photograph 6.35 – Type of sanitation in the houses within the Project RoW

With regards to electricity, the census survey showed that only 7% of the population living within the RoW are connected to electricity from EDM. Energy sources used by the HH to illuminate the house include candles (17%), kerosene (20%) and torches (19%). For cooking, the main sources of energy are fire wood (72%) and charcoal (15%).

The semi-structured interviews showed that only the localities of Pessane, Boane Sede, Matola Rio Sede, Mulatona and Mazivila are connected to the EDM electricity network. The most often asked question by the population and by the local leaders, were if their communities would be connected to electricity, as a result of the STE Project.

The collection of firewood and water is usually the women's responsibility, under the HH daily activities. It is common for young girls have to drop out of school to fulfil these daily activities.

Communications and Transport

During the fieldwork it was observed that most of the affected communities are covered by the signal of the three mobile networks. When the HH were asked what the main way of receiving and giving information was, the majority stated the local leader and cell phones. The survey also showed that 86.1% of the HH have at least one cell phone.

With regards to television, 31.3% of the population claimed to have one. It is important to note that the majority of these HH are located in Maputo Province, where they can get TV signal.

In terms of transport, it was reported that most of the population walked, as their main form of transport. The surveyed revealed that 11.6% of the HH living within the RoW have a bicycle. Also 10.0% of the HH stated that they own a car. During the same semi-structured interviews, it was stated that usually the people use public transport (*chapa 100*) when they want to travel to other places. Field observations indicate that most of the road network near the RoW is in poor conditions.

6.3.9 Housing

6.3.9.1 Provinces and Districts of Interest

According to the 2007 national census, most of the houses in the provinces of Gaza and Inhambane and districts of interest are built from precarious materials. Maputo Province shows a different scenario, where most of the houses are built with conventional materials. The precarious houses are

more common in rural settings, where the population use local materials to build their dwellings. This type of housing is vulnerable to natural disasters, like heavy rain or strong winds. Due to the nature of this type of precarious construction, it is standard for these houses to be periodically rebuilt or replaced, sometimes in a period of every five years.

The process of building the houses is a part of the local customs: usually the men build the walls, and the women "plaster" them with adobe. **Table 6.38** below shows the materials used in house construction in the three provinces. The districts of interest follow the same trend as the provinces.

Table 6.38 – Main construction materials used in dwellings in the Provinces of Inhambane, Gaza and Maputo in 2007

Material	Inhambane Province (%)	Gaza Province (%)	Maputo Province (%)
Walls			
Cement Block	12.8	19.1	55.2
Ceramic Bricks	0.2	0.8	5.0
Wood/Zinc	4.0	3.1	1.9
Adobe Blocks	0.7	2.4	0.4
Wood	60.6	50.1	32.0
Wood and mud	20.9	24.1	4.9
Paper and Plastic	0.3	0.2	0.2
Other	0.4	0.3	0.3
Roof			
Concrete	0.7	0.6	3.4
Roof Tile	0	0.8	1.0
Lillarite	1.3	1.9	2.4
Zinc	37.2	60.9	83.2
Thatch	59.7	34.8	8.6
Other	1.1	0.9	1.4
Paving			
Wooden	0.2	0.3	1.6
Marble/Granite	0.1	0.1	0.2
Cement	34.8	47.1	68.2
Tiles	0.4	0.7	2.6
Adobe	54.0	40.7	15.5
Nothing	9.9	10.3	11.6
Other	0.6	0.9	0.4

Source: INE (2013).

6.3.9.2 Project RoW

When looking at the typology of the HH dwellings within the Project RoW, the field work showed that on average there are four residential structures per HH, including generally one main house and exterior auxiliary buildings that can include a kitchen, bedroom or latrine, in particular in more rural

HHs. **Photograph 6.36** below shows the typical infra-structures found in a rural HH (the photograph shows the main dwelling and the auxiliary buildings of the HH). Additional pictures of main dwellings within the RoW are provided in section 6.3.4.2 above (see **Photograph 6.30**).

Photograph 6.36 – Typical infra-structure in a HH

The census survey showed that in what regards the main dwelling of each HH, the majority in the survey area has been constructed with conventional materials. The construction materials of the houses follow a same trend as Maputo Province, this is because most of the affected houses are within Maputo Province. It was observed that in more remote areas, in Inhambane and Gaza provinces, the houses are built with precarious material. **Table 6.39** below shows the materials used in the construction of houses located within the Project RoW.

Table 6.39 – Material used in the construction of the main house

Material used on the wall	**% of HH**
Reed or stick	28.2%
Stick and clay	2.6%
Brick without plaster	0.6%
Cement blocks with plaster	7.1%
Cement blocks without plaster	43.4%
Masonry house with plaster	5.5%
Masonry house without plaster	4.5%
Other	8.1%
Material used on the roof	**% of HH**
Grass	7.1%
Zinc	88.7%
Slab	0.3%

Roof tile	0.3%
Other	3.6%
Material used on the floor	**% of HH**
Clay	22.0%
Adobe	1.3%
Cement	74.8%
Tile	1.6%
Other	0.3%

The fieldwork showed that most houses were built within the last 10 years. The local leader in localities of Pessane and Matola Rio-Sede reported that many news houses are being built in those areas in the last few years. One reason for people to choose to move to those localities is the increase in demand for land in the city of Maputo and Matola, so people chose to move to the outskirts were more land is available at a cheaper price.

One affected HH in the Pessane locality stated that he sold his house near the airport in Maputo City and moved there, stating that with the money he got from the sale, he built a house with better conditions. The same person stated that many people in the Maputo City are also selling their houses and moving to the outskirts of the city.

One sign that people are moving outside the Maputo and Matola city is that during the field work, it was observed that many houses are being built in Pessane, Matola Rio-Sede, Boane-Sede and Mulatona Locality. **Photograph 6.37** below shows houses being built within the Project RoW.

Photograph 6.37 – Houses under construction within the Project RoW

Even though many new houses are being built, the field work showed that 63% of the interviewed HH do not have property ownership title, meaning that they have customary land rights.

When looking at the size of the main house, the fieldwork revealed that the majority of the main structures is smaller than 70 m^2. Only 32% of the affected of the main structures have a size greater than 70$m^{2.}$ **Figure 6.60** below shows the size of the main houses located within the RoW.

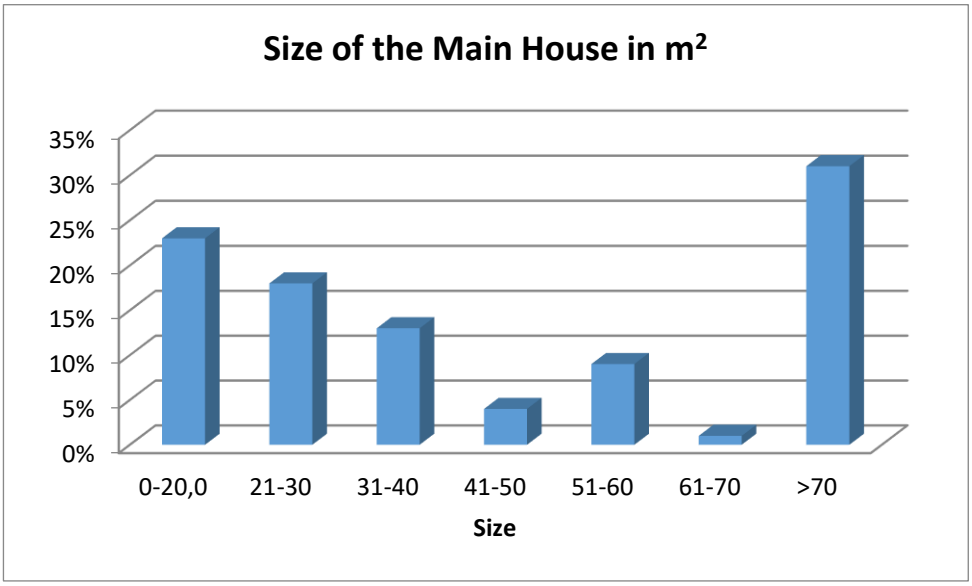


Figure 6.60 – Size of the main house of the HHs within the Project RoW

6.3.10 Economic Activities

6.3.10.1 Provinces and Districts of Interest

In the provinces and districts of interest, as in the rest of the country, the most important economic activity is agriculture. Most of the Mozambican population is dependent on subsistence farming for their survival. Other economic sectors in the provinces include fishing, tourism and industry. In recent years, the natural resources sector has being increasing substantially with the natural gas exploration in Vilanculos District, Inhambane Province, and the heavy sands prospection in Chibuto District, Gaza Province.

There is no data regarding the average incomes of the population, either at province or district level. **Table 6.40** shows the Mozambican minimum salary per month per sector.

Table 6.40 – Minimum monthly salary, per sector

Sector	Minimum Salary (MZN)	Minimum Salary (USD)
Agriculture	3,642.00	60.70
Industrial and Semi-Industrial Fishing	4,615.00	76.91
Mining	6,963.00	116.05
Quarries	5,200.00	86.66
Salta Pans	4,734.00	78.90
Manufacturing	5,695.00	99.41
Bakeries	4,335.00	72.25
Electricity, Gas and Water (large companies)	7,288.00	121.46
Electricity, Gas and Water (small and medium companies)	6,002.00	100.03
Construction	5,436.00	90.60
Non-Financial Industry	5,525.00	92.08
Hotel Industry	5,328.00	88.8

Sector	Minimum Salary (MZN)	Minimum Salary (USD)
Financial	10,400.00	173.33
Micro-Finance	9,240.00	154.00
Public Administration	3,996.00	66.60

Note: 1 USD = 60 MZN.

Fishing

Fishing in Inhambane, Gaza and Maputo Province, namely in the coastal districts, is mainly practiced by semi-industrial and artisanal fishing. Artisanal fishing is local in character, using small vessels (< 10 m long) or no vessels at all. These artisanal vessels are propelled by oar, sail or small outboard or inboard motor. Fishing occurs year-round with the exception of the closed period, proclaimed by the Sea, Interior Waters and Fishing Ministry, from January to February each year. In general, this type of fishing constitutes one of the main subsistence activities of the population living along Inhambane, Gaza and Maputo Province's coastal areas, with many families depending on this activity for survival and as a source of protein and income (MAE, 2005).

According to the Marine Fishing General Regulation, semi-industrial fishing is carried out by vessels that can operate within Mozambique's territorial waters, up to 3 miles offshore, while industrial vessels can operate more than 3 miles offshore without restrictions, except in specific cases (Fishing Ministry, 2004). The two main types of semi-industrial fishing are shrimp fishing and line fishing (from Ponta Dobela, all the way up to Sofala Bank in Sofala District). Semi-industrial trawling for shallow water shrimp occurs from March to December.

Agriculture

Agriculture also constitutes one of main economic activities in Inhambane, Gaza and Maputo Province and in all districts of interests. The main subsistence crops grown by the population are maize, beans and cassava. The main cash crops are rice, coconuts and sugar cane.

Gaza and Inhambane Province also benefit from large industrial agriculture plantations, especially sugar cane in the Maragra and Xinavane Plantations. The province of Gaza also benefits from rice fields, particularly in Xai-Xai and Chokwe Districts. Gaza and Inhambane also have large coconut and cashew plantations which are explored by the family sector.

According with INE (2013), Inhambane, Gaza and Maputo had 69, 102 and 188 large farms respectively in 2007. **Table 6.41** below shows the number of small, medium and large scale farm in the Provinces crossed by the Project alignment.

Table 6.41 – Farms in Inhambane, Gaza and Maputo Province in 2007

Size of Farms	Inhambane Province		Gaza Province		Maputo Province	
	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)
Small and medium	269,241	413,883	216,583	357,364	112,587	132,286
Large	69	1,004	188	7,003	102	1,004

Source: INE (2013)

Livestock production involves cattle, pigs, goats, sheep and chicken and it is mainly farmed by the family sector.

Industry and Commerce

In terms of the industrial sector, Maputo Province is the most industrialized of the three provinces of interest. Of note is the Beluluane Industrial Park (BIP), located in Boane District, where the Mozal aluminum smelter, a cement factory, a cereals factory and others are located. The 700 ha BIP and Free Zone complex is considered the main industrial zone in the country and aims to become the premier location in Southern Africa for export-oriented businesses. The main sectors present in the Matola area include the food and construction sectors, with well over 30 factories in the area. **Photograph 6.38** shows Industrial Facilities in Maputo Province.

Photograph 6.38 – Industrial facilities in Maputo Province

Inhambane province has the largest operational gas production project in the country. This is explored by the South African multinational Sasol with its own Central Processing Facility in Temane, producing about 183 million gigajoules (Matsinhe, 2013). Sasol has been in Temane, District of Inhassoro District, since 2004, from where a pipeline connects that point in Mozambique to Secunda, in neighbouring South Africa, along a distance of 865 kilometers (Matsinhe, 2013).

The industrial sector in Gaza Province is still incipient, when compared with Inhambane and Maputo. Its main activities are mainly small factories located in Chokwe and Xai-Xai City. Gaza Province has a planned large mining project, to explore heavy sands in the Chibuto District[8], which would increase the industrial production in the Province.

In terms of commerce, the activities in Inhambane, Gaza and Maputo Provinces are mainly concentrated in the municipalities. In the rural areas the commercial activities are mainly based on the trading of agricultural products produced primarily at the HH level. In Inhambane Province the main commercial zone is Maxixe City, where in Gaza Province is Xai-Xai City and in Maputo Province in Matola City.

[8] The term "heavy sands" refers to concentrations of heavy minerals in an alluvial (old beach or river system) or aeolic sand deposits. A mining operation can be developed in order to extract these heavy minerals from the sand deposits, through adequate processing methods.

Tourism

Tourism activities have increased in Mozambique in the last few years. The beaches along the cost of the Inhambane, Gaza and Maputo are very sought by local tourism and international tourists (MAE, 2005). Many people visit these coasts because of its beaches, practicing water sports such as fishing. Inhambane Provinces is famous for having one of the largest archipelagos in the country (the Bazaruto archipelago). Inhaca Island in Maputo Province is also located on the route of a number of cruise-liners. This industry is responsible for employing many local people to work in hotels, restaurants and bars.

6.3.10.2 Project RoW

Regarding the economic activities practiced by the population living within the Project RoW, the census survey showed that a large number of the heads of HH are farmers (33.3%). Other occupations such as construction worker, housekeeper, guard, commerce were also mentioned. When the head of the HH were asked what their main income source is, 26% mentioned from the sale of the crops cultivated in their fields, 13% mentioned that they're employed in formal sector and 7% said from sales of goods in the informal sector.

When looking at the income level of the surveyed HH, it was found that most of them have a low income. **Figure 6.61** below shows the income level of the HH surveyed within the Project RoW.

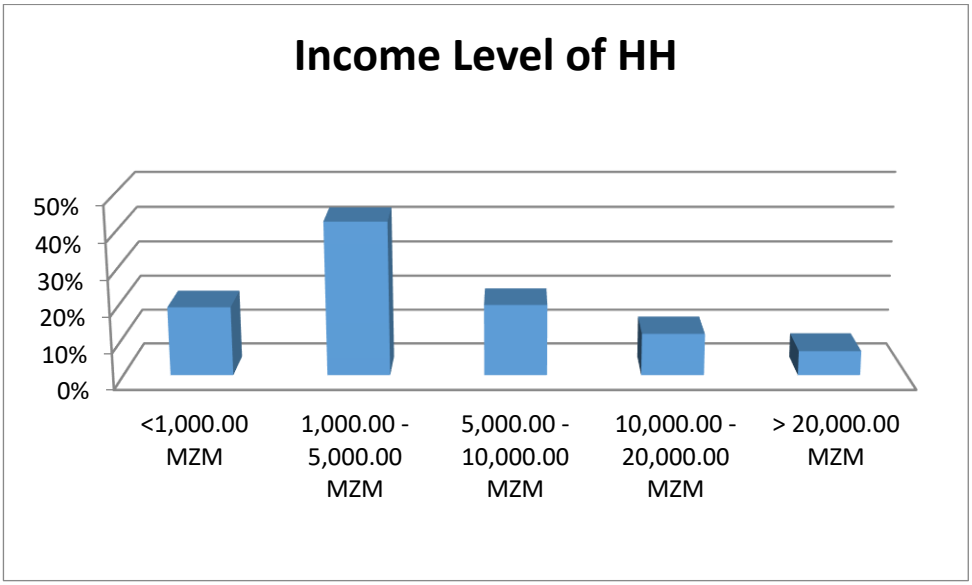


Figure 6.61 – Income level of the HH within the Project RoW

When analysing these figures, it is clear that the majority of the HH have an income lower than 5,000.00 Meticais per month (roughly 83 USD/month). Taking in consideration that each HH has an average of 4.2 members it means that the majority of the HH have an income around 39 Meticais (0.65 USD) per HH member per day. This is below the poverty line of 120 meticais per day (2 USD/day) stipulated by the United Nations.

However, the 5,000.00 Meticais monthly income is in line with the minimum wages stipulated by the government for the agricultural sector.

Possession of durable assets is an indicator of well-being and wealth of HH living in rural areas, since the habit of saving is not common. These assets are symbols of social status/wealth and are easily negotiated for other assets, food or cash, to resolve problems during times of crisis. The same applies to animals that also can be used as an indication of wealth.

In the survey area, the assets with high economic value such as automobiles, motorcycles, television or even computers are insignificant. **Table 6.42** below shows a summary of information collected regarding HH durable assets.

Table 6.42 – HH durable assets

Assets	% of HH that own the asset
Radio	47.1%
TV	31.3%
Cell phone	86.1%
Fridge	13.5%
Stove	47.1%
Bed	69.4%
Bicycle	11.6%
Motorcycle	4.5%
Cart	5.2%
Car	10.0%
Truck	1.6%
Computer	5.8%
Other	34.8%

When observing the table above, it can be concluded that the most own HH assets are of medium commercial value, such as cell phones, radios and bed. Due to their value and use, these assets are easily negotiable locally, and are traded and sold between HH. Radio and cell phones are other goods that most HHs own, due to their wide use, being the only efficient means of communication in the area.

Agriculture

Cultivation methods used by the HH are, in general, rudimentary and manual. Therefore, the cultivated area is directly associated with the available labour. During the fieldwork it was difficult to access and identify the farm land, as most of the area was fallow, and it was difficult to identify the owners of the farm land.

Agriculture in the survey area is predominantly rainfed and developed in semi-arid lowlands and occasionally at the bottom of small slopes. However, use of alluvial plains located along existing intermittent shores of the streams is also common.

During the fieldwork, a total of 88 farms were identified, of which four were considered as commercial and are dedicated to sugar cane plantation. **Figure 6.62** shows that location of the farmlands that will be crossed by the Project alignment.

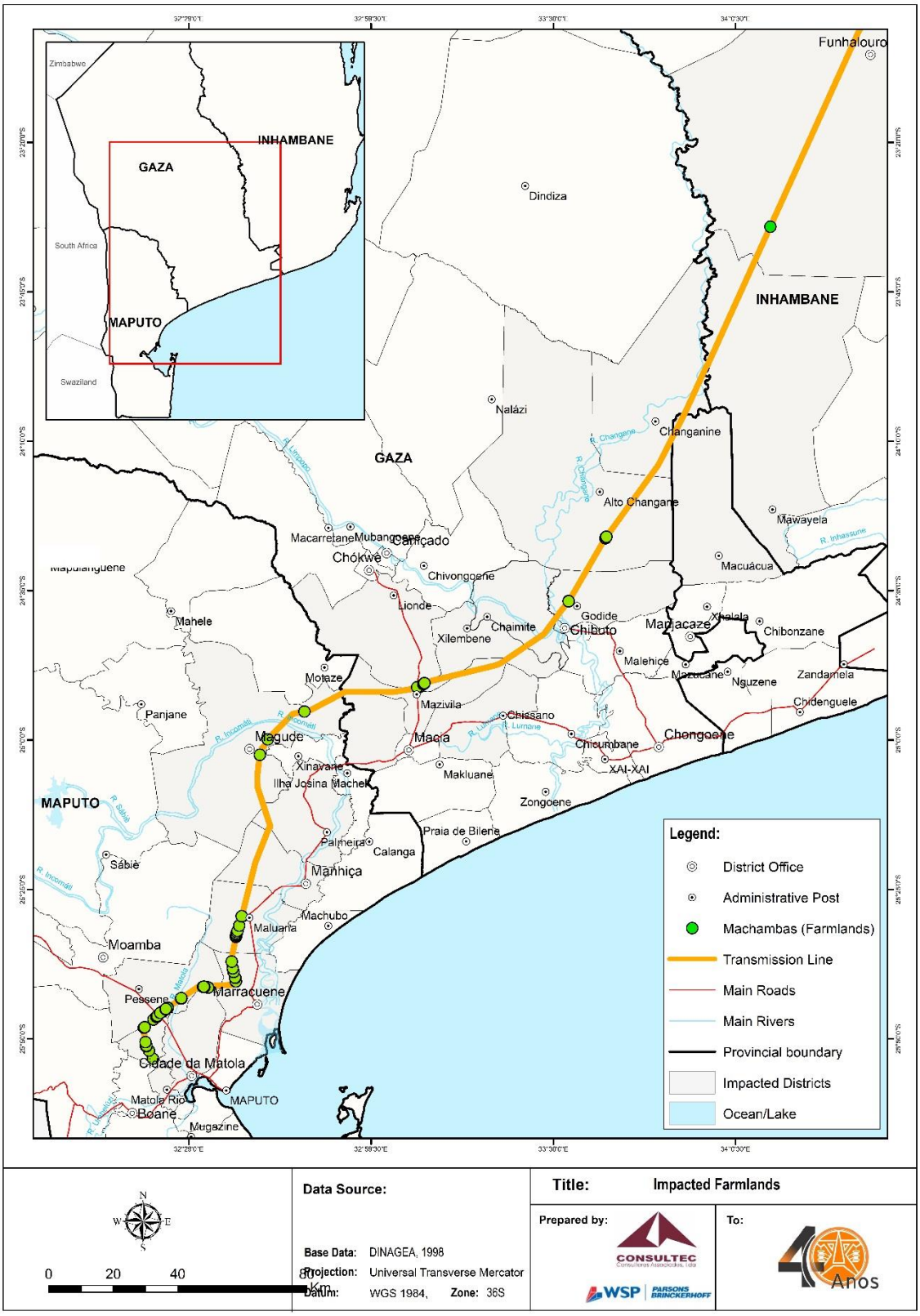


Figure 6.62 – Farms located within the Project RoW

The crops sowed by the population are in the same trend as the rest of the province. **Table 6.43** presents the main crops grown in the Project RoW.

Table 6.43 – Crops grown by HH within the Project RoW

Crops	% of HH who cultivates the crop
Maize	81%
Millet	8%
Timber	4%
Nhemba beans	73%
Sweet potato	58%
Peanut	69%
Pumpkin	54%
Cabbage	19%
Cucumber	15%
Tomato	19%
Cassava	88%
Potato	4%
Lettuce	15%
Sugar cane	23%

Most crops are grown only for own consumption. People will only sell any eventual surplus. As previously mentioned, agriculture techniques are rudimentary and most HHs use hoes for weeding the land with no support from machinery or animal traction. Most HHs (87.5%) do not use inputs such as improved seeds, fertilizers or pesticides, which results in a low productivity by hectare. **Photograph 6.39** shows a typical subsistence agricultural field in the Project RoW, currently fallow, and a support infra-structure used by the farmer during the rainy season.

Photograph 6.39 – Agricultural field in the Project RoW

Industry and Commerce

When analyzing the localities in the Project RoW, the majority of the population stated that they have to travel to be able to buy and sell goods. Only the locality of Boane-Sede stated that they have a market near by. **Table 6.44** below shows the name of the markets used by the population to buy and sell goods.

Table 6.44 – Markets used by the population residing in the localities within the RoW

Name of Market
Mercado do Zimpeto
Mercado de Chibuto
Mercado de Chalucane
Mercado de Mazivila
Mercado de Maguiguana
Mercado de Moamba Sede
Mercado de Beluuane
Mercado de Alto Changane

In relation to industry, the only one identified were mills in the localities of Pessane and Boane Sede. These mills are used by the population to make flour usually from maize. No mills were identified within the Project RoW.

Fishing

In relation to fishing, the Project RoW is inland, therefore only 4% of the affected HH claimed that they practice fishing. Usually fishing is also a subsistence activity, were the catches are used for own consumption and the surplus usually are salted and sold in the nearby markets.

Tourism

No tourism activities were identified within the Project RoW.

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