VOLUME III

Village

Annex F Technical Commission Replacement Village Recommendation

Annex G DNAIA Replacement Village Environmental Assessment Letter

Annex H Site Selection Report

Moçambique Área 1, Lda

FINAL RESETTLEMENT PLAN
ANNEX F: TECHNICAL COMMISSION REPLACEMENT VILLAGE RECOMMENDATION

MOZAMBIQUE GAS DEVELOPMENT

Translation

[Coat of arms of the Republic of Mozambique]

Republic of Mozambique

MINISTRY OF COORDINATION OF ENVIRONMENTAL AFFAIRS

NATIONAL DIRECTORATE FOR TERRITORIAL PLANNING

To

Administrator of the District of Palma

Cabo Delgado

Ref. Nr. 221/MICOA/DINAPOT/200/2014 Maputo, 12th September 2014

Subject: Opinion Regarding the Area for Resettlement of the Quitupo Community

As you are aware, during the period from 27th to 31st August, a multissectorial technical team, including technicians from the Ministry for Coordination of Environmental Affairs and the Ministry of State Administration, travelled to the District of Palma, Cabo Delgado Province, to assess the potential areas for the resettlement of the Quitupo community, affected by the Construction Project of the Liquefied Natural Gas (LNG) Plant.

From the work performed in the different areas previously indicated for the resettlement of the community, it was concluded that the area of Quitunda is the one considered eligible for the resettlement of the population directly affected by the construction of the plant, considering that it presents improved accessibility conditions, an almost flat terrain, proximity to the areas of probable employment, fertile soils, groundwater availability, integration of these areas with the areas of housing development provided for in the General Urbanization Plan and also because it corresponds to the community's requirements and expectations according to the consultations carried out. For the purpose of consistency, the present favourable opinion is drawn up, and the elaboration of the respective Resettlement Plan is recommended, which should include all the functionality details of the resettlement neighbourhood, the respective infrastructures and social facilities, in the aforesaid area, according to the legislation in force.

Without anything further at this time, our kind regards.

The National Director

[Illegible Signature over an illegible ink stamp]

Ana Isabel Senda

(N1 Senior Technician)

Cc: Members of the Technical Resettlement Monitoring and Supervision Committee

Members of the Secretariat of the Technical Resettlement Monitoring and Supervision Committee

Provincial Directorate for the Coordination of Environmental Affairs of Cabo Delgado

ANADARKO and ENI

Empresa Nacional de Hidrocarbonetos

Annex: Report of the Visits to the Resettlement Areas in Palma

[Coat of Arms of the Republic of Mozambique]

Republic of Mozambique

MINISTRY FOR COORDINATION OF ENVIRONMENTAL AFFAIRS

National Directorate for Territorial Planning

Technical Resettlement Monitoring and Supervision Committee

REPORT OF THE VISITS TO THE RESETTLEMENT AREAS IN PALMA

[Photograph]

[Photograph] *[Photograph]*

September 2015

1. Introduction

In scope of the activities carried out by the Technical Resettlement Monitoring and Supervision Committee relating to the construction of the plant for the exploration of Liquefied Natural Gas in the District of Palma, a work visit was carried out between 27th and 31st August in the same District, in the Province of Cabo Delgado, which had the following main objectives:

- Evaluate the capacity of the two proposed areas for the resettlement of the populations affected by the construction project of the gas plant (settlements of Quitupo, Ngoji and Milamba);
- Perform a brief study of the construction process of the houses in the local settlements in order to propose improvements on the methods employed;

The technical team included of the following technicians:

MICOA – (National Directorate for Territorial Planning)

- Adérito Wetela
- Inácio Novela

MAE – (National Directorate for Territorial Administration)

- José Zibia

2. Meeting with the Administrator

A courtesy meeting was held with the District Administrator to present the technical team and the purpose of the visit.

3. Visit to the Project area

The technical team successively visited the following locations:

Visit to the Host Community of Senga

At this location a meeting was held with the Gas Project's Development Committee, which is the liaison body between the local community and the Project, and one of its main roles is to create awareness to the resettlement process.

[Photograph]

Of the 15 members that comprise the Committee, 13 members were present during this meeting, of which 3 were women.

The meeting served to present the purpose of the visit, where the Committee leader, Mr. Macote Fauma, thanked the team for their presence and stated his availability to collaborate wherever necessary. He mentioned that the Senga community is receptive to welcoming those resettled from Quitunda.

Visit to the Quitunda Resettlement area *[Photograph]*

This area is the jurisdiction of the Senga community, having been designated as one of the alternative areas for the resettlement of the Quitupo community. It has an area of around 93ha where currently 11 families reside. According to what is planned these families will be integrated in the resettlement plan and will benefit from the same conditions that will be offered to the Quitupo community that will be resettled here.

This area is located closer to the potential employment locations such as the future plant, the aerodrome and the camp.

Visit to the Namba Resettlement area

[Photograph]

This area was also proposed as one of the alternatives for the resettlement of the Quitupo community and is located south of Vila Sede de Palma and north of the probable employment locations, such as the future plant, the aerodrome and the camp.

This area was rejected by the local communities because the soils are not very productive, there are many wild animals, the water table is located at much greater depths in relation to the Quitunda settlement.

Visit to the Ngoji Community

[Photograph]

This is an area close to the sea and the residents, whose permanence in the location is of a “temporary” nature (migrant fishermen), carry out fishing activities. It is the area established for the construction of the docks for the landing of cargo ships.

These groups of people and families will be relocated in the new areas identified as being areas with access to the sea, where improved accessibility, water supply and sanitation conditions will be created, as well as the improvement of the quality of the houses. The new resettlement locations will be close to the coast in order enable the population to continue to exercise their normal activities. However, during the transfer period, taking into consideration that there will be a period of partial or total interruption of activities, compensation mechanisms will be defined in order to avoid disturbances to these families’ income.

Visit to the Quitupo Community

A meeting was held with the Community Resettlement Committee where 13 of the 15 members that comprise the committee were present. This meeting served to present the objectives of the visit. However, concerns were presented regarding the start of the construction works of the houses.

[Photograph] *[Photograph]*

[Photograph] *[Photograph]*

Visit to the Milamba 1 and 2 Communities

Here there are also some families that will be directly affected by the construction of the plant. It is also an area close to the sea and its residents are of a “temporary” nature and carry out fishing activities.

These groups of people and families will be relocated to other locations identified as being areas with access to the sea, where improved accessibility, water supply and sanitation conditions will be created, as well as the improvement of the quality of the houses and they will receive the same treatment as the Ngoji community.

[Photograph] *[Photograph]*

Visit to the Maganja Community

A brief meeting was held with the leader of the Community Resettlement Committee. This is a community whose *machambas* will be affected by the construction of the plant.

[Photograph]

4. Evaluation of the Resettlement Areas

Location	Weak Points	Strong Points
Quitunda Resettlement Area	a) Area limited by the development of the plant, the aerodrome, the PGU area and the topography in the surrounding areas b) Located between the project's implementation area and the area of the PGU (of the 18000Ha), without a Plan that incorporates the two adjacent areas and all	a) Easy accessibility through the access road between Palma/Mocímboa da Praia road, the aerodrome area, the camp and the plant; b) It is characterized by fertile soils; c) The almost flat configuration of the land and with a slight inclination towards northwest;

	the proposed undertakings for the industrial area.	d) Diversified natural vegetation; e) Proximity to locations of potential employment (aerodrome, camp and plant); f) Availability of groundwater; g) The General Urbanisation Plan provides for the establishment of commercial areas in proximity to this location; h) Ease of integration of these areas with the housing development areas provided for in the General Urbanisation Plan.
Namba Resettlement Area	a) Away from possible employment locations (aerodrome, camp and plant); b) Characterised by low productivity soil; c) Proximity to mangroves, which may contribute to deforestation;	a) Proximity to the Town of Palma, in the south; b) Dense bush with diversified natural vegetation; c) Proximity to the sea; d) Flat land configuration.

	d) Possible over-exploitation of fishing resources (the town's communities already develop fishing activities in this area); e) Difficult access to groundwater; f) Existence of wild animals.	

5. Recommendations

- From the evaluation carried out, the technical group recommends that resettlement be done in Quitunda as it offers better living conditions and because there is a consensus between those affected, the hosts and the District Government in relation to resettlement in this location;
- The house model should be constructed in the resettlement area to allow for those affected to view the works as well as to give greater credibility to the process;
- Following the end of the resettlement process an Urbanisation Plan should be elaborated for the 7.000ha area awarded to Anadarko[1], in order to coherently incorporate the resettlement area, the plant, the landing strip (although it is temporary) and the General Urbanisation Plan of the 18.000ha area awarded to Empresa Nacional de Hidrocarbonetos.

[1] A provisional Right to Use and Benefit from Land (in Portuguese, *Direito de Uso e Aproveitamento da Terra* or DUAT), over a plot located at Cabo Afungi, Cabo Delgado Province, was awarded on 12 December 2012 to Rovuma Basin LNG Land, Lda. (RBLL), a company currently owned by AMA1, EEA and ENH (EEA joined RBBL as a quota holder on 19 March 2014). The DUAT was awarded for an area of 7,000 ha. Under the terms of exploitation assignment agreements between RBLL, AMA1 and EEA, and following approval of the Minister of Agriculture, AMA1 and EEA each hold exclusive exploitation rights over a certain portion of land within the Project DUAT, on equal terms. The two parties also hold joint exclusive exploitation rights over the remaining portion of land within the Project DUAT intended as common area. The exploitation assignment agreements give the Project the right to develop the provisional DUAT area on the Afungi peninsula.

6. Compensations

The team was informed that the proponent is preparing a framework regarding the rights and the forms of compensation that should be presented soon, first to the Government and then discussed with the communities.

7. Findings

- Absence of a broader plan to include all the development areas expected for Palma, which would offer better perspective of the interrelation between all areas;
- The Quitunda resettlement area (93ha) is not enough to house 550 families with plots measuring 100m x 50m. Mathematically this area merely has the capacity to host 186 plots measuring 100m x 50m, not counting the access roads, trading areas, facilities and services, while with plots measuring 40m x 20m this area may host around 750 plots including the road network, service areas, green spaces, social facilities, amongst other uses.

Maputo, on the 2nd of September 2014

Elaborated by:	Adérito Wetela	*[Illegible signature]*
	Inácio Novela	*[Illegible signature]*
	José Zibia	*[Illegible signature]*

FINAL RESETTLEMENT PLAN
ANNEX G: DNAIA REPLACEMENT VILLAGE ENVIRONMENTAL ASSESSMENT LETTER

MOZAMBIQUE GAS DEVELOPMENT

Translation

[Coat of Arms of the Republic of Mozambique]

REPUBLIC OF MOZAMBIQUE

MINISTRY OF COORDINATION OF ENVIRONMENTAL AFFAIRS

NATIONAL DIRECTORATE OF THE ENVIRONMENTAL IMPACT ASSESSMENT

DNAIA

To:

Anadarko Moçambique Área 1, Lda

Mr. Barclay P. Collins

Managing Director

Maputo

N/Ref. Nr. 1338/MICOA/DNAIA/183/2014

Maputo, 01 September 2014

Subject: Request for clarification regarding the process to be observed to obtain approval and licensing for the construction of the Resettlement Village within the DUAT area of the Liquefied Natural Gas Project

Dear Sir,

The National Directorate of Environmental Impact Assessment (DNAIA) has received a document pertaining to the above subject, which was object of our suitable attention. Regarding your request we have to inform that the construction of the resettlement village is not subject to independent licensing, but rather to the approval of the Resettlement Plan.

Kind regards.

Sincerely,

[Illegible Signature over a ink stamp]

Rosa Cesaltina Benedito

/National Director

C.C: Eni East Africa S.p.A

DNAPOT

FINAL RESETTLEMENT PLAN
ANNEX H: SITE SELECTION REPORT

MOZAMBIQUE GAS DEVELOPMENT

Multi-Criteria Assessment & Site Selection Study for Replacement Villages

FINAL REPORT

MOZAMBIQUE GAS DEVELOPMENT

EXECUTIVE SUMMARY

Anadarko Moçambique Área 1 Limitada (AMA1) and Eni East Africa (EEA) have found significant gas reserves off the northern coast of Mozambique, in the Rovuma basin areas 1 and 4, respectively. AMA1 and EEA have established the Mozambique LNG Development Project (the Project) to bring the gas onshore, process (to a liquefied form) and export it to international markets. A significant requirement for the Project is the establishment of a Liquefied Natural Gas (LNG) processing facility to process the gas and attendant on and offshore infrastructure, to be built in the Afungi Peninsula, situated in the Palma District, Cabo Delgado Province, in northern Mozambique.

An area (referred to as the DUAT Area) of approximately 7,000 hectares on the Afungi Peninsula has been provisionally granted by the Government of Mozambique (GoM) for the development and operation of the Project (LNG plant and attendant infrastructure).

In the initial planning phase of the Project, it was proposed that the DUAT Area would need to be for the exclusive use of the Project and any existing communities (an estimated 750 households) would need to be resettled into replacement accommodation at an alternative *Site* or *Sites*.

In order to seek compliance with the International Finance Corporation's Performance Standard 5 (IFC PS5), namely to minimize involuntary resettlement wherever feasible, AMA1 and EEA have explored alternative project designs for the LNG facilities. As a result, the Project footprint was reduced to an area smaller than originally envisaged.

This has opened up space so that the *Replacement Village(s)* and a Livelihood Development Zone could be located closer to the current location of the Affected Communities, i.e. inside the DUAT Area. This will minimize the disruption associated with the resettlement.

However, a number of households will still be directly and indirectly affected by the Project and will require physical and/or economic displacement. Those needing to be physically displaced will need to be relocated to one or more *Replacement Village(s)*.

WorleyParsons (WP) was awarded the *Afungi Replacement Village Project* by Anadarko Petroleum Corporation in February 2013. As part of the contractual scope of work, WP is to provide advice on *Potential Sites* for the construction of the *Replacement Village(s)* for the households that will be physically displaced by the Project. In order to do so, WP has developed a phased GIS-supported *Multi-Criteria Assessment and Site Screening Methodology* and, following Project's decision to locate the *Replacement Village(s)* within the DUAT Area, applied it to this area.

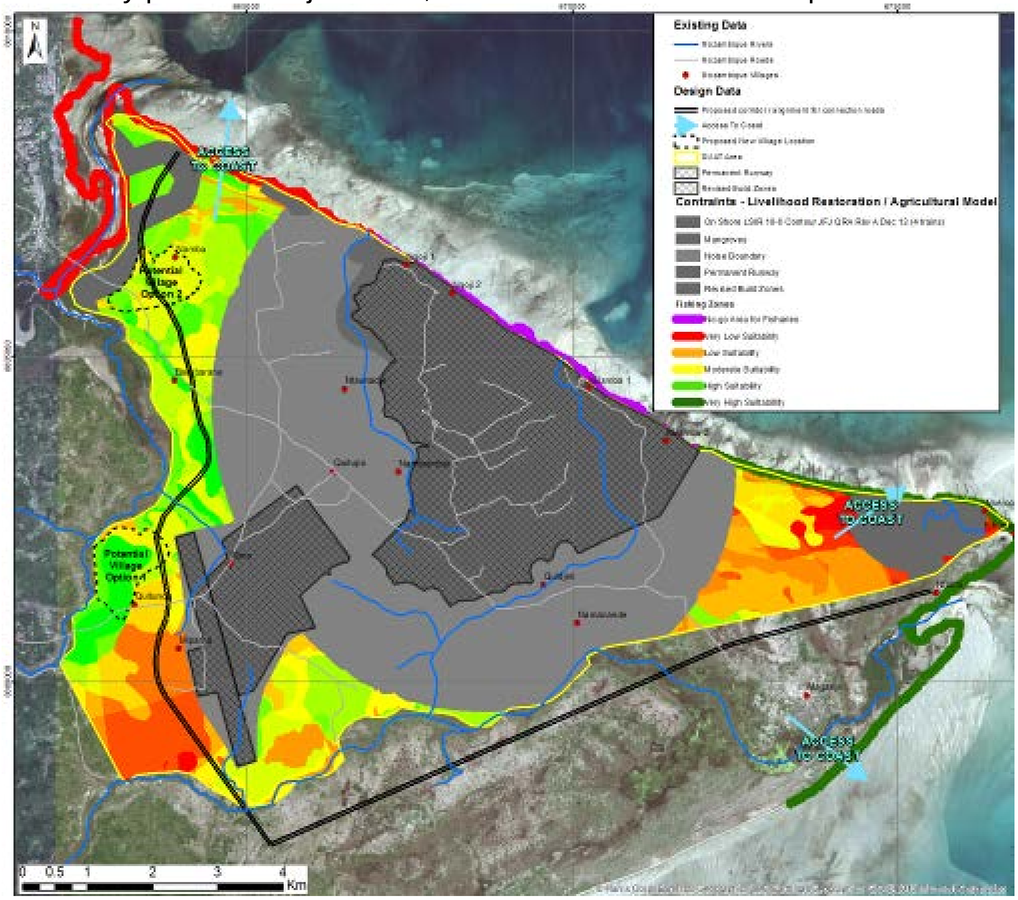
This methodology aims to clearly and transparently communicate how the *Potential Sites* have been pre-selected based on the availability and suitability of land in a defined *Study Area*, by identifying *no-go* areas (*Constraints*) and by ranking the remaining *Potentially Suitable Areas* in terms of their *Overall Suitability*, based on a number of *Comparison Criteria* that allow a differentiation of the *Potentially Suitable Areas*.

The parameters that are relevant to consider as *Constraints* and *Comparison Criteria* for identifying the *most suitable areas* for the construction of the infrastructure associated with the villages are different (and/or have different *weights*) to those that will lead to the identification of the *most suitable areas* for agriculture. Therefore, two models have been developed, one for the *Village(s) Infrastructure* and one for *Livelihood*

Development / Agriculture. The suitability of the *fishing grounds* along the coast was also assessed and considered qualitatively when selecting the *Potential Sites*.

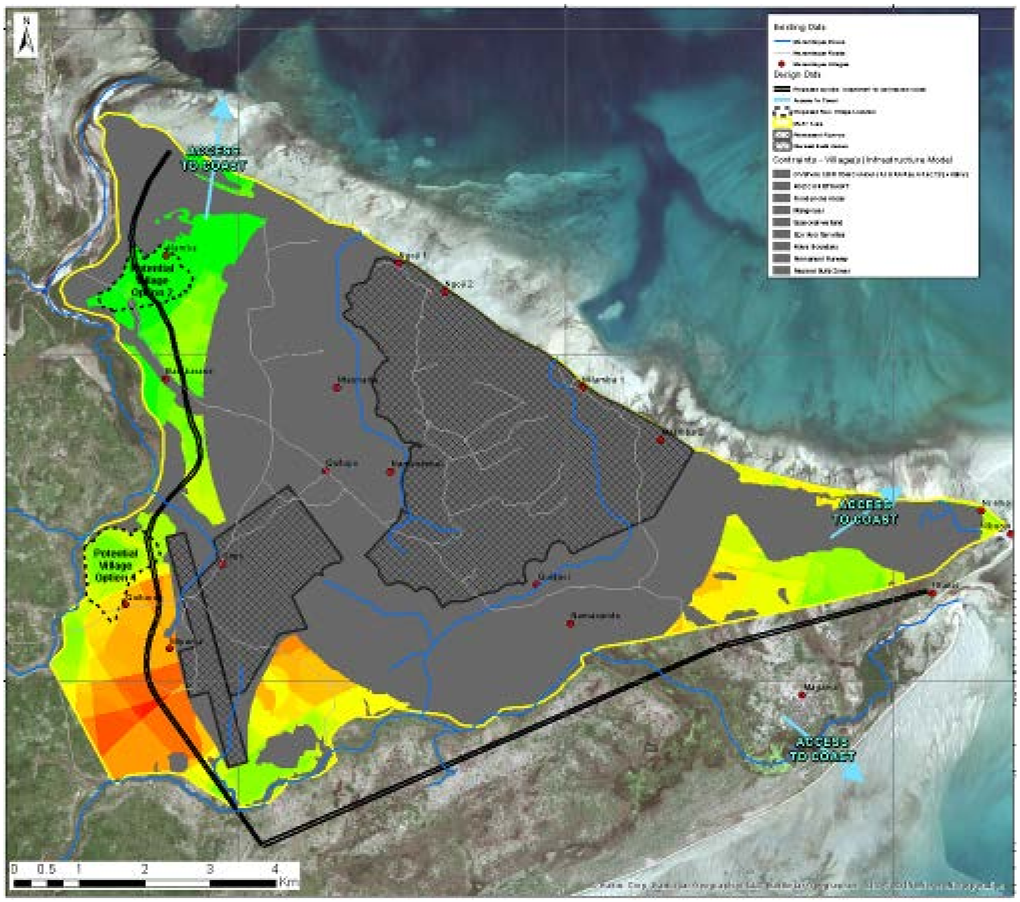
Two *Potential Sites* for the construction of the *Replacement Village(s)* have been identified inside the DUAT Area using the models. The *Sites* are located within the *most suitable areas*, close to *suitable areas* for the location of the associated agricultural plots.

The location of the proposed *Potential Sites* is presented in the two figures below, illustrating its context in terms of both *livelihood development purposes*, and the construction of the *Replacement Village(s)* and associated infrastructure. The fact that the proposed *Potential Sites* are not located in the grey areas (Constraints) immediately prevents major social, health and environmental impacts.



Potential Sites and *Overall Suitability* for livelihood development / agriculture

The outcomes of the models only hold if the parameters considered in the models (*Constraints*, *Criteria* and *weights*) correspond to those the Affected Communities consider relevant and valuable. Although the parameters used in the models include social / socio-economic considerations that, from an expert judgement point of view, are thought to be in line with likely community views and opinions with regards the siting of *Replacement Village(s)*, such assumptions can only be verified through community consultation.



Potential Sites and *Overall Suitability* for the *Village(s)* and associated infrastructure

A critical step in the way forward of the *Site Selection Process* is to seek inputs from the resettlement-affected households and communities on whether they agree with the sites proposed, their reasons for (dis)agreeing, and/or whether they have a preference for a different location.

These inputs shall be taken into account in the *Site Selection Process* going forward. This can result either in the confirmation of the proposed sites or slight adjustments to its location, or in the proposal of new sites. The results of this process shall then be presented to the GoM for approval of the final location for the *Replacement Village(s)*.

CONTENTS

FIGURES

TABLES

REPLACEMENT VILLAGE(S) – MOZAMBIQUE GAS DEVELOPMENT PROJECT'S VISION

To provide replacement accommodation that:

- *Improves the living standards of resettled households*
- *Is in line with the Government of Mozambique's expectations and regulations*
- *Provides ready access to community amenities and*
- *Creates opportunities for the training and employment of local people*.

ABBREVIATIONS

ALARP	=	As Low As Reasonably Practicable
AMA1	=	Anadarko Moçambique Área 1 Limitada
EEA	=	Eni East Africa
DUAT Area	=	Area assigned to RBLL, on a provisional basis, for the implementation of the LNG Project
CES	=	Coastal & Environmental Services
DUAT	=	Direito de Uso e Aproveitamento da Terra (Land use agreement)
EIA	=	Environmental Impact Assessment
ERM	=	*Environmental Resources Management*
FEED	=	Front End Engineering Design
LFL	=	Lower flammability limit
LSIR	=	Location Specific Individual Risk
GIS	=	Geographic Information System
GoM	=	Government of Mozambique
IFC	=	International Finance Corporation
IUCN	=	International Union for Conservation of Nature
LNG	=	Liquefied Natural Gas
MICOA	=	Ministério para a Coordenação da Acção Ambiental (Ministry of the Environment)
QRA	=	Quantitative Risk Assessments
RAFS	=	Rapid Assessment Field Study
WP	=	WorleyParsons

1. INTRODUCTION

Anadarko Moçambique Área 1 Limitada (AMA1) and Eni East Africa (EEA) have found significant gas reserves off the northern coast of Mozambique, in the Rovuma basin areas 1 and 4, respectively. AMA1 and EEA have established the Mozambique Development Project (the Project) to bring the gas onshore, process it (to a liquefied form) and export it to international markets.

A significant requirement for the Project is the establishment of a Liquefied Natural Gas (LNG) processing facility to process the gas, and attendant on and offshore infrastructure, to be built in the Afungi Peninsula, situated in the Palma District, Cabo Delgado Province, in northern Mozambique.

The Government of Mozambique has provisionally granted an area of approximately 7,000 hectares on the Afungi Peninsula for the development and operation of the Project, referred to as the DUAT[1] Area.

In the initial planning phase of the Project, it was proposed that the DUAT Area would need to be for the exclusive use of the Project and any existing communities (an estimated 750 households) would need to be resettled to an alternative *Site* or *Sites*.

In order to seek compliance with the International Finance Corporation (IFC) Performance Standard 5, namely to minimize involuntary resettlement wherever feasible, AMA1 and EEA have explored alternative project designs for the LNG facilities. As a result, the Project footprint was reduced to an area smaller than originally envisaged: the *Revised Build Zone*.

Not only does this have the potential to reduce the number of households requiring physical displacement (an estimated 450 households, to be confirmed by the census), it also opened up space so that the *Replacement Village(s)* and agricultural land could be located closer to the current location of the Affected Communities, i.e. inside the DUAT Area. This will minimize the disruption associated with resettlement.

The Project Site is illustrated in Figure 1-1.

[1] DUAT stands for "Direito de Uso e Aproveitamento da Terra" (Land use agreement). The DUAT Area is the area assigned to RBLL, on a provisional basis, for the implementation of the LNG Project.

Figure 1-1 Project Site

However, a number of households will still be directly and indirectly affected by the Project and will require physical and/or economic displacement. Those needing to be physically displaced will need to be relocated to one or more *Replacement Village(s)*.

WorleyParsons (WP) was awarded the *Afungi Replacement Village Project* by Anadarko Petroleum Corporation in February 2013. As part of the contractual scope of work, WP is to provide advice on *Potential Sites* for the construction of the *Replacement Village(s)* for the households that will be displaced by the Project.

In order to do so, WP has developed a phased GIS-supported *Multi-Criteria Assessment and Site Screening Methodology*. After defining the *Study Area*, all known parameters that may pose serious constraints to the use of the land for resettlement purposes are identified, mapped, and *blocked out* (excluded from the subsequent analysis of the *Study Area*), as they are deemed unavailable and/or unsuitable for resettlement. This process reveals the *Potentially Suitable Areas*: all remaining areas.

In order to identify, amongst the *Potentially Suitable Areas*, those most suitable for resettlement, a GIS-supported “comparison exercise” of the *Potentially Suitable* Areas was developed. A number of *criteria* that allow a comparison between the *Potentially Suitable Areas* (*Comparison Criteria*) were identified, ultimately allowing the ranking of these areas according to their *Overall Suitability*.

The ranking takes into account all the *Comparison Criteria*, each classified according to a pre-defined *Classification System* (on a scale ranging from 1 – *least suitable* to 5 – *most suitable*), as well as the relative importance of each *Comparison Criterion* (by assigning weights to each *criterion*, on a percentage scale).

The suitability of the fishing grounds along the coast was assessed based on a quantitative analysis of fisheries aspects. A *Classification System* was defined in order to assign a Global Classification to sections of the coastline within the *Study Area*.

The graphical representation of the above mentioned classifications was achieved by using different colours for both the *Potentially Suitable Areas* and the coast line sections. The *code of colours* used range from dark green, representing the most suitable areas / fishing grounds (highest classification: 5), through to light green (classification: 4), yellow (classification: 3), orange (classification: 2), through to red, representing the least suitable areas / fishing grounds (lowest classification: 1).

The parameters considered as *Constraints* and *Comparison Criteria* for identifying the *most suitable areas* for the construction of the infrastructure associated with the villages are different (and/or have different weights) than those considered for the identification of the *most suitable areas* for agriculture. Therefore, two models have been developed, one for the *Village(s) Infrastructure* and one for *Livelihood Development / Agriculture*.

Areas of higher *Overall Suitability* for the construction of the villages / infrastructure close to *suitable areas* for agriculture were identified and short-listed as Potential Sites. The location of the *Potential Sites* also takes into account proximity to the *most suitable* fishing grounds.

This methodology aims to clearly and transparently communicate how the *Potential Sites* have been pre-selected based on the availability and suitability of land within the defined *Study Area*. The parameters (*Constraints* and *Comparison Criteria*) considered in the analysis take into consideration that "*the resettlement aims at stimulating the socio-economic development of the country and guaranteeing a better quality of life of the affected population and social equity, <u>taking into account the sustainability of the physical, environmental, social and economic aspects</u>*." (Decree no. 31/2012, Art 5).

Consultations with the communities ("We still want the smell of Quitupo" – comment made at CRC meeting in September 2013) and a survey conducted under the LNG Project Environmental Impact Assessment indicate that affected households prefer to be resettled to a "nearby" location, with regards to the location where they currently reside (61.4% of surveyed households state that they prefer to be resettled to a location 'nearby' the location where they currently live. See draft LNG Project EIA, August 2013, Chapter 9, page 135, table 9.58).

The Project has therefore decided to assess the DUAT Area in an attempt to identify a number of alternative *Potential Sites* for the *Replacement Village(s)*.

The Site Screening Methodology devised was therefore implemented considering the DUAT Area as the *Study Area*. Two *Potential Sites* have been identified / pre-selected to be presented to the Government and the communities to be resettled.

It is envisaged that, following approval from the Government with regards to the *Site Screening Methodology* and its results, the Project will start engaging with the Affected Communities in order to validate / review the assumptions the methodology and models were based upon, and confirm (or not) the resulting *Potential Sites*.

This report presents the results of the implementation of the *Site Screening Methodology* developed and the overall *Site Screening Process* undertaken by WP on behalf of the Project.

This report also makes recommendations in regards to next steps considered necessary in order to validate the *Site Screening Process* and its findings, namely the *Community Engagement Process for Site Selection*.

2. MULTI-CRITERIA ASSESSMENT AND SITE SCREENING METHODOLOGY

2.1 General Methodology

As part of WP's contractual scope of work for the *Afungi Replacement Village Project*, WP is to provide advice on the location of *Potential Sites* for the construction of the *Replacement Village(s)* and associated infrastructure, for the households that will be displaced by the LNG Project. In order to do so, WP developed a robust and replicable methodology for Site Screening that aims to clearly and transparently communicate how the *Potential Sites* for the *Replacement Village(s)* have been identified based on the availability and suitability of land within a defined *Study Area*.

The implementation of this methodology results in the identification of *Potentially Suitable Areas* in the *Study Area*, and the *ranking* of these areas in terms of their *Overall Suitability*, taking into consideration a number of technical, environmental and social parameters.

The parameters considered as *Constraints* and *Comparison Criteria* for identifying the *most suitable areas* for the construction of the infrastructure associated with the villages are different (and/or have different weights) than those considered for the identification of the *most suitable areas* for livelihood development / agriculture. Therefore, two *Suitability Models* have been developed, one for the *Village(s) Infrastructure* and one for *Livelihood Development / Agriculture*.

These models were then used to support the identification of a number of *Potential Sites* that not only are located within the *most suitable areas* for the construction of the *Replacement Village(s)*, but also, as much as possible, located nearby *suitable areas* for livelihood development / agriculture.

The parameters considered in the analysis take into consideration that "*the resettlement aims at stimulating the socio-economic development of the country and guaranteeing a better quality of life of the affected population and social equity, <u>taking into account the sustainability of the physical, environmental, social and economic aspects</u>*." (Mozambican Decree no. 31/2012, Art 5).

It is important to note that the *Suitability Models* merely support the integration of the information regarding a big number of variables (*Criteria*) that would otherwise be hard to interpret. They consist of useful tools to *support* the identification of the *Potential Sites*, but need to be used with caution and awareness that the models will not the best location for the *Potential Sites* in isolation. It is therefore important to understand exactly how they "work", as well as its strengths and limitations, in order to be able to take the most (but not more) out of them.

Because it's an objective and standardized methodology, third parties can use it and confirm its results. It has the necessary degree of flexibility that suits the context and reality of this Project in terms of its dynamics and level of detail of the information available at each moment. It allows a gradual inclusion of additional data and information as it becomes available, and/or an increase in the level of detail of the information used, at each iteration, keeping the same principles and approach. It also allows the inclusion, at any given time, of new *Constraints* and/or *Comparison Criteria*.

With the addition of the new constraints and/or comparison criteria and/or a change in the Study Area, the *Suitability Models* can be re-run and apply the same general step by step methodology. Although this obviously generates completely new models, there is absolutely no need for any change in the principles the methodology is based upon.

In fact, when the *Extended Study Area* (oval shape outside the DUAT Area) was suggested to replace the original *Circular Study Area*, and later when the "*Inside the DUAT Area*" alternative was considered, there was no need to develop a specific methodology to account for these adjustments. It was simply necessary to apply the same methodology to a different *Study Area*, and to adjust it considering the adequate data and information available with regards to a new set of *Site Screening Parameters* (*Constraints* and *Comparison Criteria*).

This chapter describes and explains the phased GIS-supported *Multi-Criteria Assessment and Site Screening Methodology* developed by WP.

2.2 Detailed Methodology

This section describes and explains in detail the phased GIS-supported *Multi-Criteria Assessment and Site Screening Methodology* developed by WP, with each of the following sections focusing on each phase.

2.2.1 Phase 1 – Definition of the *Study Area*

The *Study Area* is defined as the total area that will be subjected to an assessment in accordance with the subsequent phases of the *Multi-Criteria Assessment and Site Screening Methodology*. It is the area from which the *Potential Sites* for the location of the *Replacement Village(s)* will ultimately be identified.

2.2.2 Phase 2 – Constraints Mapping

After defining the *Study Area*, the methodology implies the identification of all parameters that may pose serious constraints (hereafter referred to as *Constraints*) to the use of the land for either the construction of the physical infrastructures associated with the *Replacement Village(s)*, or for livelihood development / agriculture purposes. These *Constraints* may be technical, environmental and/or social.

For each of the two *Suitability Models* to be developed (i.e. for the physical infrastructure for the Replacement Village(s) and for the livelihood development/agriculture locations), the areas that correspond to a *Constraint* (*no-go* areas) must be mapped (*Constraints mapping*) and systematically excluded / *blocked out* from the *Study Area*, as they are deemed *unavailable* and/or *unsuitable* for the respective purposes.

This process reveals, for each *Suitability Model*, the *Potentially Suitable Areas*: all the remainder (non-constrained) areas. The subsequent analysis (phases) will be carried out over these areas only.

The area that results from overlapping all the *Constraints* that apply simultaneously to the two *Suitability Models* defines a *Total Exclusion Zone*. The *Total Exclusion Zone* is deemed unavailable for resettlement purposes, meaning that no activity (that is not directly related to the LNG Project) shall take place there.

2.2.3 Phase 3: *Suitability Models* – Multi-Criteria assessment and ranking of *Potentially Suitable Areas* according to their Overall Suitability

The areas identified as *Potentially Suitable* for each *Suitability Model* now need to be assessed using a comprehensive set of *criteria* that allows a comparison between those areas (*Comparison Criteria*), so that they can be ranked according to their *Overall Suitability*.

This is done, for each of the *Suitability Models*, by conducting a GIS-supported *comparison exercise* of the *Potentially Suitable* Areas, in a number of steps described in the following sections.

2.2.3.1. Comparison Criteria

Appropriate *Comparison Criteria* (i.e. parameters that allow a differentiation of the *Potentially Suitable Areas* in terms of its *suitability* for a particular Environmental or Social aspect) are identified:

Environmental *Comparison Criteria*:
EC_1, EC_2, …, EC_n

Social *Comparison Criteria*:
SC_1, SC_2, …, SC_n

2.2.3.2. Relative Weights

A *Relative Weight* (using a percentage scale) is assigned to each *Comparison Criterion*. This represents the relative importance of each *criterion* in the comparison of the *Potentially Suitable Areas* – i.e. the more important the *criterion*, the higher weight/percentage is allocated to it.

***Relative Weight* for each Environmental *Comparison Criterion*:**
$W(EC_1)$, $W(EC_2)$, …, $W(EC_n)$

***Relative Weight* for each Social *Comparison Criterion*:**
$W(SC_1)$, $W(SC_2)$, …, $W(SC_n)$

2.2.3.3. Information, *Classification System* and Classification of *Potentially Suitable Areas*

Detailed information regarding each parameter (*Comparison Criterion*) is then obtained, covering all *Potentially Suitable Areas*, and capture it into thematic GIS layers.

A *Classification Systems* is defined, providing objective guidance for the classification (scoring) of the *Potentially Suitable Areas* in terms of its suitability with regards to each parameter (*Comparison Criterion*). These *Classification Systems* should use a standardized *suitability scale* in five classes, from **5** ("most suitable") to **1** ("least suitable") – i.e. the more suitable the areas are with regards to each *criterion*, the higher the score.

For *each Comparison Criterion, all Potentially Suitable Areas* are classified using the respective *Classification System*.

Area Classification for each Environmental *Comparison Criterion*:
$C(EC_1), C(EC_2), \ldots, C(EC_n)$

Area Classification for each Social *Comparison Criterion*:
C(SC1), C(SC2), … , C(SCn)

The information captured in the thematic GIS layers is therefore converted into new layers, each representing the "suitability" of the *Potentially Suitable Areas* in terms of a specific parameter (*Comparison Criterion*).

In these layers, the following code of colours was used to establish a correspondence with each of the five *suitability classes* defined:

5 - Dark green (most suitable)
4 - Light green
3 - Yellow
2 - Orange
1 - Red (least suitable)

This means that, for each *Comparison Criterion*, the *Potentially Suitable Areas* get *graded* by *degree of suitability*, using the above code of colours.

In some cases, depending on the parameter and information available, it may not be possible to establish all five classes. In other cases, although five classes are defined, some classes may not be represented in the *Study Area* / *Potentially Suitable Areas*.

2.2.3.4. *Suitability Models*: Overall Suitability

For each area (*Potentially Suitable Area*), the *weighted average* of the classifications given to all *Comparison Criteria* is calculated by multiplying the classification for each *Comparison Criterion* by the respective *Relative Weight* – according to the formula below:

$$\frac{C(EC1) \times W(EC1) + C(EC2) \times W(EC2) + \ldots + C(ECn) \times W(ECn) + C(SC1) \times W(SC1) + C(SC2) \times W(SC2) + \ldots + C(SCn) \times W(SCn)}{W(EC1) + W(EC2) + \ldots + W(ECn) + W(SC1) + W(SC2) + \ldots + W(SCn)}$$

This *weighted average* corresponds to the *Overall Suitability* (rating) of each area: the higher the score, the higher the *Overall Suitability* of the corresponding area.

In GIS / mathematical terms, this corresponds to applying to each layer (corresponding to the classification with regards to a specific parameter, or *Comparison Criterion*) the respective *Relative Weight* and adding up *vertically* (for the same area) the results for all layers (that correspond to all parameters considered in the comparison exercise).

The above mentioned calculations are automatically carried out by the GIS software for all *Potentially Suitable Areas*, and the output is represented as a new layer / map – the *Suitability Models* – in which the *Potentially Suitable Areas* are ranked according to their *Overall Suitability*, from "most suitable" (high scores) to "least suitable" (low scores).

This ranking takes into account the classification and weights of all the *Comparison Criteria* defined.
The *Overall Suitability* of the *Potentially Suitable Areas* is also represented as a gradation of colours, ranging from dark green (corresponding to the areas of highest *Overall Suitability*), through to light green, yellow, orange and finally red (corresponding to the areas of lowest *Overall Suitability*).

The *Suitability of the Fishing Grounds* was also assessed based on a quantitative analysis carried out on fisheries aspects, and classified using the same (1 to 5) *suitability scale*. The *Suitability of the Fishing Grounds* was graphically represented in the *Suitability Models* by means of lines along the coast line, using the same code of colours (from dark green, representing the *most suitable / productive fishing grounds*, through to red, representing the *least suitable / productive fishing grounds*).

2.2.4 Phase 4 – Identification of the *Most Suitable Areas* and of *Potential Replacement Site(s)*

The *Suitability Models* developed can now be used to support the identification of a number of suitable *Potential Replacement Sites*. These should be suitable for the construction of the villages and be located close to *suitable areas* for agriculture and fishing. The short-listing of *Potential Sites* must therefore be taken into account:

- The output of the *Village(s) Infrastructure Model*: This should be used to support the identification of the best *areas* for the construction of the physical infrastructures associated with the *Replacement Village(s)*: the *greener* areas correspond to the *most suitable areas* for this purpose. The size of the *Sites* must be able to accommodate the required public infrastructure, as well as the house plots for each household to be resettled;
- Proximity to suitable Agricultural Areas: The output of the Livelihood Development / Agricultural Model should be used to support the identification of the best agricultural plots: the greener areas correspond to the most suitable areas for this purpose. These areas should be large enough to allow the development of the livelihood related to agriculture for the households to be resettled, and be located as close as possible to the location of the Replacement Village(s);
- Proximity to suitable / productive fishing grounds: The output of the analysis carried out on the Suitability of the Fishing Grounds should also be used to support the identification of the best areas for the construction of the Replacement Village(s): the green lines along the coast line correspond to the *most suitable / productive fishing grounds*. The location of the Replacement Village(s) should be located as close as possible to *suitable fishing grounds*.

The fact that these *Potential Sites* are selected within the areas of *highest Overall Suitability* ensures that the *Overall Suitability* of those short-listed *Sites* is maximized.

3. ROAD MAP OF THE *SITE SCREENING PROCESS* PROGRESSION FOR THE *REPLACEMENT VILLAGE(S)* PROJECT

The short-listing of *Potential Sites* where to build the *Replacement Village(s)* was achieved through an interactive process adjusted to the context and reality of the Project in terms of its dynamics and level of detail of the information available at each moment. As the *Study Area* evolved, and additional or further detailed data and information become available, the *Site Screening Methodology* was implemented and the respective *Suitability Models* produced and/or reviewed.

The road map of the *Site Screening Process* followed until the short-listing of the *Potential Sites* presented to the Government of Mozambique (the outcome of the Studies presented in this report) is detailed in Appendix A – Road Map of the Site Selection Process for the Replacement Villate(s) Project.

The first approach to the *Site Screening Process* was to test and apply the *Site Screening Methodology* developed to a Circular *Study Area* around the DUAT Area, and is presented and described in detail in Appendix B – Report: “Replacement Village Multi-Criteria Assessment & Site Selection Study” (WorleyParsons, June 2013): Desktop Data Model.

The results of this implementation exercise were presented to the wider Resettlement and Project Teams at a workshop held in Maputo on the 3rd and 4th of May 2013. After describing the reasoning behind the *Site Screening Methodology* developed, the *exercise* carried out was used to illustrate the way of implementing the methodology *step by step* until the generation of the *Suitability Models*. The main outcomes / decisions of the workshop were:

1. Validation of the *Site Screening Methodology*;
2. Decision to extend the *Study Area* further north and south (definition of the *Extended Study Area*);
3. Discuss the limitations of the desktop *Suitability Models* and outline of strategies to overcoming these in order to take the *Site Screening Process* forward; in particular, it was decided to conduct a *Rapid Assessment Field Study* (RAFS) to address the information limitations discussed;
4. Decision to develop new *Suitability Models* by applying the approved *Site Screening Methodology* to the *Extend Study Area*, using the information obtained from the RAFS.

The *Rapid Assessment Field Study* (RAFS) was conducted by **Coastal & Environmental Services (CES)** following field work conducted during a site visit that took place between June 18th and July 5th. Appendix C – “Rapid Assessment Field Study Report” (September 2013); Coastal & Environmental Serices (CES) contains the report produced to present the results of the RAFS.

The *Site Screening Methodology* was then applied to the *Extend Study Area* (oval shape around the DUAT Area) using the updated information compiled in the RAFS *Report*, and considering a revised set of *Site Screening Parameters* (*Constraints* and *Comparison Criteria*) agreed upon with the wider Resettlement and Project Teams. New *Suitability Models* based on real, larger scale data, and ground-truthed information, were developed.

In Appendix D – Post Rapid Assessment Field Study Models, specifics regarding the implementation of the *Site Screening Methodology* to the *Extended Study Area* have been presented and described in detail.

The updated *Suitability Models* and the proposed *Potential Sites* were then presented, at a higher level within the Project (including the LNG Project Director), at a workshop held in Centurion, on the 6th of September, 2013.

Following the presentation of the *Post Rapid Assessment Field Study Suitability Models* to the Project at the workshop in Centurion, and in order to seek compliance with the IFC Performance Standard 5, namely to minimize involuntary resettlement wherever feasible, AMA1 and EEA have decided investigate the feasibility of reducing the LNG Project footprint. This opened up space so that the *Replacement Village(s)* and agricultural land could be located closer to the current location of the Affected Communities, specifically inside the DUAT Area.

The *Site Screening Methodology* was therefore applied to the DUAT Area (as the "new" *Study Area*) and a number of iterations were conducted, as additional information and studies become available.
The preliminary *Suitability Models* for *Site Screening Inside the DUAT Area* revealed the existence of some apparently *suitable areas* for both the *Replacement Village(s)* and the agricultural plots. In Appendix E – Paper: "Resettlement Replacement Village – Resettlement Inside the DUAT Area" is presented a paper prepared in order to summarize the preliminary findings of the implementation of the *Site Screening Methodology* to the "*Inside the DUAT Area*" and to present a number of issues requiring a position / decision from AMA1 and EEA that would allow the *Site Screening Process* to move forward.

In Appendix F – Decision Paper – Summary "Resettlement: Replacement Village(s) Site Selection" is presented a summary version of the above mentioned paper, prepared in order to obtain final approval from AMA1and EEA with regards to the option of resettling inside the DUAT Area.

A discussion of the *Site Screening Parameters* took place with the Resettlement and Project Teams, and additional parameters were introduced. In addition, new studies were carried out and new sources of information were used (Quantitative Risk Assessment, Noise Modelling specific for Resettlement purposes and air quality modelling) to complement the data previously used, and the *Suitability Models* were reviewed accordingly.

All details regarding the implementation of the *Site Screening Methodology* to the *DUAT Area*, namely the final (prior any engagement) *Suitability Models* developed that led to the identification of the *Potential Sites* presented to the GoM is presented in Chapter 4.

4. SITE SCREENING – RESULTS: Inside the DUAT Area

4.1 Introduction

This chapter presents the results of the implementation of the *Site Screening Methodology* developed to the DUAT Area.

In the following sections, the main *Assumptions* and *Limitations* associated with the development of the *Inside the DUAT Area Suitability Models* (one for the *Village(s) Infrastructure* and one for *Livelihood Development Zone*) will be presented. After this, the implementation of the *methodology* to the DUAT Area will be described in detail, with each of the sub-sections presenting and explaining, step by step, the specifics regarding each of the phases of the methodology.

The *Suitability Models* supported the identification of a number of *Potential Sites*, located inside the DUAT Area, where to resettle and develop livelihoods activities. Additionally, these *Potential Sites* are located in areas that are believed not to be directly and/or significantly affected by the LNG Project.

4.2 Assumptions

The following assumptions were considered in the assessment:

- There is no legal impediment to resettlement within the current provisional DUAT Area.
- Land use rights for the resettled and remaining population to be ascertained.
- Tribal, traditional and community ownership is not a barrier to village relocation areas.
- Political affiliations, religious and similar factors are not considered a barrier to village relocation areas.
- No DUAT's have been issued within the current provisional DUAT Area.
- Total households to be resettled: approximately 556 (final numbers to be confirmed by the census):
    - 508 households associated with Quitupo;
    - 46 households associated with Senga; and
    - 2 households associated with Maganja.
- 1-2 Replacement *Villages* will be required for resettlement.
- The *Revised Build Zone* (as indicated in Figure 4-1) is the reduced area considered to be what is required for the construction of the LNG facility and associated services, and consists of the *New Build Zone* and the *Extended New Build Zone*.
- No households will be resettled to a location inside both the *Total Exclusion Zone* and/or the *Buffer Zone*.
- The Livelihood Development Zone is only constrained by:

- Revised Build Zone;
- Noise Buffer Zone;
- Quantitative Risk Assessment;
- Mangrove stands;
- Mari*ne Exclusion Zone*.

- The above mentioned areas (*Total Exclusion Zone*) will be fenced with cattle fence to indicate demarcation; no construction (habitation) shall occur within the fenced areas. Additional security and safety measures will be implemented as required to safeguard local residents.

- All results presented in this report are considered valid for a Project scenario with four trains (not for the subsequent phases of the Project). The QRA results available at the time of writing of this report correspond to this scenario.

- All households located within the ambient noise contour must be relocated. The "*suitable boundary for resettlement*" has been determined based on the "*Supplementary Noise Assessment*" Report (ERM). Updated noise modelling from the Project / Contractors was expected to confirm / correct this boundary. As it has not been received at the time or writing of this report, it was decided to account for an additional buffer/coefficient, corresponding to approximately 2 extra dB(A). The noise buffer considered therefore corresponds to an ambient noise contour of 43 dB(A).

- Public roads will be built within the DUAT Area, connecting the Replacement Village(s) with the existing villages and the coast.

- Pedestrian access through the DUAT Area will be provided. An under/overpass will be provided in order to grant communities a way to cross the *Revised Build Zone* (between the *New Build Zone* and the *Extended New Build Zone*).

- Permanent *Housing* for AMA1 and EEA staff will be built inside the DUAT Area (occupying an area of around 40ha), the location of which will be determined after final approval of the location of the *Replacement Site(s)*.

- There will be sufficient land agricultural available inside the DUAT Area for re-distribution amongst the households that need to be resettled, taking into account:
  - the actual loss of land within the Revised Build Zone (many of the households that will be resettled own/use land outside the Revised Build Zone, that they will still be able to use);
  - that people who own/use land within the DUAT Area but do not live there may receive economical compensation and/or replacement land outside the DUAT Area.

- The above mentioned assumption needs to be validated through the asset survey and land re-distribution process. If not enough land (area) is available, alternatives will need to be pursued (such as using land from outside the DUAT Area).

- Maganja will keep most of its agriculture land.

4.3 Limitations

The limitations of the assessment are as follows:

- The *Constraints* and *Comparison Criteria* considered in the models, as well as the weights assigned to each *criterion* require validation by the Government of Mozambique and the communities, through the *Stakeholder Engagement Process for Site Screening*. However, there has been no consultation with the Local Communities with regard to socio-economic parameters that reflect community aspirations and resettlement / compensation preferences to date.

- The LNG Project EIA was written based in the assumption that all communities located inside the DUAT Area would be have to be resettled outside the DUAT Area. As a consequence, no assessment of the environmental and social impacts has been conducted:
    - of the LNG Project on the communities residing inside the DUAT Area (particularly relevant for those who will no longer be resettled);
    - of the Replacement Village(s) inside the DUAT Area;

- ENH Logistics recently release a planning report has been released recently for the 18,000ha Industrial Zone. The planned *Replacement Village(s)* will need to be integrated into the planning.

- Information regarding some parameters considered in the *Site Screening Methodology*, namely with regards to noise and air quality, has been made available (hence accounted for in the methodology implemented) for the Operations Phase of the LNG facility only. No studies estimating noise levels during the Construction Phase have been conducted, hence this impact will have to be assessed and accounted for / managed when people move to the *Replacement Village(s)*.

- Information about areas currently in use for agriculture (existing cultivated areas) inside the DUAT Area, that would have been important to consider as a *Constraint*, could not be used once no updated and accurate data is available. A rough estimate of these areas has been conducted based on an interpretation of satellite imagery of the DUAT Area. Nevertheless, due to the fact that this imagery dates from 2010, it is likely that more areas are currently used for agriculture. On the other hand, other agriculture areas may not have been identified at the scale of the analysis carried out, either because of their small size, or due to shifting agriculture practice (fallow land, at the date of the data capture). It was therefore decided not to consider this information in the current analysis, but as soon as the census and asset surveys are completed, this information shall be considered in the *Site Screening Process*.

- The results of the Quantitative Risk Assessment available at the time of writing of this report are based on a four train scenario.

- With regards to ambient noise, the "*suitable boundary for resettlement*" used to outline the *Constraint* and to define the *Classification System* for the associated *criterion* should have been confirmed / reviewed based on updated noise modelling from the Project / Contractors, which was not available at the time of writing.

4.4 Implementation of the Methodology to the DUAT Area

This section describes in detail the way in which the phased GIS-supported *Multi-Criteria Assessment and Site Screening Methodology* developed was implemented specifically *to the DUAT Area*.

The data and information used with regards to the parameters considered as *Constraints* and *Comparison Criteria* were mostly derived from the LNG Project EIA. Wherever possible, this information was supplemented by additional data and information produced by WP, as well as from Project and Contractors, as per indicated.

Each of the following sub-sections explains, step by step, the implementation of each of the phases of the methodology and presents the specifics regarding the development of the "*Inside the DUAT Area*" *Suitability Models*, namely the *Site Screening Parameters* (*Constraints* and *Comparison Criteria*) considered.

4.4.1 Phase 1 – Definition of the *Study Area*

As mentioned in Chapter 3, the reduction of the LNG Project footprint to an area that is much smaller than originally envisaged (the *Revised Build Zone*) has the potential to reduce the number of households requiring physical displacement. As a matter of fact, those households situated outside the Project's *Revised Build Zone* in areas that are found not to be significantly affected by the Project may not need to be resettled.

This approach has also opened up space so that the *Replacement Village(s)* and agricultural land could be located inside the DUAT Area, thus allowing the resettlement of the affected households to occur closer to their current location.

In this context, the *Site Screening Methodology* was implemented in order to generate *Suitability Models* that would support the identification of *Potential Sites* for the location of the *Replacement Village(s)* in a *Study Area* defined as the DUAT Area, with the exception of the *Revised Build Zone* (area not dashed inside the yellow boundary, in Figure 4-1).

It is important to note that (at least) all communities residing inside the *Revised Build Zone* will need to be resettled, for what this area cannot be *candidate* for the location of the *Replacement Village(s)*, and had to be excluded from the *Study Area*.

Figure 1-1 depicts the area that will be subjected to an assessment in accordance with the subsequent phases of the *Site Screening Methodology* developed, and from within which the *Potential Sites* will ultimately be identified.

Figure 4-1 *Study Area* (DUAT Area), excluding the *Revised Build Zone*

4.4.2 Phase 2 – Constraints Mapping

The *Study Area* was then assessed in terms of the availability and suitability of areas for both the construction of the physical infrastructure associated with the villages, and for the establishment of the associated agricultural plots.

The parameters that may pose serious constraints to the use of the land (*Constraints*) for each of these two purposes differ, and have been identified in Table 4-1. This Table presents the technical, environmental and social *Constraints* (*no-go* areas) considered relevant for each *Suitability Model*.

Table 4-1 Relevant *Constraints* (*no-go* areas) considered for the two *Suitability Models*

PARAMETER	CONSTRAINT (NO GO)	RELEVANT CONSTRAINTS		ZONING
		LIVELIHOOD DEVELOPMENT - AGRICULTURE MODEL	VILLAGES / INFRASTRUCTURE MODEL	
LNG Construction Area	Inside the LNG Construction Aera (Build Zone and "Extended Build Zone", including areas for the LNG Plant, Permanent runway, Camp, etc.	X	X	TOTAL EXCLUSION ZONE
Explosion Risk Boundary (QRA)	Inside the LNG Plant Explosion Risk Boundary (QRA)	X	X	
Noise levels	Inside areas with estimated noise levels at the receptors higher than 45 dB(A) - worst case scenario (LNG flare processing and shipping scenario)	X	X	
Mangrove Stands	Inside mangrove stands	X	X	
Wetlands and flood-prone areas	Inside wetlands and flood-prone areas		X	BUFFER ZONE
Ecological sensitivity	Inside areas classified as "Very High Ecological Sensitivity" for vegetation and herpetofauna		X	
Air Quality	Inside areas where the NO2 annual average concentration exceeds the Mozambican Guideline Value		X	

For each *Suitability Model*, the areas that correspond to each of the relevant *Constraints* have been mapped and systematically excluded / *blocked out* from the *Study Area*, as they are deemed *unavailable* and/or *unsuitable* for the respective purposes.

All the remainder (non-constrained) areas within the *Study Area* (for each *Suitability Model*) are subject to subsequent analysis regarding their suitability.
The following sections present additional information about each of the *Constraints* considered for each *Suitability Model*, such as the reasoning for including the *Constraints*, and the sources of information used to produce the respective mapping exercise.

4.4.2.1. LNG Construction Area

The area where the LNG Plant will be built, referred to as the *Revised Build Zone* (*Build Zone* and *Extended Build Zone*), will need to be for the exclusive use of the LNG Project. For this reason:

- all communities residing in the *Revised Build Zone* need to be resettled, and

- the Replacement *Village(s)* and/or associated agricultural plots cannot be located in the *Revised Build Zone*.

Apart from the LNG Plant, a *Temporary Airstrip* will be constructed, and a *Permanent Runway* will be built to the South-West of the *Extended Build Zone*. The Project has provided information with regards to the location of these infrastructures and associated safety zones to consider. The construction camps will also be built in this area.

For the reasons explained above, and in order not to compromise the viability of the planned infrastructure (namely the ***Permanent Runway***) the *Revised Build Zone* has been blocked out (considered a *Constraint*) for both the construction of the physical infrastructure associated with the villages and for the establishment of the areas for livelihood development/agricultural plots.

4.4.2.2. Explosion Risk Areas (QRA)

The results of the Quantitative Risk Assessment available at the time of writing are based on a four-train scenario. .

The QRA will, however, fall inside the Noise Buffer Zone, which is considered the "*suitable boundary for resettlement and livelihood development".*

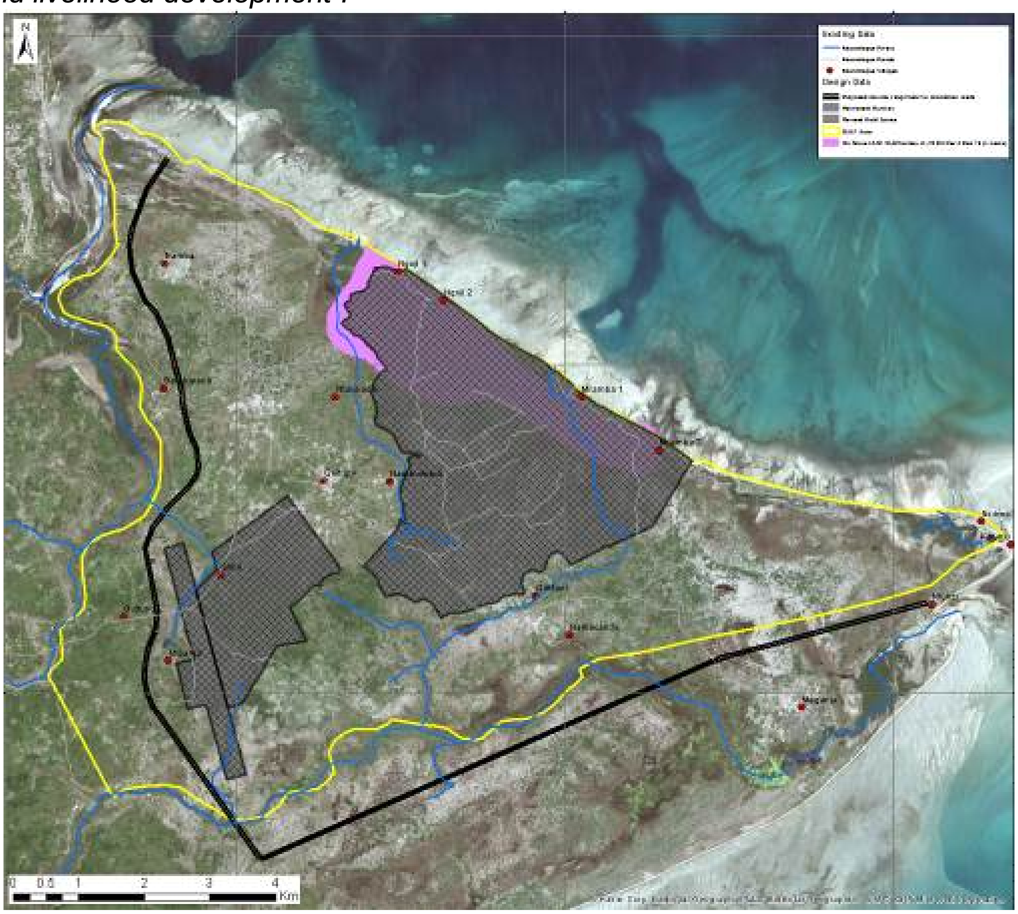


Figure 4-2 *Revised Build Zone* and QRA (overlap)

4.4.2.3. Mangrove Stands

Mangroves are a unique forest type and are limited to the intertidal area of estuaries, lagoons and sheltered coastal zones. Mangroves are extremely productive ecosystems that provide numerous good and services both to the marine environment and people:

- **Fisheries**: Mangrove forests are home to a large variety of fish, crab, shrimp, and mollusc species. They also serve as nurseries for many fish species, including coral reef fish, which makes them vitally important to coral reef and commercial fisheries as well.

- **Timber and plant products**: Mangrove wood is resistant to rot and insects, making it extremely valuable. Many coastal and indigenous communities rely on this wood for construction material as well as for fuel. These communities also collect *medicinal plants* from mangrove ecosystems and use mangrove leaves as animal fodder.

- **Coastal protection**: Mangroves help stabilize the coastline and prevent erosion by stabilizing sediments with their dense tangled root systems. They therefore protect the coastline from damaging storm and hurricane winds, waves, and floods, events that may become more frequent due to climate change. In areas where mangroves have been cleared, coastal damage from hurricanes and typhoons is much more severe.

- **Water Quality**: Mangroves help maintain water quality and clarity, by filtering pollutants and trapping sediments flowing down rivers and off the land.

- **Tourism Potential**: Given the diversity of life inhabiting mangrove systems and their proximity to coral reefs and sandy beaches, there is a huge tourism potential associated with these ecosystems.

Worldwide, mangroves are being destroyed 3 to 5 times quicker than other forest types. Mozambique's mangroves are amongst those with highest diversity in Africa.

Areas inside ***mangrove stands*** have been considered unsuitable for both the construction of the physical infrastructure associated with the villages and the establishment of the areas for livelihood development (namely the agricultural plots and for other livelihood activities), in an attempt to preserve these ecological/economical important ecosystems. As a consequence, mangroves have been identified as a *Constraint* (no-go area).

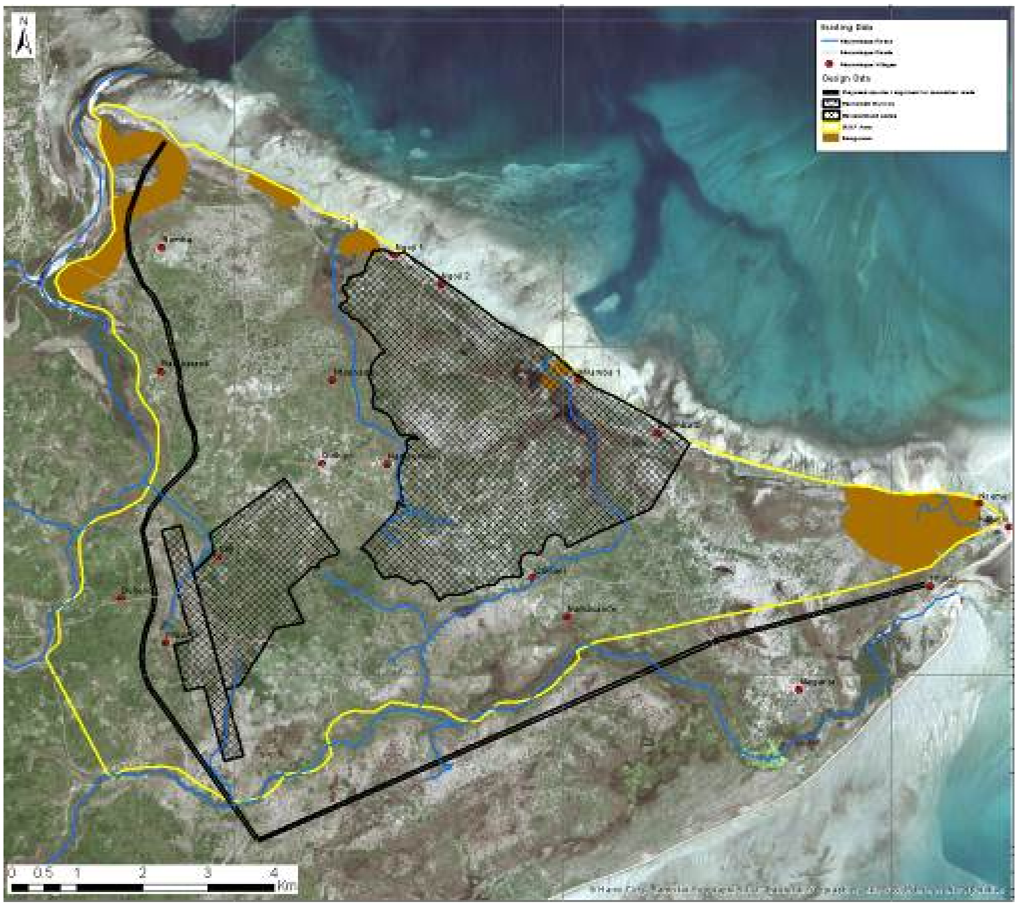


Figure 4-3 Mangrove Stands

The source of the data/information used in order to map these mangroves is as follows:

- Figure 7.45 – Distribution of mangrove stands in Palma Bay: Mangrove stands (Draft Environmental Impact Assessment (EIA) Report for the LNG Project in Cabo Delgado; Impacto / ERM; August 2013).

4.4.2.4. Wetlands

Wetlands are transitional areas between terrestrial and aquatic systems, where the water table is usually at or near the surface or the land is covered by shallow water.

Wetlands provide important economic, social and cultural benefits. They are important for primary products such as pastures, timber and fish. Wetlands also help reduce the impacts from storm damage and flooding, maintain good water quality in rivers by removing pollutants from water, promote groundwater recharge, protect shorelines from erosion, store carbon, help stabilize climatic conditions and control pests. Wetlands are amongst the most productive ecosystems in the world, comparable to rain forests and coral reefs. They are also a source of substantial biodiversity, as they support an exceptional variety of aquatic, terrestrial and wetland-specific fauna and flora. They also support a number of recreational and tourist activities.

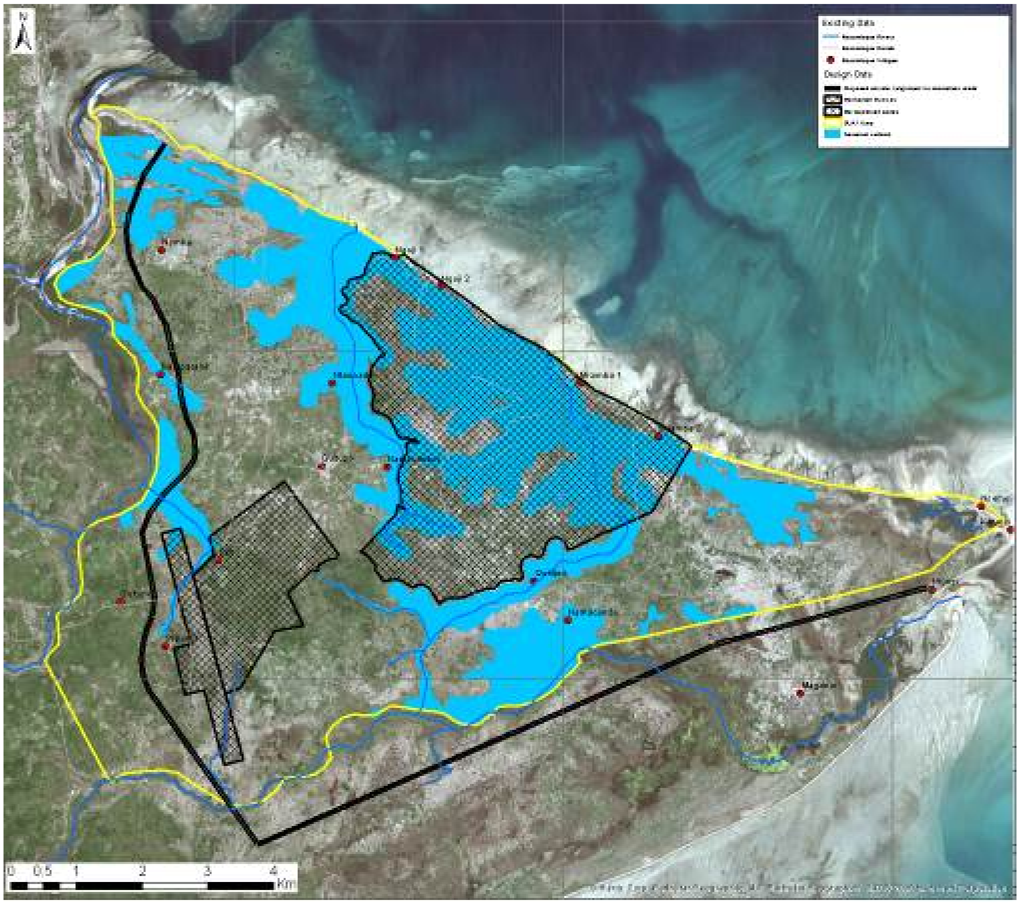


Figure 4-4 Wetlands

Areas inside ***wetlands*** have been considered unsuitable for the construction of the physical infrastructure associated with the villages, for technical reasons. As a consequence, this has been identified as a *Constraint* (no-go areas) for the *Village(s) / Infrastructure Model*.

These areas are traditionally used by Local Communities for their livelihood activities, and therefore can be used for livelihood development activities.

However, since wetlands are important for economic, social and environmental reasons, they should be avoided and preserved to the extent possible, even for the conduction of such activities, considering the important benefits they provide. This has been addressed to a certain extent through the definition of a *criterion* that avoids the areas of higher *Ecological Sensitivity*. Since wetlands are home to an exceptional variety of fauna and flora, they have been, in general, identified as being "very high" or "high" ***ecologically sensitive***.

The source of the data/information used in order to map these areas was:

- Figure 8.19 – Surface Water Ecology Survey Area: wetland buffer (150m), enclosing estuary areas and permanent, seasonal and unspecified wetland (Draft EIA Report for the LNG Project in Cabo Delgado; Impacto / ERM; August 2013).

4.4.2.5. Flood-prone Areas

Flood-prone areas are areas that are very likely to get flooded (higher than 99% during any given year), either with surface and/or ground water, have been considered unsuitable for the construction of the physical infrastructure associated with the villages.

Some ***flood-prone areas*** may, however, be suitable for certain livelihood activities (namely certain types of agriculture and/or intertidal collection), which is the reason this *Constraint* has not been considered for the establishment of the areas for livelihood development.

The source of the data/information used in order to map these areas was:

- <u>Surface Water</u>: Surface Water Modelling: Figure 8.16 – Delineated flood lines for the 1 in 100 year rainfall event (Draft EIA Report for the LNG Project in Cabo Delgado; Impacto / ERM; August 2013);

- <u>Groundwater</u>: "Groundwater Flood Extents" (WP Groundwater Modelling, modified from CES data).

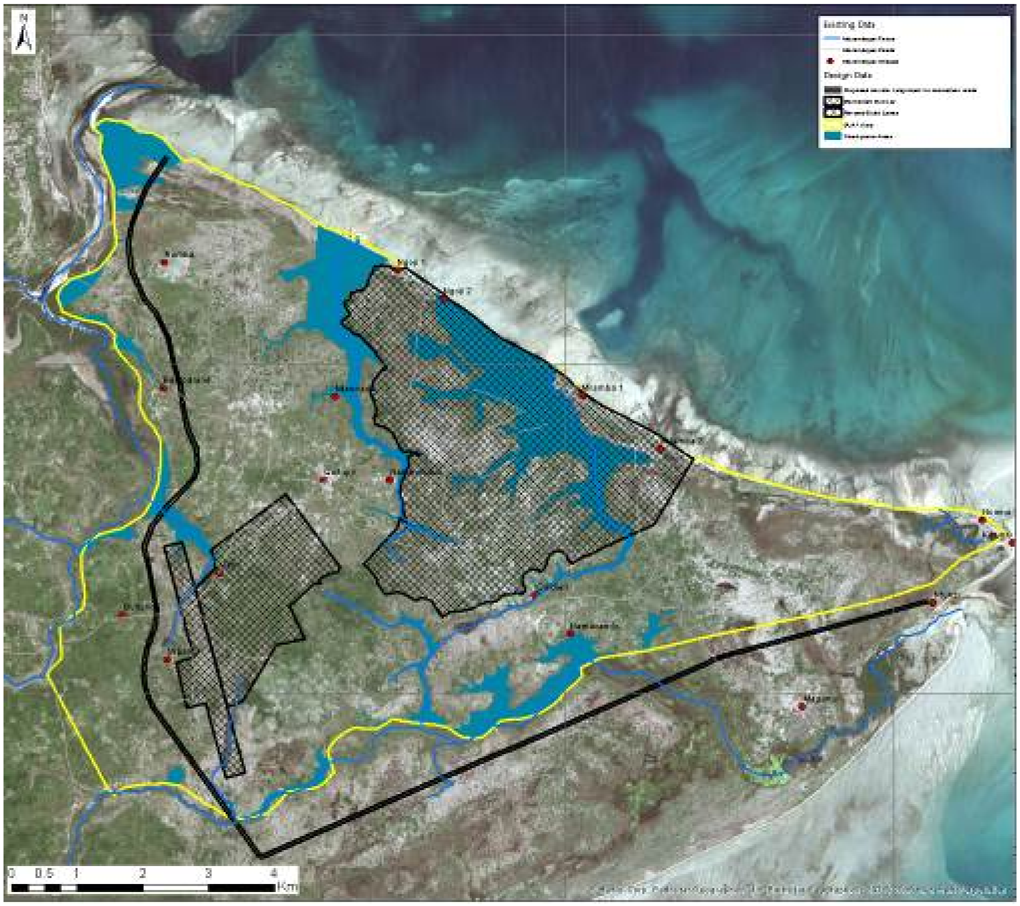


Figure 4-5 Flood-prone areas

4.4.2.6. Ecological sensitivity

Ecologically *Sensitive* areas, apart from its intrinsic environmental importance, provide important economic, social and cultural benefits to the communities, both directly and indirectly. These areas are in general strongly related with important natural resources and the products/services that these provide, which in turn are directly associated with the livelihood of the communities to be resettled.

According to the Resettlement Decree (Decree no. 31/2012, Art 5) "the resettlement aims at stimulating the socio-economic development of the country and guaranteeing a better quality of life of the affected population and social equity, **taking into account the sustainability of the physical, environmental, social and economic aspects**."

Ecological Sensitivity is therefore seen as an important parameter to take into consideration in the *Site Screening Process*, also in alignment with the Resettlement Decree.

In order to promote the sustainability of environmental (and subsequently social and economic) aspects, the areas of higher ***ecological sensitivity*** should be preserved. This would allow the ecosystems to be kept in equilibrium and therefore provide all the benefits associated, allowing the resettled communities to continue practicing their subsistence activities, which depend on this equilibrium.

The areas of ***very high ecological sensitivity*** should therefore be blocked out for the construction of the *Replacement Village(s)*, because building a village there would destroy / significantly damage these sensitive areas.

The LNG Project EIA has studied in detail the ecology of the Afungi Area. It has identified and described in detail the existing habitat types (vegetation, herpetofauna, avifauna and mammals). It has studied the *sensitivity of each of these components / habitat types*, and mapped it – within the DUAT Area – by identifying the areas ("Units") with different degrees of sensitivity. These areas were classified from "very low" to "very high" ***ecological sensitivity***.

This resulted in the production of several "*sensitivity maps*", one for each *habitat type*. Each map represented the classification of the different "Units" identified for the respective *habitat type*, according to its different *degrees* of sensitivity.

The "*sensitivity maps*" produced for all *habitat types* have then been overlapped and a *global map* has been produced, summarizing the overall ***ecological sensitivity*** of the areas within the DUAT Area. This map combines all "*key onshore environmental sensitivities"* and represents the areas classified by *degree of sensitivity*, regardless the *component* or *habitat type* in question. In other words, a certain area will show up in the ***global map*** classified as of ***very high ecological sensitivity*** if that area has been classified as such with regards to, at least, one *habitat type*, … and the same reasoning is applied to the subsequent (lower) degrees of ***ecological sensitivity***.

The source of the data/information used in order to map this *Constraint* was Figure 8.83 ("Key onshore environmental sensitivities: Sensitivity rating – *very high")* of the Draft EIA Report for the LNG Project in Cabo Delgado (Impacto / ERM; August 2013).

The areas classified in the ***global map*** as having a ***very high ecological sensitivity*** have been *blocked out* (defined as a *Constraint*, or no-go areas) for the construction of the *Replacement Village(s)* and associated infrastructures. As per the explanation above, it is considered that building a village in these *very sensitive* areas would significantly impact and/or destroy them.

On a further detailed analysis of the areas that are classified in the ***global map*** as of having a ***very high ecological sensitivity***, it is possible to observe (using the individual *sensitivity maps*), that these correspond to areas of ***very high ecological sensitivity*** for the *habitat types* vegetation and herpetofauna (reptiles and amphibians). These areas correspond, in general, to dense woodlands and wetlands and, in short, its ***very high ecological sensitivity*** derives from the fact that all animal groups are reliant on these areas for their survival.

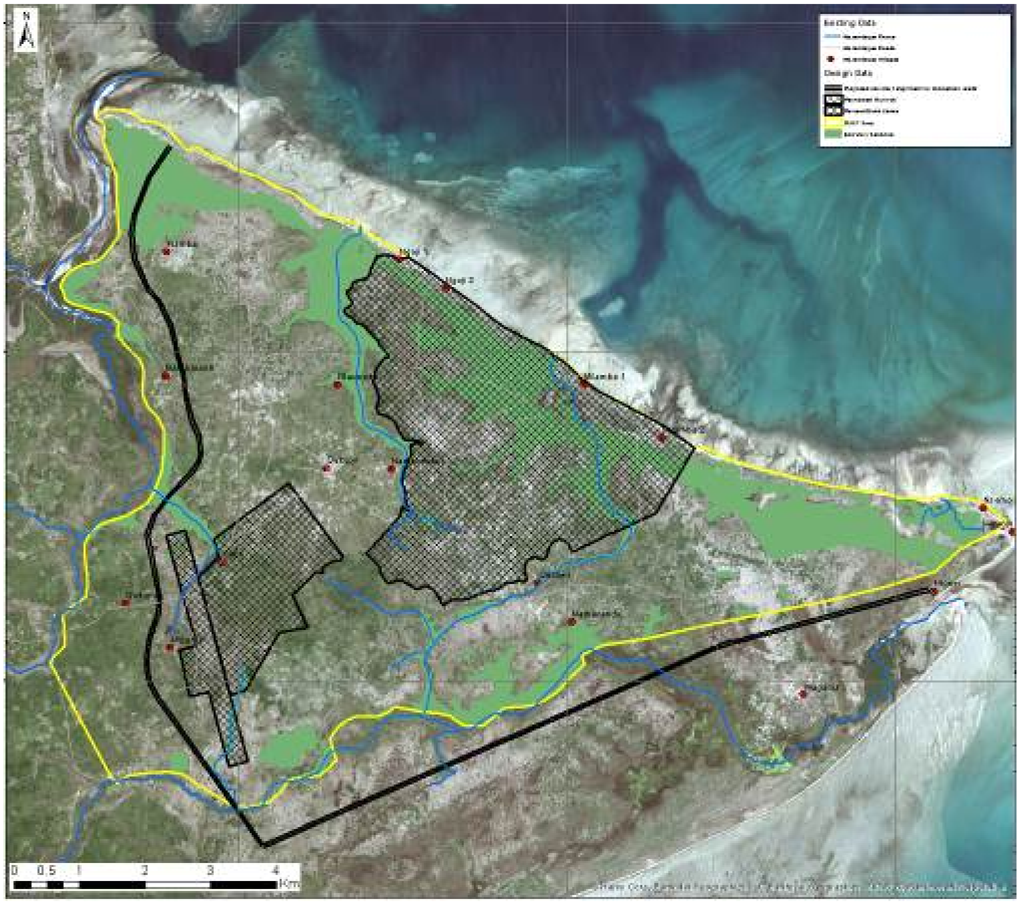


Figure 4-6 Areas of "*Very High Ecological Sensitivity*"

Although the areas classified as ***very high ecological sensitivity*** are very important for environmental / ecological and socio-economic reasons, and should therefore be preserved to the extent possible, it was considered that some livelihood development activities might be carried out there. This would have to be done in a sustainable manner, without destroying these highly sensitive areas. For this reason, these areas have not been blocked out for the establishment of the areas for livelihood development and have not been defined as a *Constraint* (no-go areas) for the *Livelihood Development / Agricultural Model*.

The livelihood development activities should be planned in such a way that ensures that these areas are avoided and preserved to the extent possible, in order to control and limit the significance of the associated impacts over these areas.

Despite the fact that these areas have not been blocked out for livelihood development purposes, this concern has been addressed to a certain extent through the definition of a *criterion* that avoids the areas of higher ***ecological sensitivity***. This has been achieved through the definition of a *Classification System* which assigns a poor classification to the areas of higher ecological suitability (when building the *Suitability Models*) in an attempt to avoid its use, for both the villages and for livelihood development purposes. This will be further explained in later sections.

4.4.2.7. Noise levels

Noise from oil and gas development comes from a number of sources: well pumps and compressors, traffic, drilling and completion activities, etc. High noise levels can cause hearing impairment, annoyance, sleep disturbance, stress, etc.

International standards have been developed to provide guidelines for noise levels for areas with different characteristics. According to the World Health Organization (WHO, 1999), the recommended noise levels for residential, institutional, and educational areas, are 55 dB(A) during the day (07:00 to 22:00) and 45 dB(A) at night. A 'conversation at home' is on average as loud as 50 dB(A).

ERM has carried out, on behalf of the Project, a supplementary noise assessment in order to support the Resettlement Village Site Screening Process (*Supplementary Noise Assessment - to Support the Resettlement Village Site Screening Process*; ERM, December 2013). The aim of this study was to identify the areas where the noise levels are expected to be higher than 45 dB(A) during the operation of the LNG facility, considering both the noise from the Project and the already existing noise sources (mostly natural sources).

A key aspect of this assessment was the development of suitable means for informing the decision making process for the *establishment of a suitable boundary for resettlement and livelihood development*. In order to do so, two main aspects were considered: *the increase in background levels* and an estimate of the *areas where the ambient noise levels (existing + LNG) would be greater than 45 dB(A)*. Areas outside this "*suitable boundary for resettlement and livelihood development*" should therefore be excluded as potential resettlement and livelihood *development* areas.

Different operating scenarios / plant configurations (corresponding to different operational phases of the Project) have been modelled. Nevertheless, the "worst case scenario" (Scenario 4) was considered for the purpose of the *Site Screening Process* followed (presented in this report), corresponding to the simultaneous occurrence of: 14 LNG processing trains, 4 flare system in operation and shipping utilities. The report considered a logical and defensible approach for the establishment of the "*suitable boundary for resettlement and livelihood development*" to apply a *safety factor* of 3 dB(A), which corresponds to recommending the 42 dB(A) LNG Plant noise contour as the "*suitable boundary for resettlement and livelihood development*". This boundary would then correspond to the 45 dB(A) LNG Ambient noise contour.

On this basis, the 42 dB(A) LNG Plant noise represented in Figure A.4b – Predicted Noise Levels Scenario 4 (14 LNG Train Units) in Appendix A to the above mentioned ERM report, was initially used to represent the "*suitable boundary for resettlement and livelihood development*", corresponding to the 45 dB(A) LNG Ambient noise contour.

Updated noise modelling from the Project / Contractors was expected to confirm / correct this buffer. At the time of writing, however, the updated noise modelling was not available. It was therefore decided to account for an additional coefficient, corresponding to approximately 2 extra dB(A), to build in an extra safety margin. The way this coefficient has been incorporated is by taking the 43 dB(A) LNG Ambient noise contour (represented in the above mentioned Figure A.4b, Appendix A to the ERM report, and corresponding to a decrease of the 2 dB(A) with regards to the previously considered the "*suitable boundary* *for resettlement and livelihood development*") as the ***new*** "*suitable boundary for resettlemen and livelihood development*" (the *estimated* 45 dB(A) LNG Ambient noise contour).

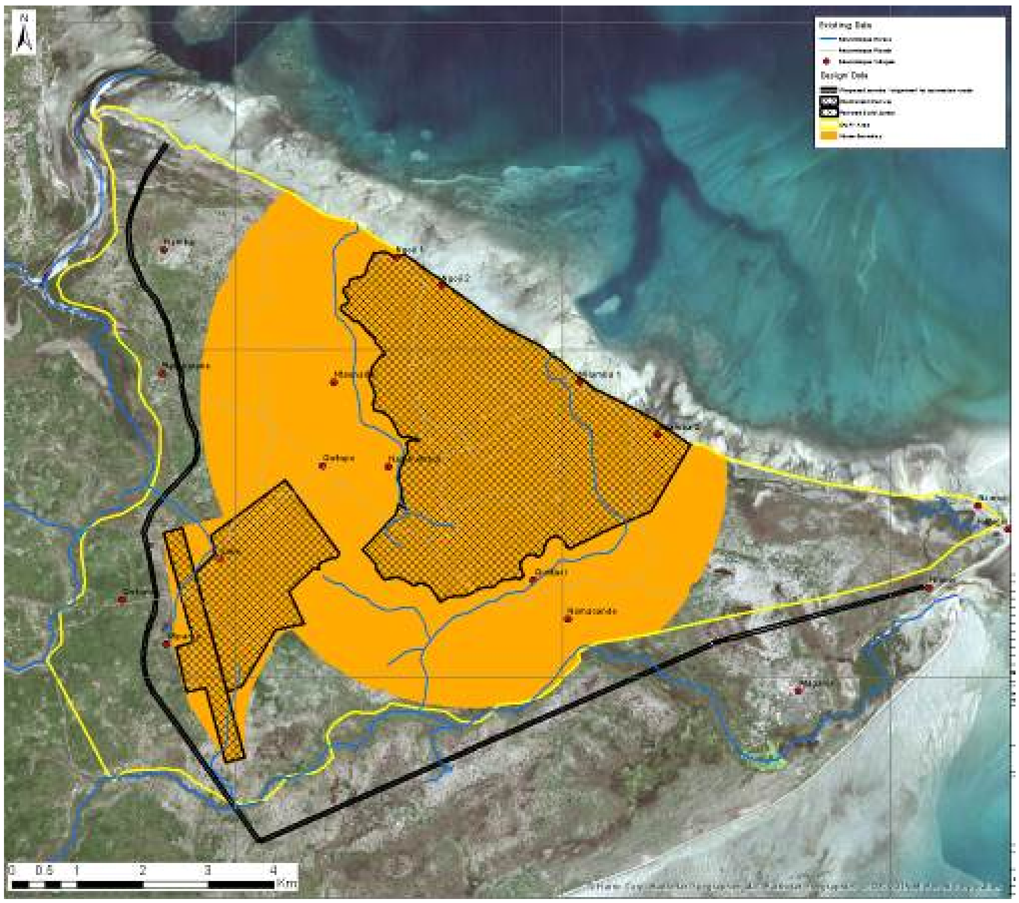


Figure 4-7 Noise boundary for resettlement and livelihood development

The area inside the "*suitable boundary for resettlement and livelihood development*" is considered unsuitable for purposes of the location of the *Replacement Village(s)* and associated infrastructure, as well as for livelihood *development* purposes. The area has therefore been identified as a *Constraint* (no-go areas) for the *Village(s) / Infrastructure Model* and for the *Livelihood Dvelopment Model*.

4.4.2.8. Air Quality

The LNG trains emit several air pollutants, out of which NO_2 is the primary pollutant of concern with regards to human health, and therefore this pollutant was used in order to define the areas that are adequate for resettlement purposes.

The Mozambican Government has set standards for NO_2 concentrations in the air (Decree no. 67/2010). These include a long-term (annual average) concentration guideline of 10 µg NO_2/m^3 and a short term (1-hour) concentration guideline of 190 µg NO_2/m^3.

The long-term (annual average) concentration limit is particularly appropriate to determine the areas suitable for resettlement, considering the potential to exceed such limit.

On behalf of the Project, ERM has conducted studies to estimate the concentrations of these two air quality parameters in the surroundings of the LNG Plant (*AQ for resettlement v0.2*; ERM, November 2013).

These studies have allowed the identification of an area where the NO_2 annual average concentration in the air is expected to exceed the Mozambican Guideline Value. This area has been mapped and presented in the following Figures, included in ERM's report, which have been used by WP as the source of the data/information for the purposes of Site Screening:

- Figure 4.1: Annual NO_2 impact (Scenario 1: 14 Trains operational, no flaring)
- Figure 4.2: Short term (1hr max) NO_2 impact (Scenario 2: 14 Trains operational, 2 flares in emergency event).

The parameter "*NO_2 annual average concentration*" has been defined for continuous exposure. It was assumed that people may remain in the areas where they live, which is why this limit needs to be complied with, and why this parameter has been identified as a *Constraint* (no-go areas) for the *Village(s) / Infrastructure Model*.

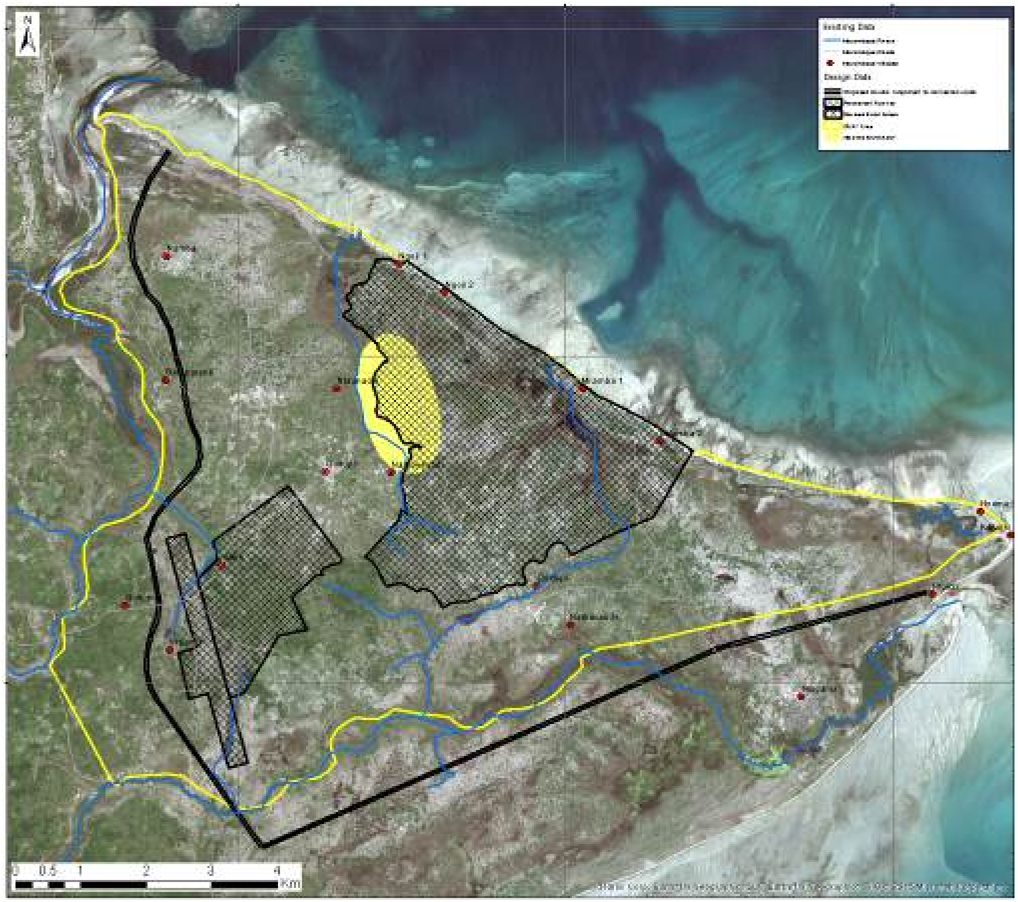


Figure 4-8 Air Quality (NO_2 annual average concentration) boundary for resettlement

The areas where the *NO_2 annual average concentration* exceeds the Mozambican Guideline Value are therefore considered unsuitable for the construction of the physical infrastructure associated with the villages and should therefore be blocked out.

This parameter was not used to define “no-go” areas for livelihood purposes, because the limit set has been defined for long-term / continuous exposure, which is not the case in the Livelihood Development Zone, where people spend shorter periods of time (“temporary” activities). This means that livelihood development activities can be carried out in those areas, since the air quality is compatible with the “nature” of such activities (taking into account the time people remain in those areas).

The adequate parameter to consider for this purpose (definition of “no-go” areas for livelihood purposes) would be the short term (1hr max) NO_2 average. Nevertheless, according to the model, it is not expected that the short term (1-hour) NO_2 concentration guideline is exceeded anywhere, not even inside the LNG build area. For this reason, this parameter ended up not being used to define additional “no-go” areas (*Constraint*) related with air quality, for the *Livelihood Development / Agriculture Model*.

4.4.2.9. Summary – *Individual Constraints*

The individual constraints that apply to the *Livelihood Development/Agricultural Model* are represented (in Figure 4-9) in different colours, allowing an understanding of the reason a given area is deemed *unavailable* or *unsuitable* for the establishment of the agricultural plots associated to the *Replacement Village(s)*.

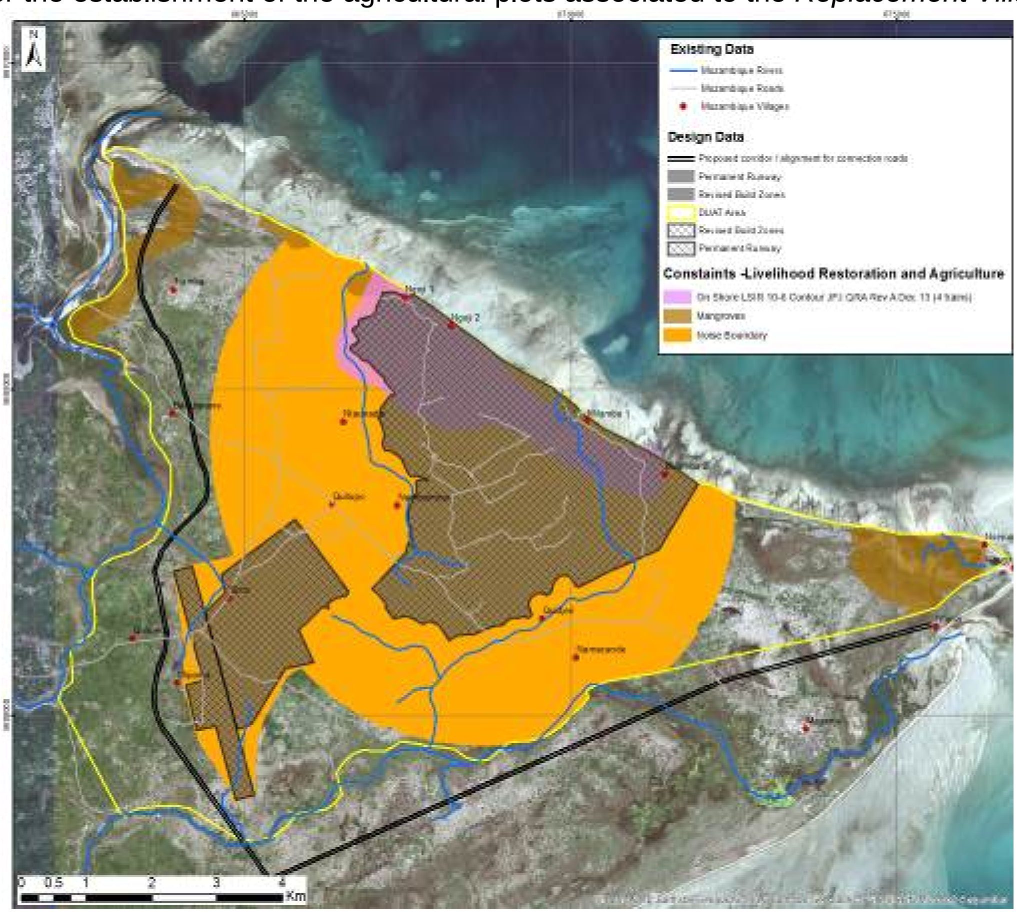


Figure 4-9 *Constraint mapping*: Individual constraints – Livelihood Development/Agricultural Model

Similarly, the individual constraints that apply to the *Village(s) Infrastructure Model* are represented in Figure 4-10 in different colours. This representation allows an understanding of the reason why a given area is deemed *unavailable* or *unsuitable* for the construction of the *Replacement Village(s)*.

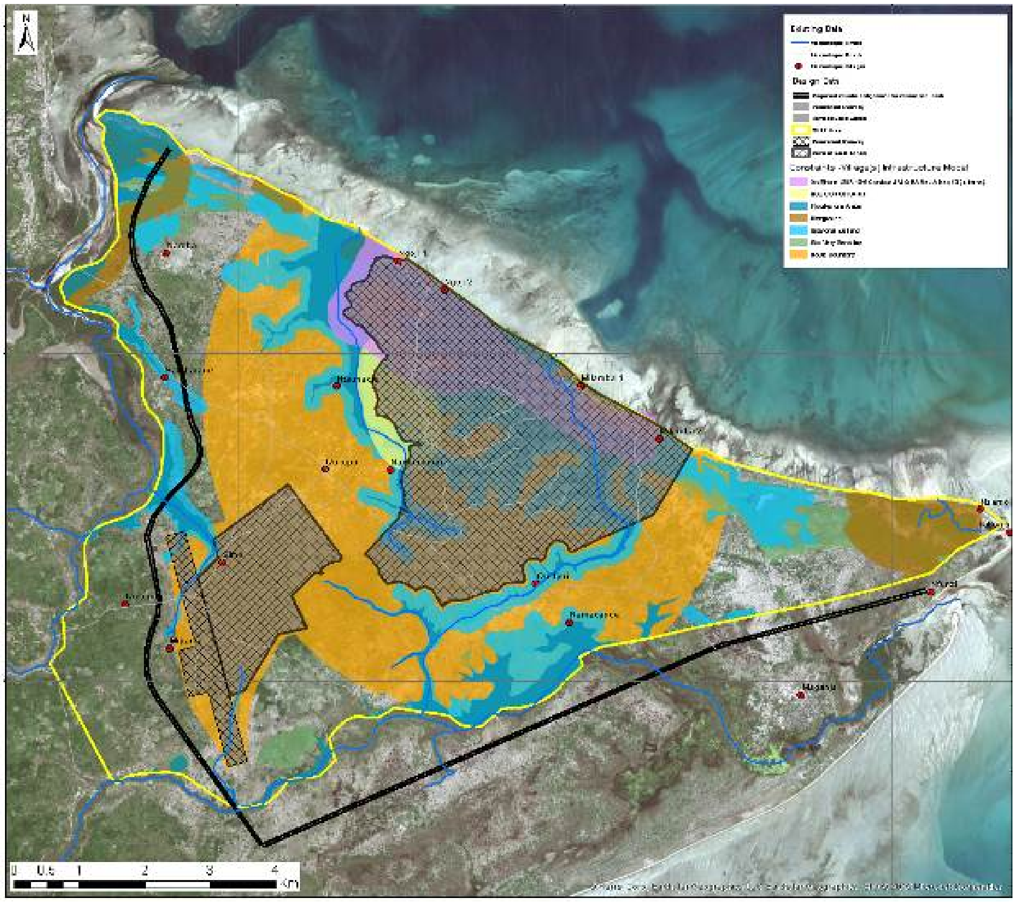


Figure 4-10 *Constraint mapping*: Individual constraints – Village(s) Infrastructure Model

4.4.2.10. **Summary – *Combined Constraints***

The total areas that are deemed *unavailable* or *unsuitable* for either the establishment of the agricultural plots or the construction of the *Replacement Village(s)* have been combined and are represented in grey in Figure 4-11 and Figure 4-12 respectively. These grey areas represent *combined constraints* for each model.

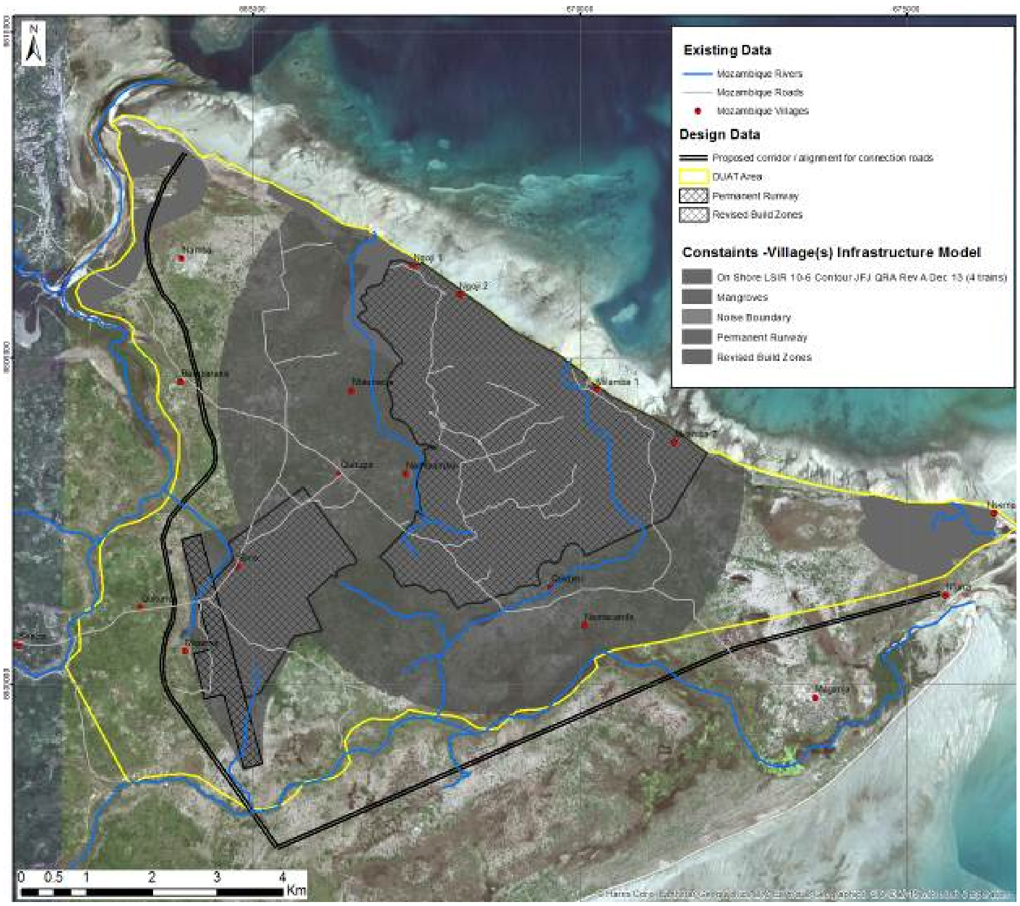


Figure 4-11 *Combined constraints* (in grey) and *Potentially Suitable Areas* for the Livelihood Development/Agricultural Model

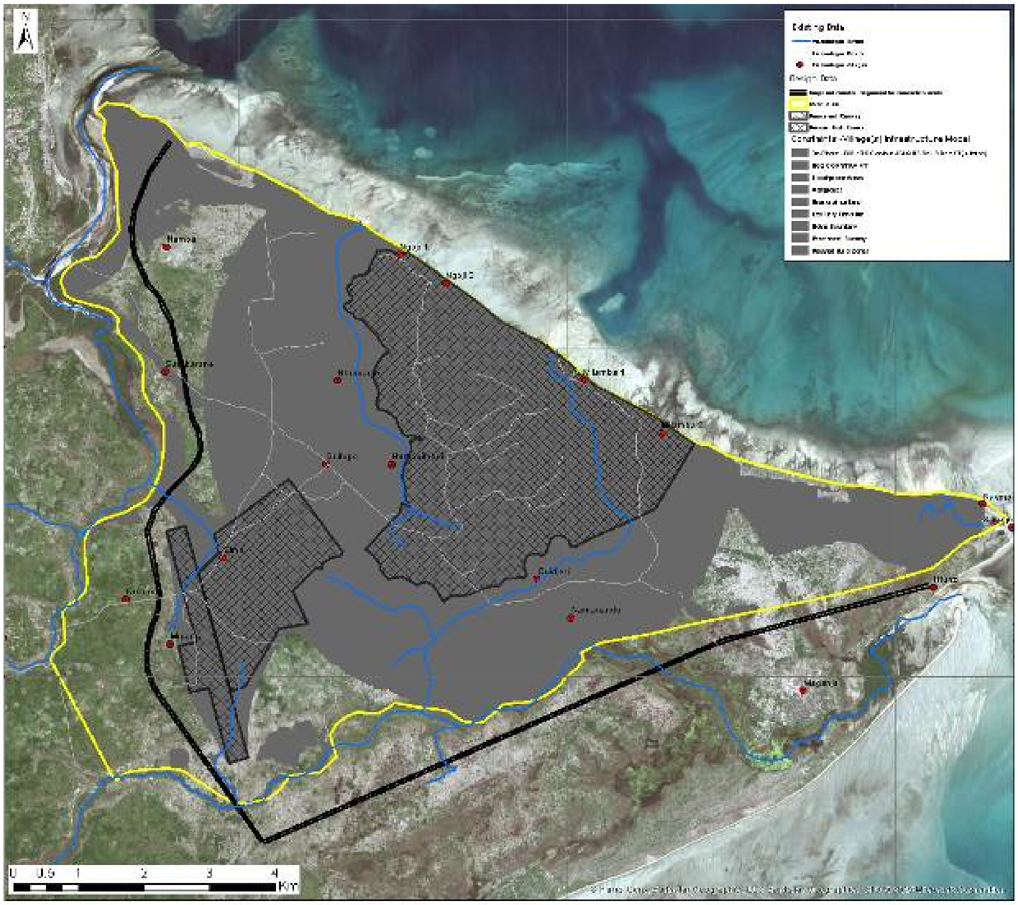


Figure 4-12 *Combined constraints* (in grey) and *Potentially Suitable Areas* for the Village(s) Infrastructure Model

4.4.2.11. Zoning Maps

As mentioned, the area that results from overlapping all the *Constraints* that apply simultaneously to the two *Suitability Models* defines the *Total Exclusion Zone* – represented in pink in Figure 4-13. This area is deemed unavailable / unsuitable for resettlement purposes, meaning that no activity (that is not directly related to the LNG Project) shall take place there.

This area shall be fenced in order to prevent the communities accessing it.

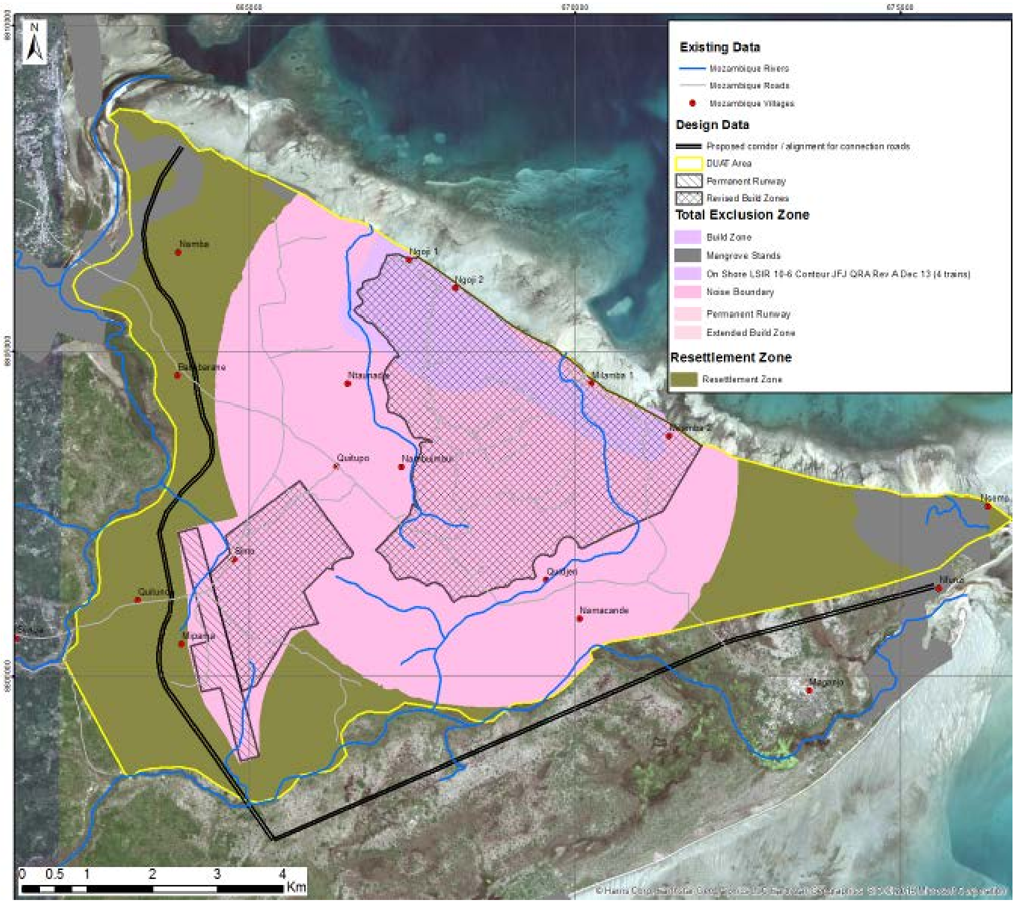


Figure 4-13 *Total Exclusion Zone (pink)*

Some other areas may be unsuitable for the location of the *Replacement Village(s)* and associated infrastructure, but not for carrying out certain livelihood development activities, such as agriculture and intertidal collection. These areas (that result from overlapping all the *Constraints* that apply only to the *Village(s) Infrastructure Model*) define a *Buffer Zone* – represented in light green in Figure 4-14.

This area is deemed unavailable for the construction of the *Replacement Village(s)*, but available (and perhaps suitable) for livelihood development activities.

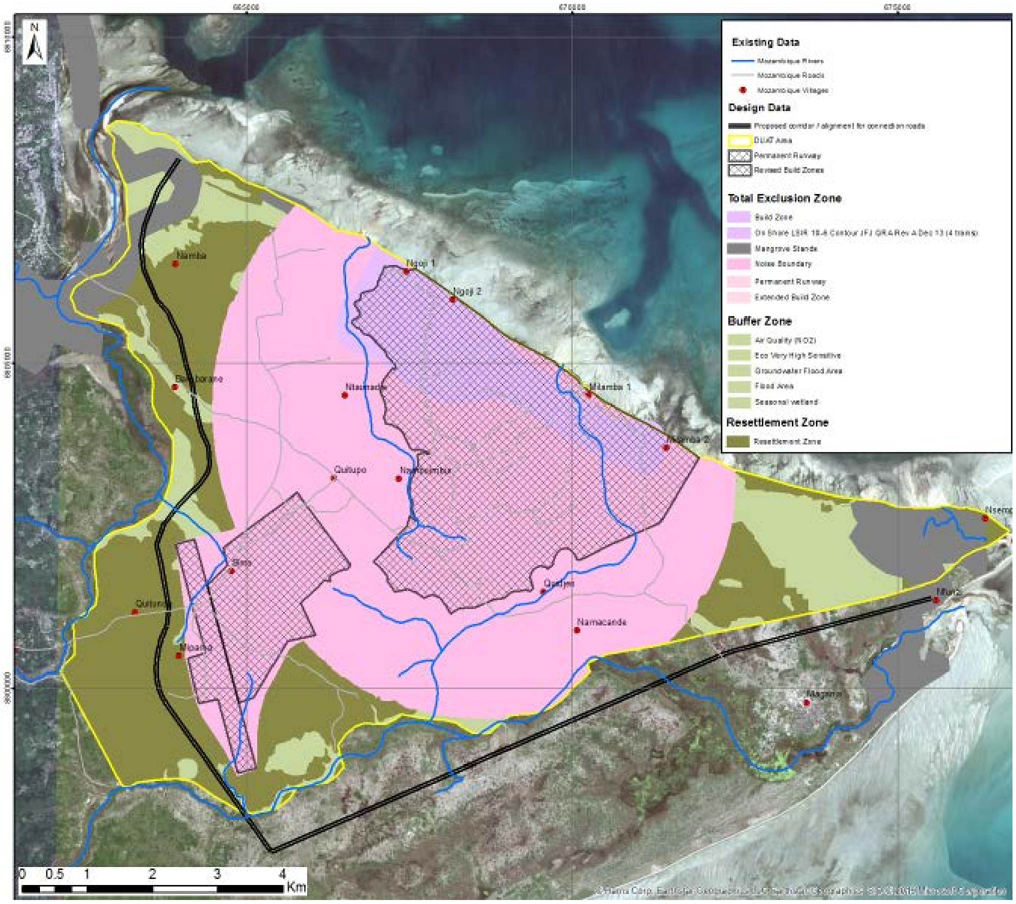


Figure 4-14 *Buffer Zone (light green)*

4.4.3 Phase 3: *Suitability Models* – Multi-Criteria assessment and ranking of *Potentially Suitable Areas* according to their Overall Suitability

For each model, several parameters were identified to be used as *criteria* for comparing the *Potentially Suitable Areas* that resulted from Phase 2. It is worth stressing that, in order to qualify as *Comparison Criteria*, the parameter must allow a differentiation of the areas in terms of its suitability with regards to a particular aspect.

For each *Comparison Criterion*, a *Classification System* was developed in order to allow an objective classification of the *Potentially Suitable Areas*. In general, five classes were defined, ranging between (**5**), classification attributed to the *most suitable areas*, and (**1**), attributed to the *least suitable areas*. For each model, the *Potentially Suitable Areas* were then classified for all applicable *Criteria*, using the respective *Classification System*.

For each of the two *Suitability Models*, a *Relative Weight* was assigned to each *criterion* (on a percentage scale) in order to reflect the relative importance each represents within the respective model: aspects considered more "*relevant*" for the purpose of each model have received a higher *Relative Weight*.

Table 4-2 indicates the parameters considered as *Comparison Criteria* for each of the two models. It also summarizes the *Classification Systems* developed for each *criterion* and the *weights* assigned to each, for both models.

In this section, further detail is presented with regards to *Classification Systems* developed to classify the *Potentially Suitable Areas* for each of the *Comparison Criteria*. Using the spatial information available, the *Potential Suitable Areas* have been classified, and the results of this classification are presented. For each *Comparison Criteria*, a map is presented representing the Potential Suitable Areas classified in different colours, corresponding to the different classes according to the respective *Classification System*. As mentioned in the Site Screening *Methodology*, the different classes are represented using different colours, varying between green representing the "best" class and red representing the "worst". In other words, all areas are "graded" by degree of suitability.

Table 4-2 *Comparison Criteria*, *Classification System* and Weights used for the two models

PARAMETER	*CRITERION*	CLASSIFICATION SYSTEM		WEIGHT (%)	
				VILLAGE(S) INFRASTRUCTURE	LIVELIHOOD RESTORATION - AGRICULTURE
Access to the sea	"Proximity to the coast"	Classes of "Distance to the coast"	5 = 0 - 1.5 km 4 = 1.5 - 3.0 km 3 = 3.0 - 4.5 km 2 = 4.5 - 6 km 1 = > 6 km	**25**	**0**
Access to and availability of services and markets / trade	"Proximity to Palma", considered to be the neighbouring town that can serve as hub for services and markets / trade	Classes of "Distance to Palma"	5 = 0 - 3 km 4 = 3 - 6 km 3 = 6 - 9 km 2 = 9 - 12 km 1 = > 12 km	**15**	**15**
Access to suitable agricultural land	Agricultural potential of the soils	Classes of "agricultural potential" of the soils	5 - High (Map Unit 3) 4 - Moderate (Map Unit 2) 3 - Moderate to low (Map Unit 1) 2 - Low (Map Unit 5) 1 - Very low (Map Unit 4)	**5**	**40**
Access to Water (in quantity and quality)	Ground Water Availability (Quantity and Quality of the deep and shallow aquifers)	Classes of groundwater quality and availability	5 - Very Good 4 - Good 3 - Fairly good 2 - Poor 1 - Bad	**15**	**25**
Access to a quiet environment (in terms of noise)	Noise levels – worst case scenario (LNG flare processing and shipping scenario)	Classes of Estimated "noise levels" at the receptors	5 = < 39 dB(A) 4 = 39 dB(A) <= X < 41 dB(A) 3 = 41 dB(A) <= X < 43 dB(A) 2 = 43 dB(A) <= X < 45 dB(A) Add. blocked out: > 45 dB(A)	**15**	**0**
Access to an unpolluted environment (in terms of air quality)	NO2 annual average concentration (14 Trains operational, no flaring)	Classes of "NO2 annual average concentration" (in ug NO2/m3)	5 = < 5.0 3 = 5.0 <= X < 7.5 1 = 7.5 <= X < 10.0	**5**	**0**
	Short term (1 hour max) NO2 concentration (14 Trains operational, 2 flares in emergency blowdown event)	Classes of "NO2 Short term (1 hour max) concentration" (in ug NO2/m3)	5 = < 95.0 3 = 95.0 <= X < 142.5 1 = 142.5 <= X < 190.0	**5**	**0**
Ecological Sensitivity	Key onshore environmental sensitivities (combined)	Classes of Ecological Sensitivity	5 - Very Low Sensitivity 4 - Low Sensitivity 3 - Moderate Sensitivity 2 - High Sensitivity 1 - Very High Sensitivity	**15**	**20**
Access to suitable fishing grounds (qualitative criterion)	Suitability of the fishing grounds (qualitative criterion)	Classes of suitability of the fishing grounds	Very High: > 1.28 High: > 1.09 and < 1.28 Moderate: > 0.91 and < 1.09 Low: > 0.72 and < 0.91 Very Low: < 0.72	**Qualitative analysis**	

4.4.3.1.1. Access to the sea

It was assumed that all communities, although to different extents, depend on both agriculture and fishing. For this reason, and in order to minimize changes to the livelihood of fishing communities, the *Replacement Village(s)* should desirably be located "close" to the coast to provide the communities an easier/faster access to the sea for fishing and intertidal collection activities. Therefore, areas located closer to the coast were considered to be more favourable for the location of the *Replacement Village(s)* than areas located further away.

It was therefore considered that the *criterion* "*Proximity to the coast*" would allow a differentiation between the *Potentially Suitable Areas* for the location of the *Replacement Village(s)*, but not for the location of the agricultural plots.

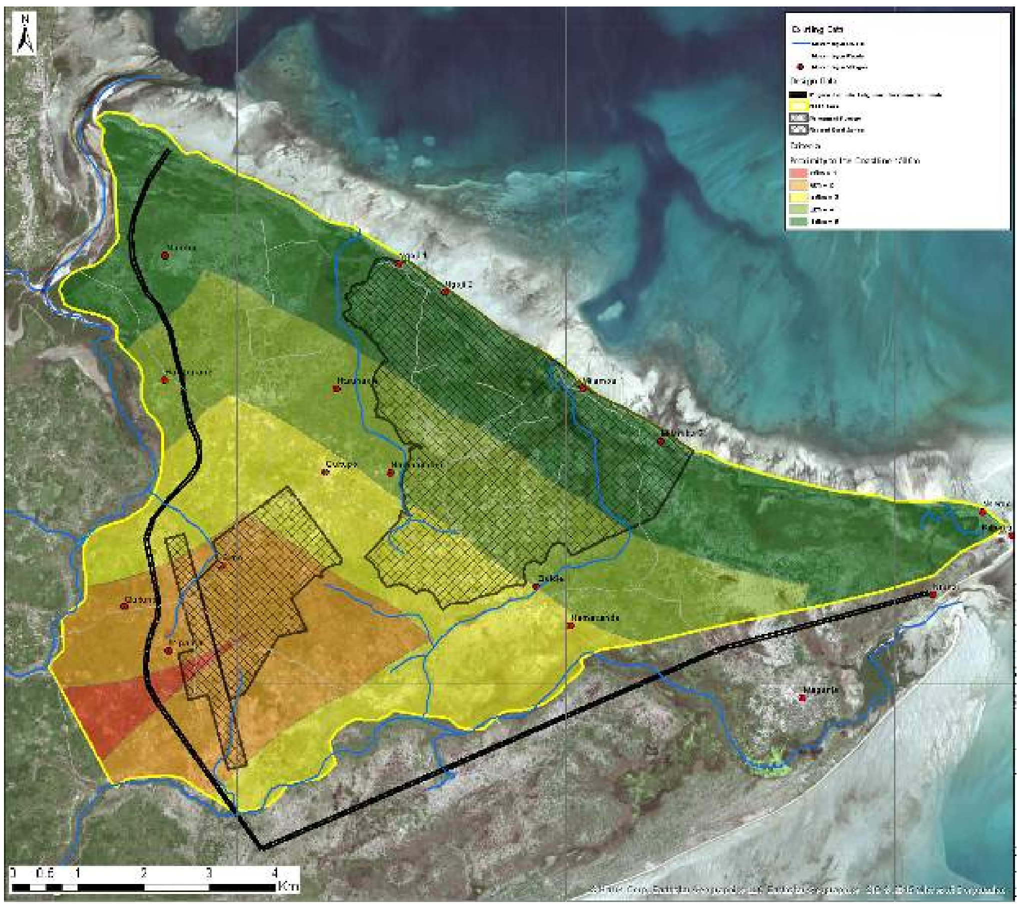


Figure 4-15 Classification of the *Potentially Suitable Areas* according to its "*Proximity to the coast*"

Five classes of "*Distance to the coast*" (*Classification System*) were defined to classify and compare the *Potentially Suitable Areas* in terms of it "*Proximity to the coast*": areas which distance to the coastline (measured in km a straight line) is up to 1.5, 3.0, 4.5, 6.0 km or greater than 6.0 km: the closer to the coast, the higher the classification should be.

The classification of (5) was therefore attributed to the areas located at a distance of up to 1.5 km from the coast (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas located at a distance of over 6.0 km from the coast (the least suitable according to this *criterion*).
Figure 4-15 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Proximity to the coast*", using five classes of "*Distance to the coast*".

4.4.3.1.2. Access to and availability of services and markets / trade

It was assumed that the communities to be resettled would value having access to a larger town that offers a number of services as well as access to markets and trade opportunities. In the Afungi Area, Palma town was considered to offer these opportunities. For this reason, the *Replacement Village(s)* should desirably be located "close" to Palma town. The areas located closer to Palma town were therefore considered to be more favourable for the location of the *Replacement Village(s)* than areas located further away.

It was therefore considered that the *criterion* "*Proximity to Palma*" would allow a differentiation between the *Potentially Suitable Areas*. This *criterion* was considered relevant for both the location of the *Replacement Village(s)* and associated infrastructure (for ease of access to services and markets / trade, in general) and for the location of the associated agricultural plots (for ease of access to markets where to trade / sell the agricultural produce).

Five classes of "*Distance to Palma*" (*Classification System*) were defined to classify and compare the *Potentially Suitable Areas* in terms of its "*ease of access*" to services and markets / trade: circles around Palma town 3, 6, 9 and 12 km radius (measured in a straight line), were used to define areas (buffers) which distance to Palma is up to 3, 6, 9, 12 km or greater than 12 km: the closer to Palma, the higher the classification should be.

The classification of (5) was therefore attributed to the areas located at a distance of up to 3 km from Palma town (areas within the 3 km radius circle, closest to Palma town: the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas located at a distance of over 12 km (areas outside the 12 km radius circle, furthest away from Palma town: the least suitable according to this *criterion*).

Figure 4-16 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Proximity to Palma*", using five classes of "*Distance to Palma*".

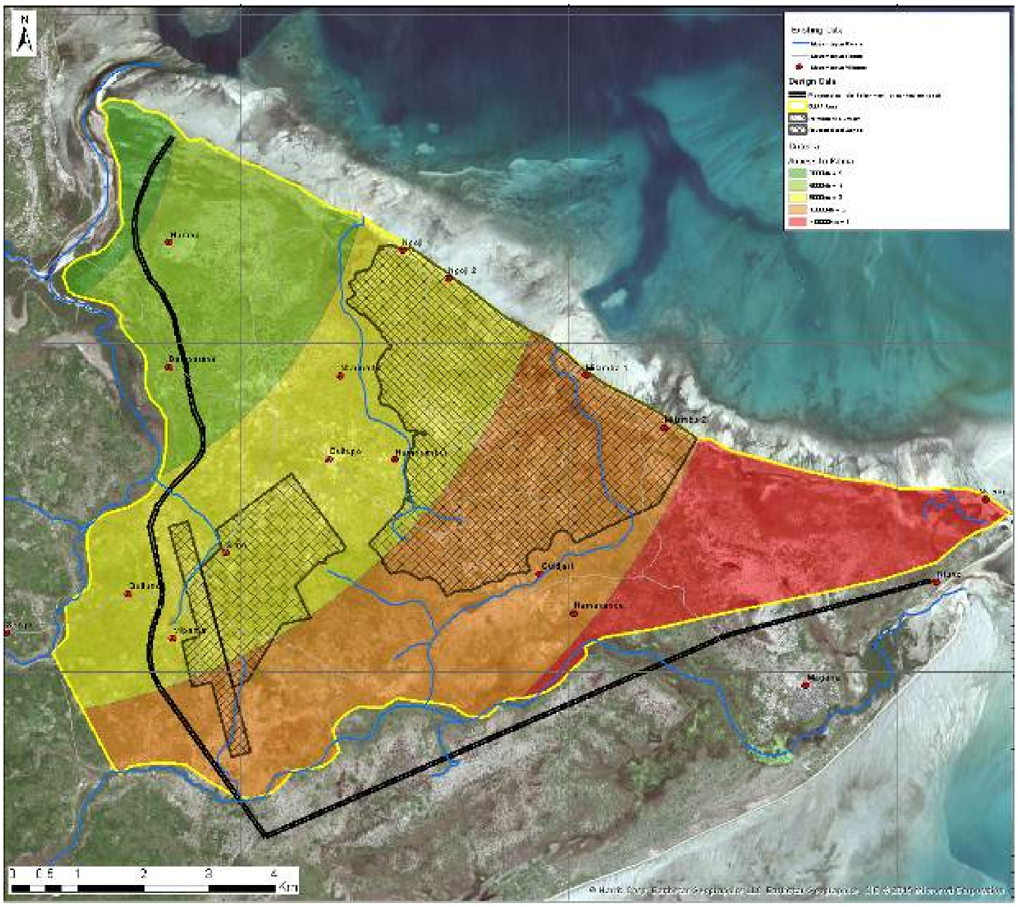


Figure 4-16 Classification of the *Potentially Suitable Areas* according to its "*Proximity to Palma*"

4.4.3.1.3. Access to suitable agricultural land

As mentioned, the livelihoods of the communities to be resettled are closely related to agriculture. In order to minimize changes to the livelihood of agricultural communities, it was considered that the communities to be resettled need to have access to suitable agricultural land. For this reason, the *Replacement Village(s)* should desirably be located in and/or close to areas with soils with a relatively good (to the extent possible, considering the area) agricultural potential. The establishment of the agricultural plots in these areas would allow resettled communities to re-establish their *machambas* and to continue practicing their subsistence agriculture, or even increase their agricultural production.

It was therefore considered that the *criterion* "*Agricultural potential of the soils*" would allow a differentiation between the *Potentially Suitable Areas*. This *criterion* was considered relevant for both the location of the *Replacement Village(s)* and associated infrastructure, and the location of the agricultural plots, although far more relevant for the latter, as these would be the areas exclusively dedicated to agricultural production.

It was then necessary to investigate the areas within the DUAT Area that might be available to support agricultural activities, as well as the characteristics of the soils and the respective agricultural potential, in order to define a *Classification System* that allows the comparison of the *Potentially Suitable Areas*.

With regards to the availability of land, this would have to be confirmed at a later stage, after the conclusion of the census and asset surveys, and in consultation with affected and host communities.

Regarding the characteristics of the soils and respective suitability for agricultural activities, the *Classification System* defined consisted in the definition of five classes of "*Agricultural potential of the soils*" in order to classify and compare the *Potentially Suitable Areas*. These have been defined based on the report "*Agriculture: Reconnaissance Soil Survey (14-24 May 2013)*", considering the "*Revised soils map*" of the DUAT Area presented in this report, as well as the respective *addendum*. This report established a correspondence between the different soils types present in the DUAT Area (represented, in the "*Revised soils map*", as different "*Map Units*", each defined and described in the report) and the respective "Priority" for use for agriculture. The higher the "Priority", the higher the "agricultural potential of the soils", and therefore the higher the classification assigned.

In order to define the *Classification System* to classify the *Potentially Suitable Areas* with regards to the "*Agricultural potential of the soils*", the following classes were defined to classify and compare the *Potentially Suitable Areas*. The way these classes have been defined allows the establishment of a correspondence with the *Priorities* assigned to each of the "*Map Units*". The higher the "*agricultural potential of the soils*", the more *suitable* the corresponding area is for the location of the agricultural plots (and establishing of the *machambas*):

- 5 – "*High agricultural potential" (*Priority 1: Map Unit 3 – "*Best for agricultural purposes*");
- 4 – "*Moderate agricultural potential*" (Priority 2: Map Unit 2);
- 3 – "*Moderate to low agricultural potential*" (Priority 3: Map Unit 1);
- 2 – "*Low agricultural potential*" (Priority 4: Map Unit 5 – "*similar to Map Unit 4, but with slightly higher cation exchange capacity*");
- 1 – "*Very low agricultural potential*" *(*Priority 5: Map Unit 4 – "*very low cation exchange capacity and low water holding capacity*").

The higher classification (5) was attributed to the areas with soils with higher agricultural potential – *first priority* (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas with soils with lower agricultural – *last priority* (the least suitable according to this *criterion*).

Figure 4-17 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Agricultural potential of the soils*"*, using five classes of* "*Agricultural potential of the soils*".

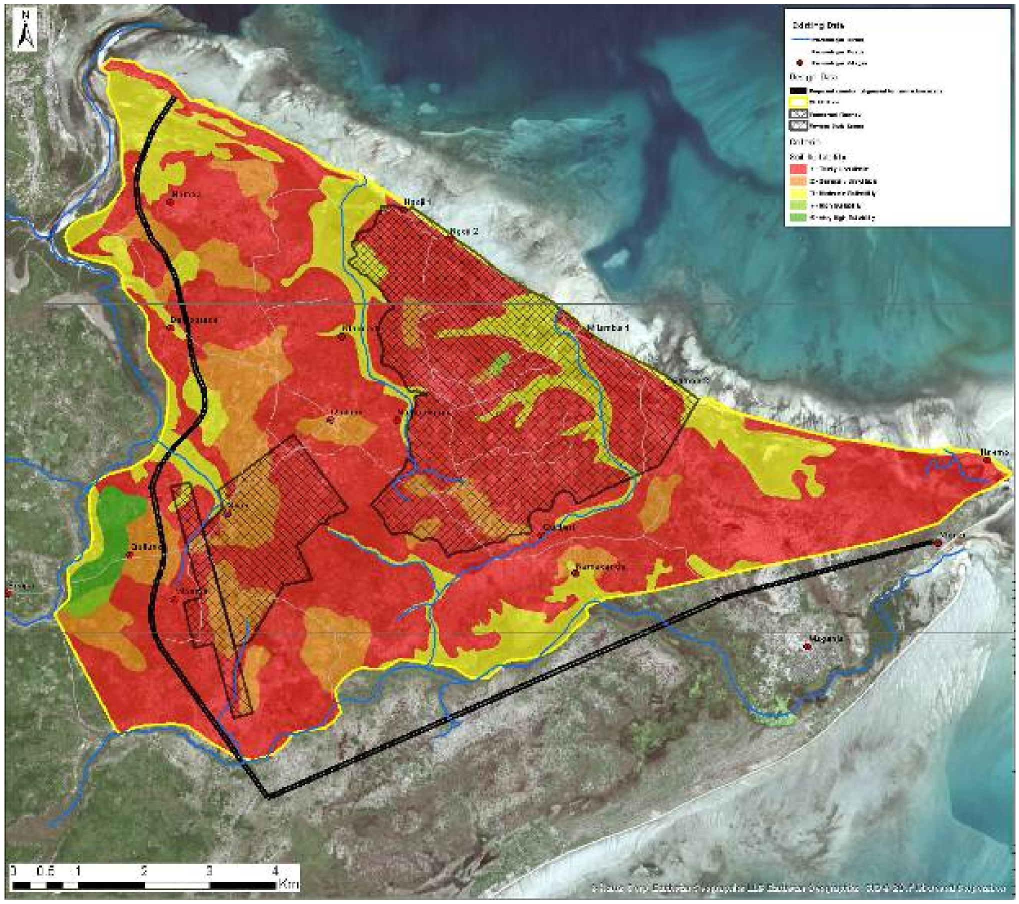


Figure 4-17 Classification of the *Potentially Suitable Areas* according to the "*Agricultural potential of the soils*"

4.4.3.1.4. Access to Groundwater (in quantity and quality)

It was assumed that the communities to be resettled need to have access to sufficient quantities of groundwater of the best possible quality for both their day-to-day use / consumption and for agriculture. Therefore, providing access to enough and good quality water is essential to grant good living conditions to the resettled communities, as well as to allow them to continue practicing their subsistence agriculture, or even to increase their agricultural production.

For these reasons, the *Replacement Village(s)* and the associated agricultural plots should desirably be located in areas where groundwater is available / accessible, in quantities enough to satisfy the demand and with a level of quality adequate for the expected use. These areas are preferable because they provide easier access to higher quantity / quality of this fundamental resource, comparing with locations where groundwater is inaccessible or harder to reach, or where it is available, but in little quantity and/or poor quality.

It was then considered that the *criterion* "*Groundwater availability (quantity and quality of the deep and shallow aquifers*" allows for a differentiation between the *Potentially Suitable Areas*. This *criterion* was

considered relevant for both the location of the *Replacement Village(s)* (for day-to-day use) and the location of the associated agricultural plots (for water use in agriculture).
It was therefore necessary to investigate the areas within the DUAT Area where the aquifers are expected to be accessible, more productive and the water has the highest possible quality.

Studies have been conducted in order to obtain the necessary information to define a *Classification System* that allows for the comparison of the *Potentially Suitable Areas* in terms of "*Groundwater availability*".

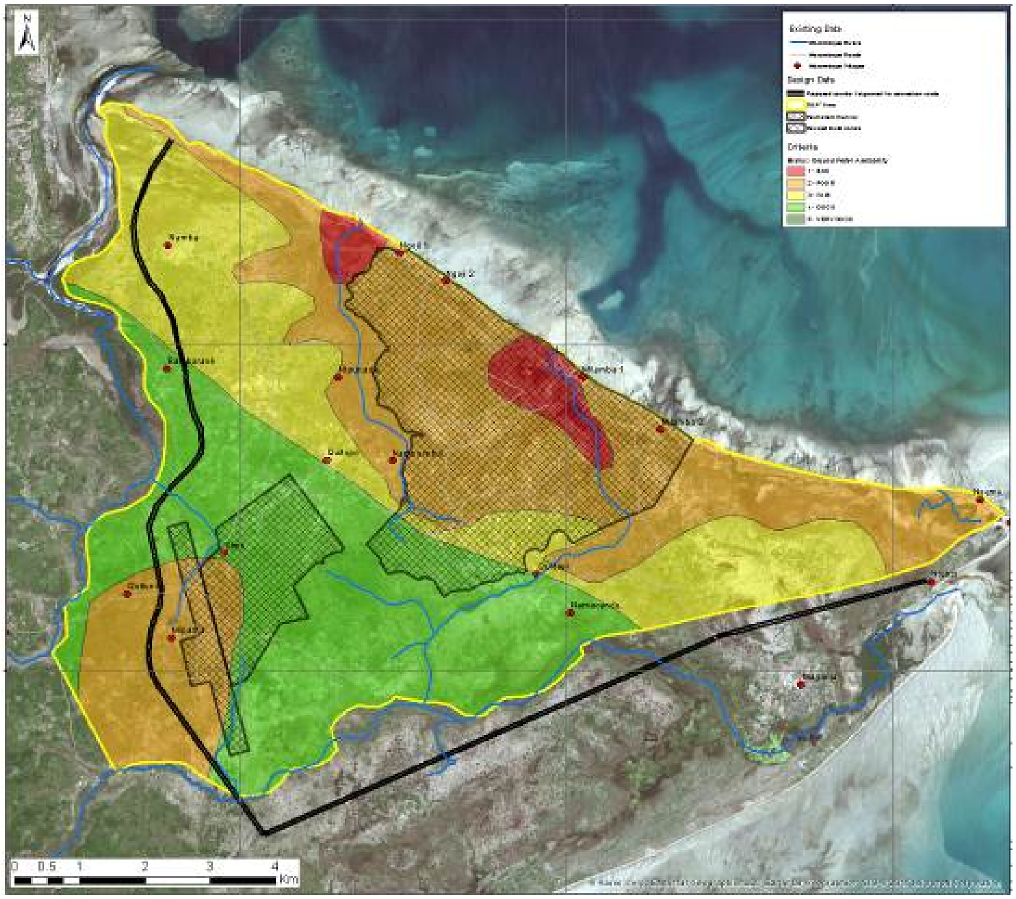


Figure 4-18a Classification of the *Potentially Suitable Areas* according to "Shallow g*roundwater availability*"

The geology and hydrogeology of the area surrounding the DUAT Area were determined from literature and field data, and this has informed the likely availability and quality of water supply.

Saline intrusion, formation water, mineralisation and sanitary pollution have been identified as the contributors to areas of lower water quality. Agricultural practices may also influence the quality of water.

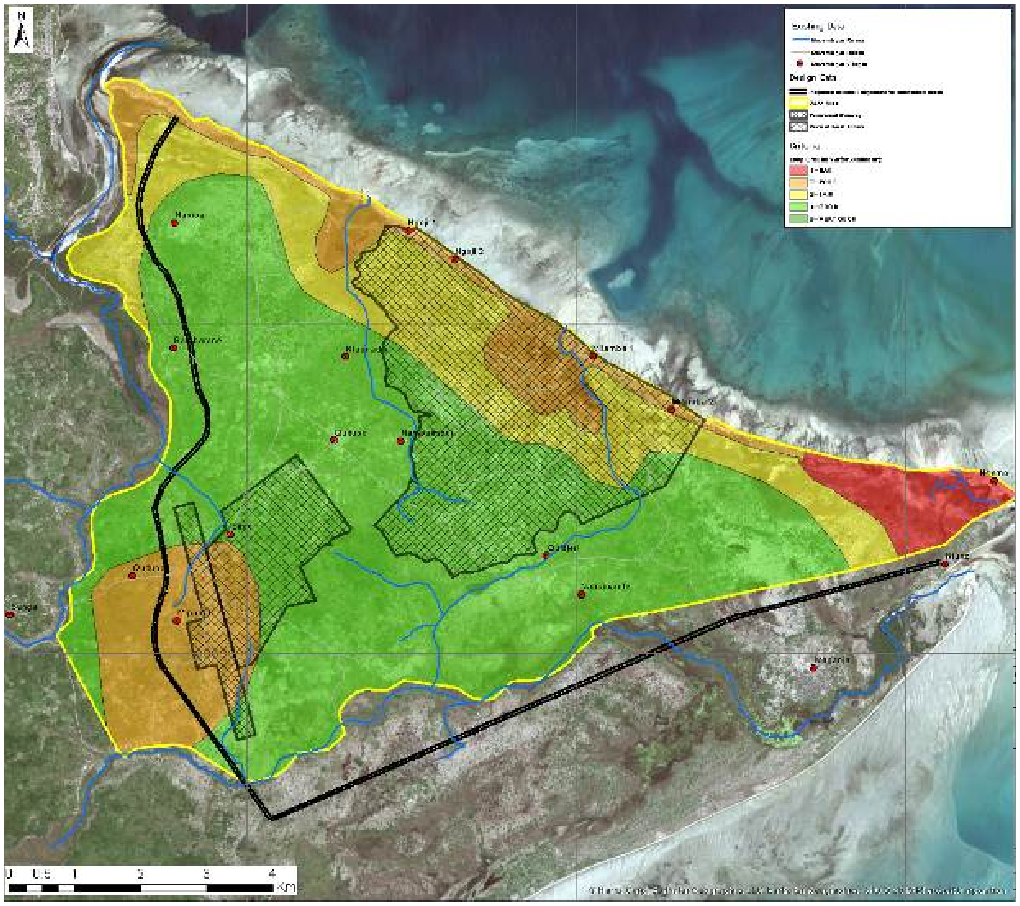


Figure 4-18b Classification of the *Potentially Suitable Areas* according to "*Deep groundwater availability*"

Aquifers with sufficient productivity to support resettled people appear to be present across the *Study Area*. The groundwater discharges along the coastal margin forming wetlands, the extents of which are highly seasonal. Areas of "groundwater flooding" have been established from numerical modelling to inform location planning. The effects of climate change may alter the productiveness, particularly in the shallow rapidly responding coastal dune aquifers, and extents of groundwater flooding. The development of the LNG facility will also locally impact on quality and productiveness, through construction activities, change of land use and the installation of a well field to supply the Project. These potential impacts have been assessed and considered in the analysis.

Based on the information provided by these studies, the *Classification System* defined consisted in the definition of five classes of "*Groundwater quality and availability*". These have been defined taking into consideration aspects related to both the aquifers productivity (quantity) and water quality, regarding both the deep and shallow aquifers. The better the areas are in terms of both groundwater availability and quality (of both the deep and shallow aquifers), the higher the classification of the areas according to this *criterion*.

The classification of (5) was attributed to the "Very Good" areas (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the "Bad" areas (the least suitable according to this *criterion*).

Figure 4-18 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Groundwater availability (quantity and quality)*", using five classes of "*Groundwater quality and availability*" (Figure 4-18a for the *shallow aquifers* and Figure 4-18b for the *deep aquifers*).

4.4.3.1.5. Access to a quiet environment (in terms of noise)

It was assumed that communities should be resettled to areas where they can benefit from a quiet environment in terms of noise. As mentioned, according to the World Health Organization (WHO, 1999), the recommended noise levels for *residential, institutional, and educational areas*, are 55 dB(A) during the day (07:00 to 22:00) and 45 dB(A) at night.

As mentioned, the areas within the Afungi Peninsula where the ambient noise levels are expected to be higher than 45 dB(A) (considering the studies carried out by ERM conducted for resettlement purposes and the precaution "extra 2 dB(A) coefficient") have been blocked out (considered as 'no-go' areas) for purposes of the location of the *Replacement Village(s)* and for *Livelihood Development*.

As noise decreases with distance from the noise sources (amongst other factors), the further away from the noise sources, and specifically from the "blocked out" area, the lower the noise levels are expected to be, and the more quiet the surrounding environment is expected to be.

It was therefore considered that the "*Noise levels at the receptors*" allow a differentiation between the *Potentially Suitable Areas* for the location of the *Replacement Village(s)* and associated infrastructure. In order to minimize disturbance/nuisance related to noise, in particular related with the LNG facility, the *Replacement Village(s)* should desirably be located away from the "*suitable boundary for resettlement and livelihood development*".

The *Classification System* defined to classify and compare the *Potentially Suitable Areas* in terms noise, consisted in the definition of five classes of "*Estimated noise levels at the receptors*" (buffers), each class corresponding to decreasing the noise levels in 2 dB(A), starting from the 45 dB(A) boundary. The further away from this boundary, the higher the classification (as the lower the noise levels are expected to be). Again, the "*Supplementary Noise Assessment*" Report – *Figure A.4b - Predicted Noise Levels Scenario 4 (14 LNG Train Units)* was used as the source of data for the definition of the above mentioned classes. When the model had already been run, it was decided to account for the *precaution* factor of 2 dB(A), it was necessary to adjust the Classification System used, once the areas initially classified as 1 (between 43 dB(A) and 45 dB(A)) ended up being blocked out, extending the 'no-go' areas considered for this Constraint.

The classes considered were:

- Blocked out > 45 dB(A)
- 2 = between 43 dB(A) and 45 dB(A)
- 3 = between 41 dB(A) and 43 dB(A)
- 4 = between 39 dB(A) and 41 dB(A)
- 5 = less than 39 dB(A)

Figure 4-19 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Noise levels at the receptors*", using the five classes of "*Estimated noise levels at the receptors*".

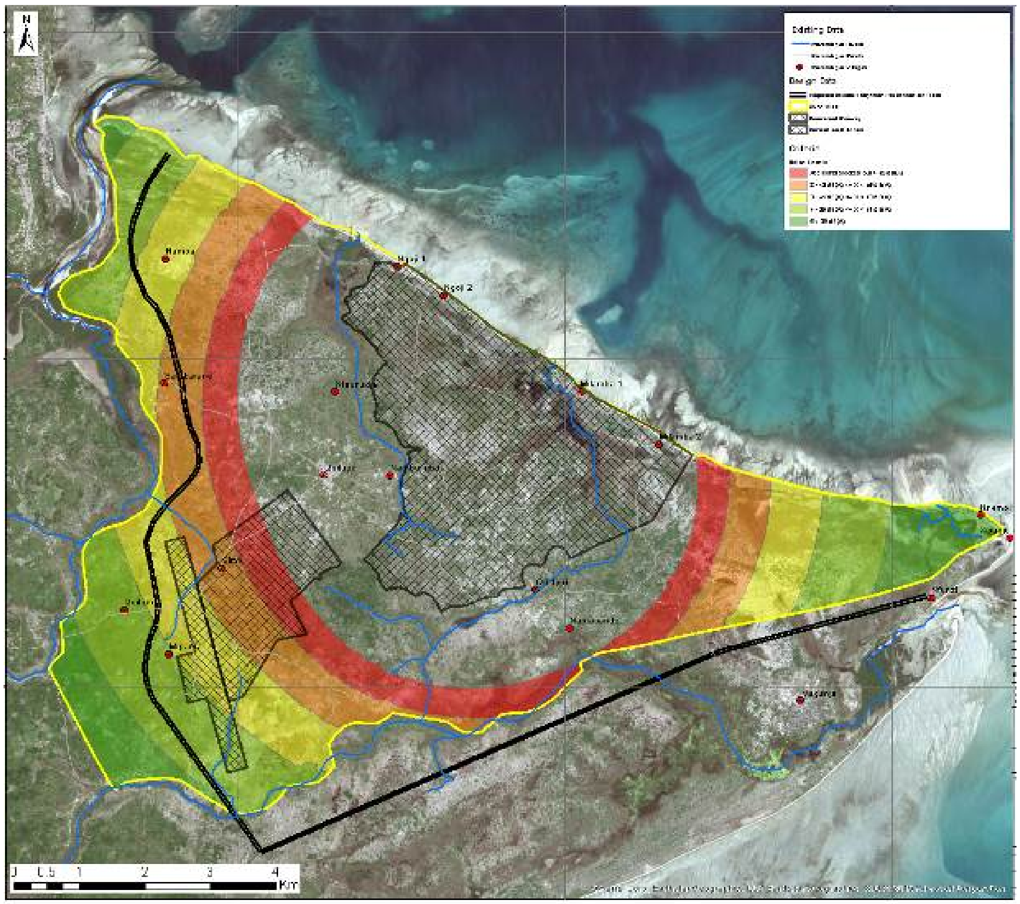


Figure 4-19 Classification of the *Potentially Suitable Areas* according to the "*Noise levels at the receptors*"

According to the *Classification System* defined, the *red buffer* (rather than corresponding to the classification of 1 as usual) corresponds to the additional areas that have been blocked out under the "*noise constraint*" due to the decision to account for the "precaution 2 dB(A) coefficient". As a consequence of including this coefficient, the original 45 dB(A) Ambient Noise Contour extended from the internal line of the *red buffer*, to the external one.

4.4.3.1.6. Access to an unpolluted environment (in terms of air quality)

It was assumed that communities should be resettled to areas where they can benefit from an unpolluted environment in terms of air quality.
The Mozambican Government has set standards for NO_2 concentrations in the air (Decree no. 67/2010). These include a long-term (annual average) concentration guideline of 10 µg NO_2/m^3 and a short term (1-hour) concentration guideline of 190 µg NO_2/m^3.

As mentioned, the area where the NO_2 annual average concentration in the air (in the surroundings of the LNG Plant) is expected to exceed the guideline has been blocked out as a potential area for the *Replacement Village(s)*. The short term concentration is not expected to be exceeded, so no (additional) areas were blocked out.

NO_2 concentrations decrease, in general, with distance from the emission sources, amongst other factors. Therefore, the further away from these sources (and the "blocked out" area), the lower these concentrations are expected to be, and consequently, the "cleaner" the air is expected to be.

It was therefore considered that NO_2 concentrations (both the "annual average concentration" and the "1 hour max concentration") allow a differentiation between the *Potentially Suitable Areas* for the location of the *Replacement Village(s)* and associated infrastructure.

In order to minimize disturbance/nuisance related to poor air quality, in particular related with the LNG facility, the *Replacement Village(s)* should desirably be located away from the emission sources / "blocked out" area.

The *Classification Systems* defined to classify and compare the *Potentially Suitable Areas* in terms air quality, consists of three classes of "*NO_2 annual average concentration*" and of "*1-hour NO_2 max concentration*" (buffers). The further away from the emission sources / "blocked out" area, the better (higher) the classification (as the lower the NO_2 concentrations are expected to be). The classes (buffers) considered were:

NO_2 annual average concentration (µg NO_2/m^3):

- 1 = between 7.5 and 10.0 (between ¾ of the guideline value and the guideline value)
- 3 = between 5.0 and 7.5 (between half and ¾ of the guideline value)
- 5 = below 5.0 (less than half the guideline value)

Short term (1 hour max) NO_2 concentration (µg NO_2/m^3):

- 1 = between 142.5 and 190.0 (between ¾ of the guideline value and the guideline value)
- 3 = between 95.0 and 142.5 (between half and ¾ of the guideline value)
- 5 = below 95.0 (less than half the guideline value)

Again, the revised LNG Project EIA Air Quality Assessment Report: Figures 4.1. Annual NO_2 impact (Scenario 1: 14 Trains operational, no flaring) and 4.2. Short term (1 hour max) NO_2 impact (Scenario 2: 14 Trains operational, 2 flares in emergency blowdown event) was used as the source of data for the definition of the above mentioned classes.

Figure 4-20 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*NO_2 concentrations*", using the defined classes of "*NO_2 concentrations*".

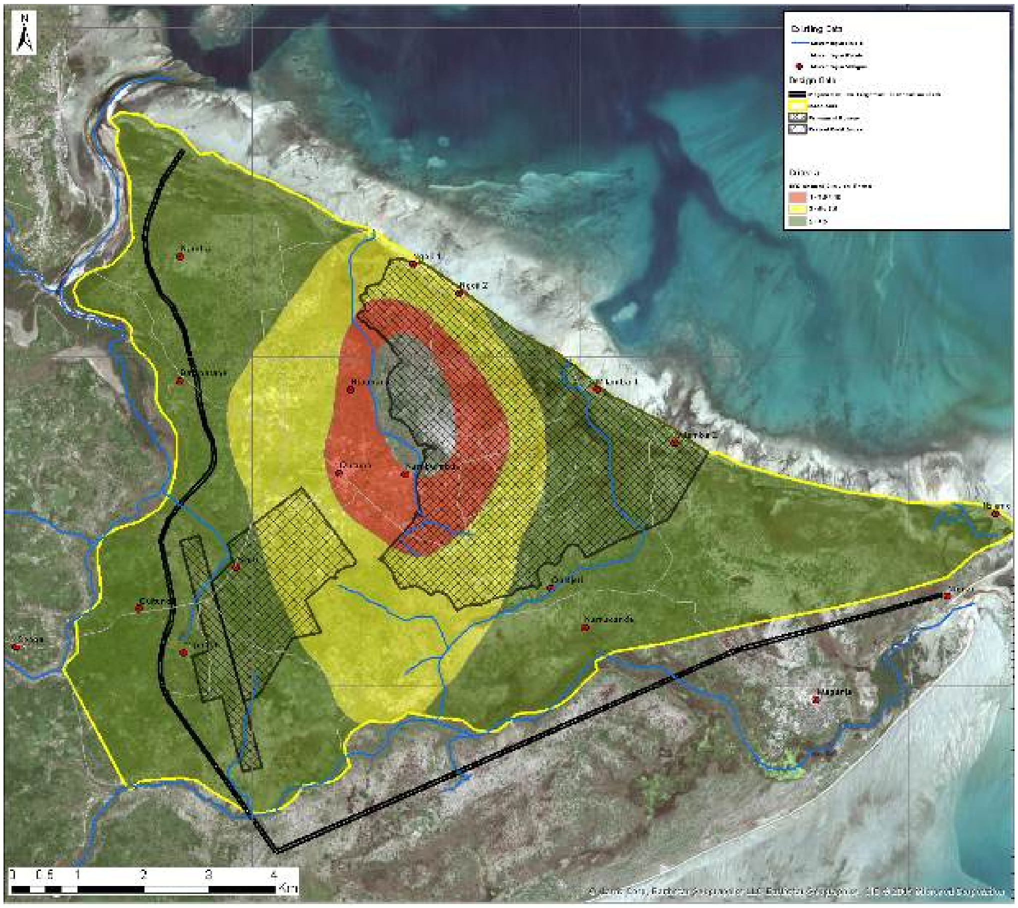


Figure 4-20 Classification of the *Potentially Suitable Areas* according to the *NO_2 annual average concentrations*

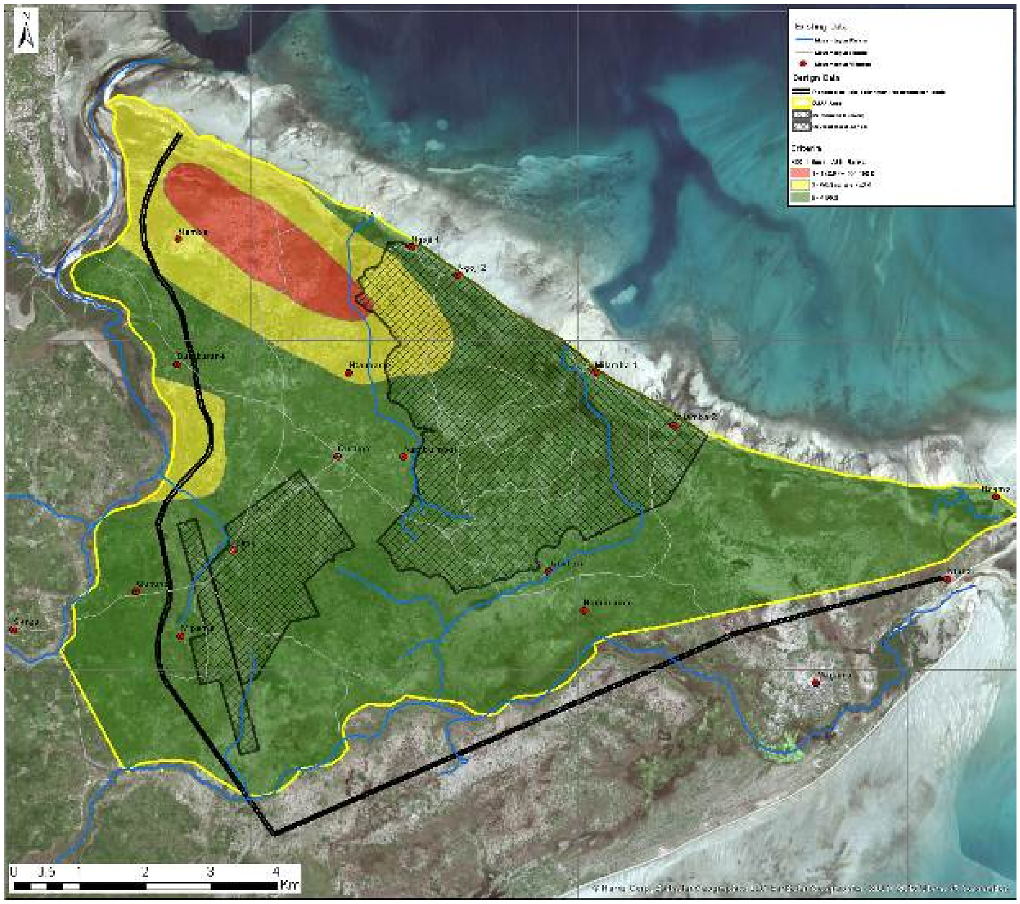


Figure 4-21 Classification of the *Potentially Suitable Areas* according to the *NO_2 short term concentrations*

4.4.3.1.7. Ecological Sensitivity

As mentioned, it was assumed that ecologically sensitive areas play a very important role in society as they usually provide important economic, social and cultural benefits, both directly and indirectly, apart from their intrinsic ecological value. Once the areas of higher ***ecological sensitivity*** are in general strongly related with natural products/services that are directly associated with the livelihood of the communities to be resettled, they should be avoided and preserved.

Ecological Sensitivity would therefore allow a differentiation between the areas, and should be used as a *criterion*, for both the location of the *Replacement Village(s)* and of the associated agricultural plots. These should desirably be located in areas of lower ***ecological sensitivity***.

The studies conducted for the LNG Project EIA with regards to the ecology of the Afungi Area resulted in the production of a ***global map*** summarizing the overall ***ecological sensitivity*** of the areas within the DUAT Area, and representing the areas classified by *degree of sensitivity*.

This map was already used to provide input to the *Site Screening Process* with regards to this parameter, as it was the basis for blocking out the areas of ***very high ecological sensitivity*** for the construction of the *Replacement Village(s)*.

Areas with lower ***ecological sensitivity*** are preferable for both the location of the *Replacement Village(s)* and of the associated agricultural plots, which is why the ***global map*** was used again to provide further input to the *Site Screening Process*, through the definition of a *criterion* that avoids the areas of higher ***ecological sensitivity*** for both these purposes.

The five "*Classes of ecological sensitivity*" defined in the ***global map*** have been used as the *Classification System* for this *criterion,* in order to compare the areas for both the location of the *Replacement Village(s)* Infrastructure and the location of the associated agricultural plots.

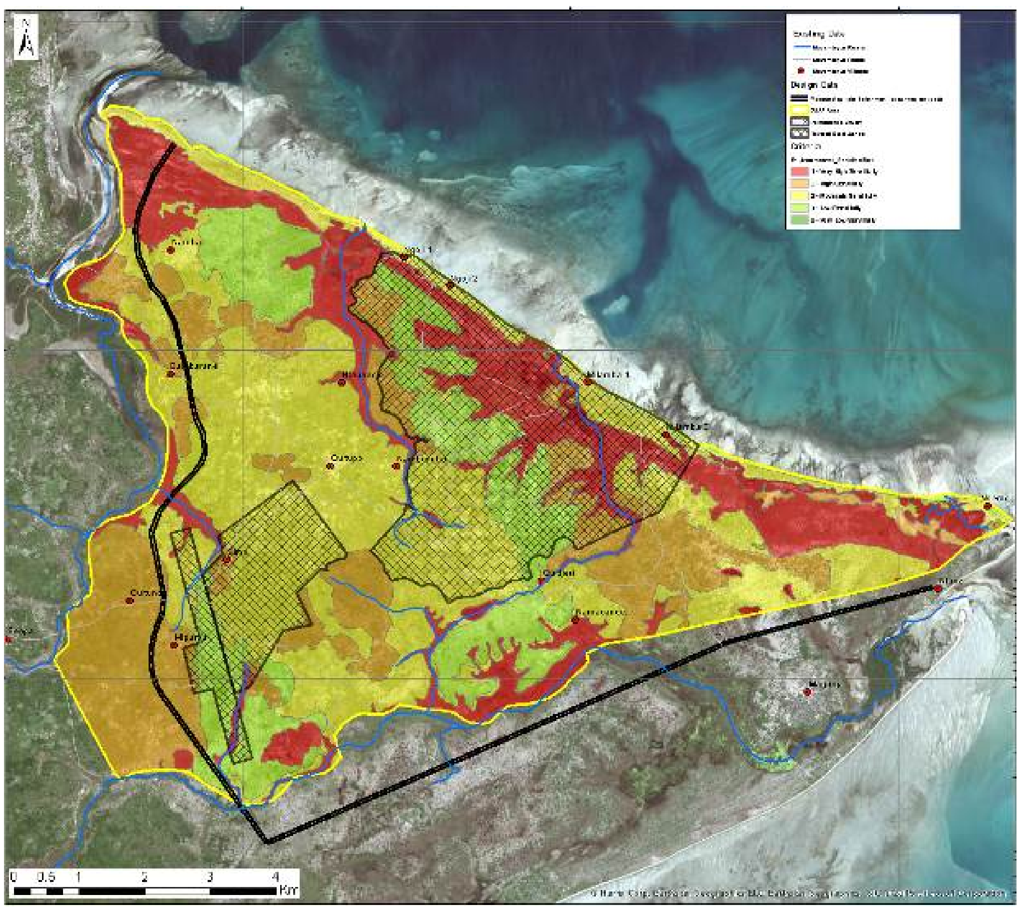


Figure 4-22 Classification of the *Potentially Suitable Areas* according to its "*Ecological Sensitivity*"

When building the *Suitability Models*, this *Classification System* assigns a poor classification to the areas of higher ***ecological sensitivity,*** in an attempt to avoid its occupation for both purposes: the higher the ***ecological sensitivity***, the lower the classification. The classification of (1) was attributed to the areas with "very high" ***ecological sensitivity*** (the least suitable according to this *criterion*), …, and the classification of

(5) attributed to the areas with "very low" ***ecological sensitivity*** (the most suitable according to this *criterion*).

Figure 4-22 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Ecological Sensitivity*", using five classes of ***ecological sensitivity***.

4.4.3.1.8. Access to suitable fishing grounds

As mentioned, it was assumed that the communities to be resettled depend on fishing and intertidal collection activities. Therefore, although it is important to be close to the sea (reason why "proximity to the sea" is important and has been captured in another *criterion*) there are other aspects related to fishing and the characteristics of the coastline that are important to consider when assessing a location in terms of its suitability for fisheries. The coastline is not homogeneous, making some areas more attractive to the fisherman than others.

For this reason it is important to define a *criterion* ("*Suitability of the Fishing Grounds*") that captures these differences and allows a differentiation between the *Potentially Suitable Areas* for the construction of the *Replacement Village(s)*. The consideration of such criterion aims at pushing the location of the *Replacement Village(s)* towards the coastal areas that maximize the aspects that bring fishing advantages, thereby minimizing the changes to the livelihood of the fishing communities.

The aspects taken into account were:

- Protection from south and east waves;
- Immediate coastal access;
- Intertidal plane;
- Proximity of sea grass;
- Distance to Reef;
- Potential for mitigation measures; and
- Existing fishing pressure.

The coastline inside the DUAT Area was split into sections and each section was classified for each of the parameters mentioned above as "poor", "fair" or "good". In order to determine a Global Classification for each section, the qualitative classification was converted to a quantitative one: 0, 1 and 2 respectively, a "weight" was assigned to each parameter (1 or 2, according to the relative importance of each), and a weighted average classification was determined for each section. All this information is detailed in Table 4-3.

A *Classification System* was then defined, considering the range of classifications achieved in the analysis, and five classes of "*Suitability of the Fishing Grounds*" (*Classification System*) were defined in order to classify and compare the "*Suitability of the Fishing Grounds*" of the coastline inside the DUAT Area (presented in Table 4-2).

The fact that the *coastline*, rather than the *Potentially Suitable Areas*, was classified, does not allow the integration of this classification in the model. In other words, the Final *Suitability Models* are not able to automatically integrate this *criterion*, which is why it will have to be accounted for in a qualitative way. The way this will be done will be explained in upcoming sections.

For this reason, there was no need to convert the Global Classification to the scale from 1 to 5, and the *Global Classification* was rather presented qualitatively.

Table 4-3 Classification of Sections along the coast according to the Suitability of the Fishing Grounds (parameters, weights, classification and Global Classification)

Section / From / To / ***PARAMETER***	**WEIGHT**	**Palma Ngodje**	**Ngodje Milamba**	**Milamba Nsemo**	**Nsemo Maganja**	**Maganja Mondlane**
Protection from south waves	1	2	2	2	2	1
Protection from east waves	1	2	2	1	1	2
Immediate coastal access	1	2	2	2	1	1
Intertidal plane	2	0	2	2	2	2
Proximity of Sea grass	2	0	2	2	2	2
Distance to Reef	1	0	1	2	2	1
Potential for mitigation measures (infrastructure)	1	1	2	1	1	1
Potential for mitigation measures (reef)	1	0	1	1	1	2
Potential for mitigation measures (fad)	1	0	0	1	2	1
Existing fishing pressure	2	0	0	0	0	1
Global Classification (Suitability of the Fishing grounds)	**13**	**0.54**	**LNG Build Zone**	**1.38**	**1.38**	**1.46**
		Very Low		**Very High**	**Very High**	**Very High**

0 – Poor; 1 – Fair; 2 – Good

The areas closer to the best classified sections (classified as "very high" suitability) are preferable because they provide better access to suitable fishing grounds and to better areas for intertidal collection activities, compared with the areas further away from these sections and/or closer to sections classified as "very low" suitability.

This *criterion* complements the other *criterion* considered: "*Proximity to the coast*". Together, they push the location of the *Replacement Village(s)* towards the areas as close as possible to the sea, in the sections of the coastline that offer the most suitable fishing grounds.

Figure 4-23 illustrates the classification of the coastline inside the DUAT Area boundary according to the *criterion* "*Suitability of the Fishing Grounds*". A similar correspondence was established between the classes established under the *Classification System* for this *criterion* and the code of colours generally used to represent the level of *suitability*.

The *Suitability of the Fishing Grounds* was represented as lines along the coast which colour represents the *Global Suitability* of the respective section (green lines corresponding to "very high" *Suitability* and red lines "very low" *Suitability of the Fishing Grounds*).

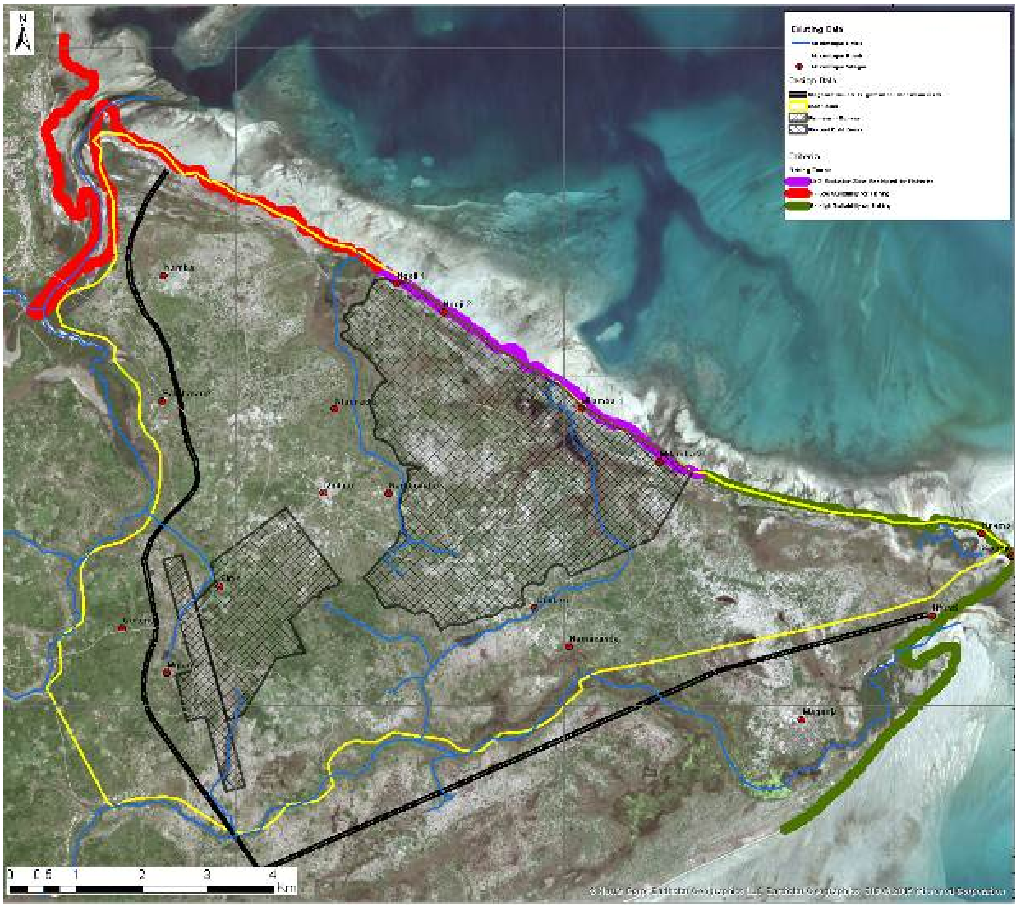


Figure 4-23 Classification of the of the coastline inside the DUAT Area according to the "*Suitability of the Fishing Grounds*"

4.4.3.2. *Suitability Models*: Overall Suitability

After classifying the *Potentially Suitable Areas* for all the *Comparison Criteria*, the GIS software, considering the *weights* assigned to each *criterion*, calculates – for each area in the map – the *weighted average* of the classifications for all the *Comparison Criteria*. This *weighted average classification* represents the *Overall Suitability* of that *area*. This is done separately for each of the two models developed (*Village(s) Infrastructure Model* and the *Livelihood Development / Agricultural Model*), since the *Comparison Criteria* and respective *weights* differ between the two models, as per indicated on Table 4-2.

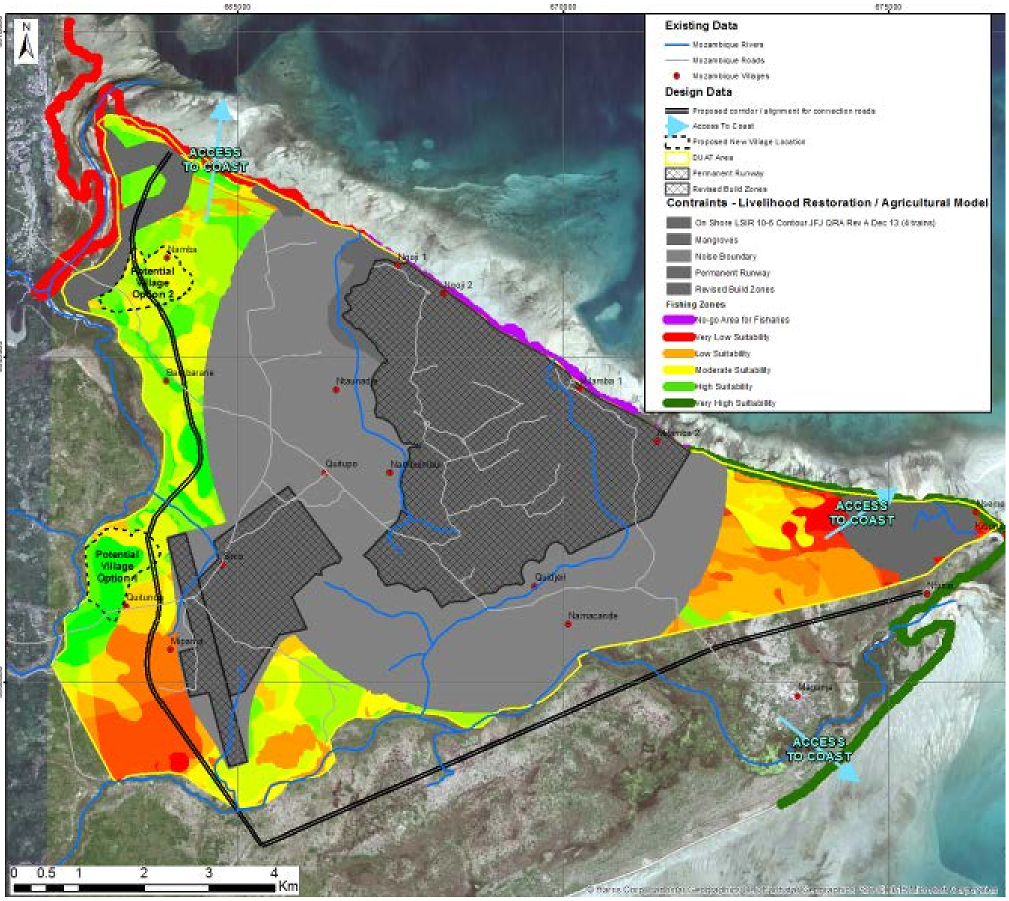


Figure 4-24 *Overall Suitability*: Livelihood Development / Agricultural Model

The *Potentially Suitable Areas* can then be *ranked* according to their *Overall Suitability*, using a gradation of colours, ranging from dark green (corresponding to the areas of higher *Overall Suitability*), through to light green, yellow, orange and finally red (corresponding to the areas of lower *Overall Suitability*).

The results of the two *Suitability Models* developed are presented below: *Livelihood Development / Agricultural Model* (Figure 4-24) and *Village(s) Infrastructure Model* (Figure 4-25).

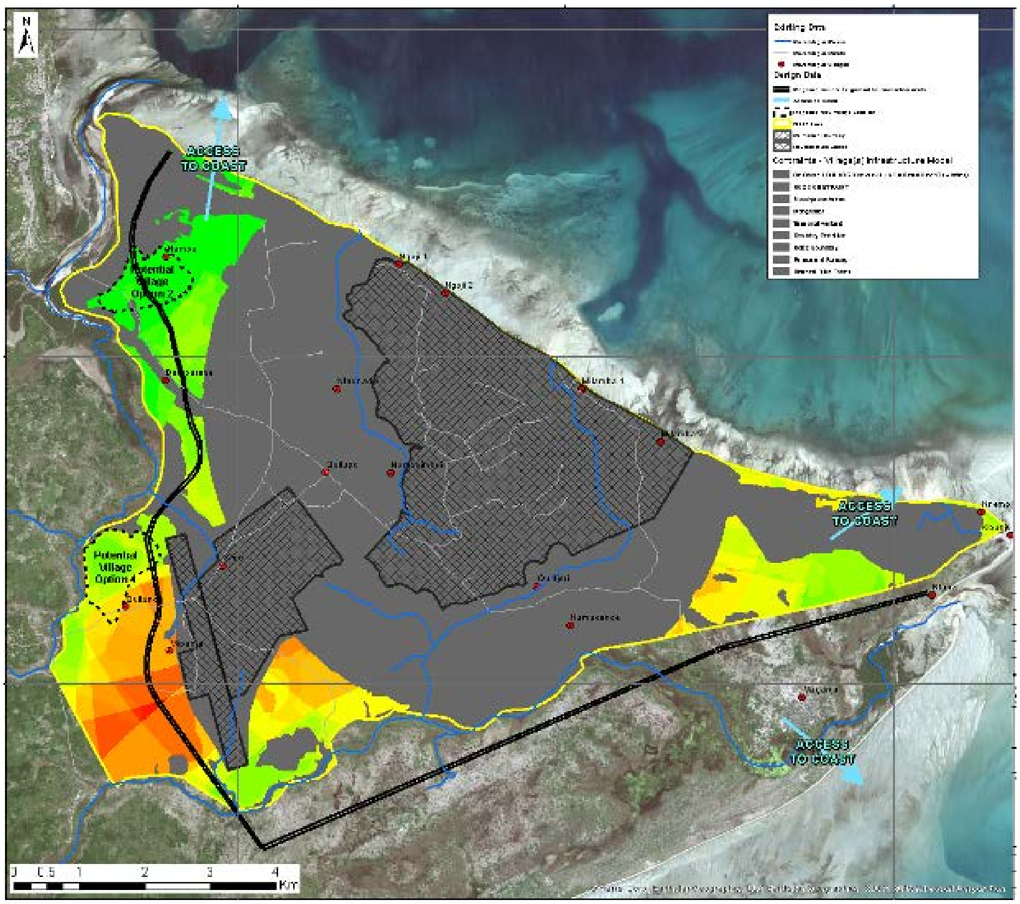


Figure 4-25 *Overall Suitability*: Village(s) Infrastructure Model

The qualitative analysis to be carried out with regards to the fisheries aspects takes into account the representation of the *Suitability of the Fishing Grounds* of the several sections of the coast line, as per presented in the *Livelihood Development / Agricultural Model*.

4.4.4 Phase 4 – Identification of the *Most Suitable Areas* and of *Potential Replacement Site(s)*

The *Suitability Models* can now be used to support the identification of a number of suitable *Potential Replacement Sites* where to build the *Replacement Village(s)* and associated infrastructure.

The identification (short-listing) of the *Potential Replacement Sites* took into account:

- The output of the *Village(s) Infrastructure Model:* this model was used to support the identification of the best areas for the location of the *Replacement Village(s)* and associated infrastructures: the *greener* areas correspond to the *most suitable areas* for this purpose. The size of the *Sites* must allow the construction of the village(s) and associated infrastructure, considering the number of families to be resettled;

- Proximity to the best *Agricultural Areas:* the output of the *Livelihood Development / Agricultural Model* was used to support the identification of the best agricultural areas: the *greener* areas correspond to the *most suitable areas* for agriculture. The agricultural plots should therefore be located within these areas. The total areas to assign to this purpose should be large enough to allow the restoration of the livelihood related to agriculture for the families to be resettled, **and be as close as possible** to the *Replacement Village(s)*;

- Proximity to the best fishing grounds: the output of the analysis carried out on the *Suitability of the Fishing Grounds* was used to support the identification of the best sections of the coast line in terms of fishing: the green lines along the coast correspond to the *most suitable* sections of the coast line for fishing and related (intertidal collection) subsistence activities (the *most suitable fishing grounds*).

Considering the above, two *Potential Replacement Sites* have been identified to be presented to the GoM as *Potential Replacement Sites*. The location of these has been indicated in Figure 4-24 and Figure 4-25 above. The alternative *Sites* are:

- *Potential Village* – Option 1 (to the NW of Quitunda);

- *Potential Village* – Option 2 (to the S / SW of Namba).

A third *Potential Site* (adjacent to Barabarane) had originally been identified, but been dropped due to uncertainties related to the extent of the "Exclusion Zone" associated with the Permanent Runway and potential related impacts.

The fact that these *Potential Sites* have been selected within the areas of *higher Overall Suitability* (according to the *Village(s) Infrastructure Model*) and close to the areas of *higher Overall Suitability* (according to the *Livelihood Development / Agricultural Model*) ensures that the *Overall Suitability* of the short-listed *Sites* is maximized.

Figure 4-26 and Figure 4-27 identify:

- the Total Exclusion Zone: area where no activity (that is not directly related to the LNG Project) shall take place (unavailable for both habitation and livelihood activities). The Total Exclusion Zone is inside the Project Industrial Zone and is the area in which construction will nominally take place. and

- the Buffer Zone: area deemed unavailable for the construction of the *Replacement Village(s)* and where livelihood development activities (such as agriculture and intertidal collection) cannot take place. The Buffer Zone is inside the Project Industrial Zone and is the area in which it is expected that the operations of the LNG Facility will generate up to 45 dBA at night.
-

The Exclusion Zone shall be fenced in order to prevent the communities from being able to physically access it, due to either project restrictions and/or safety/security reasons.

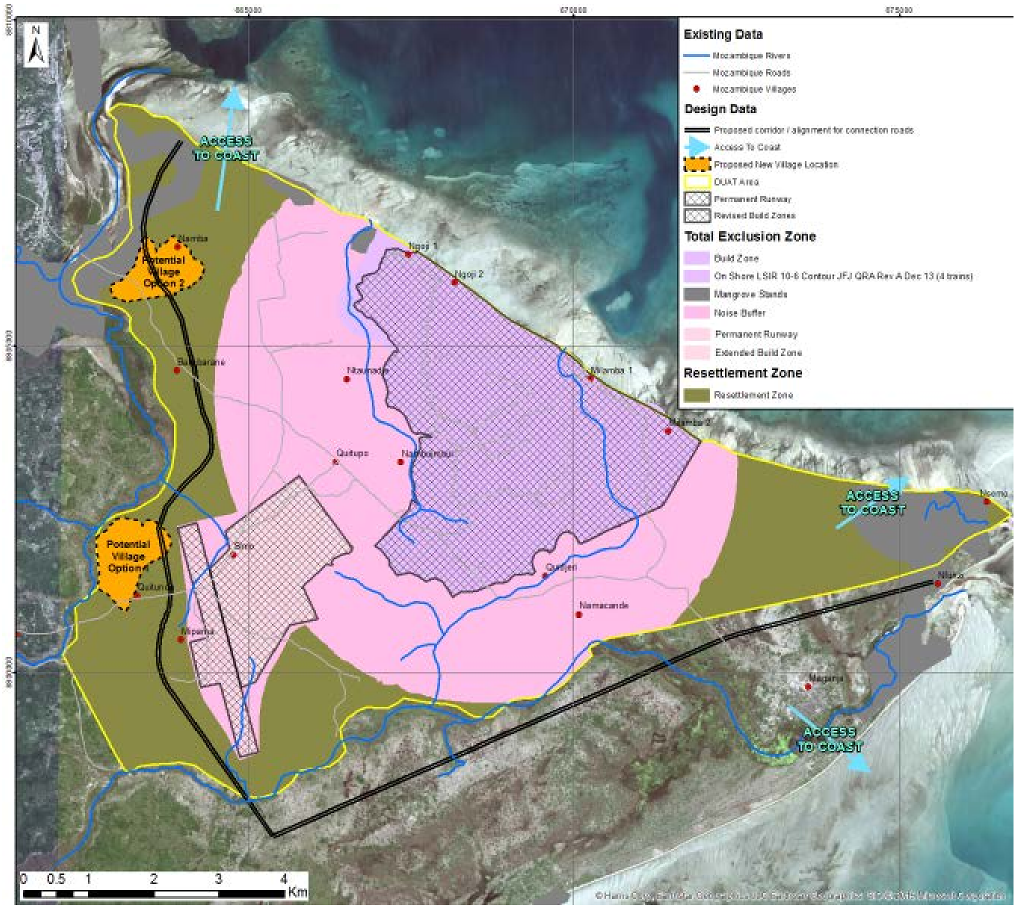


Figure 4-26 *Potential Sites*: Total Exclusion Zone (pink)

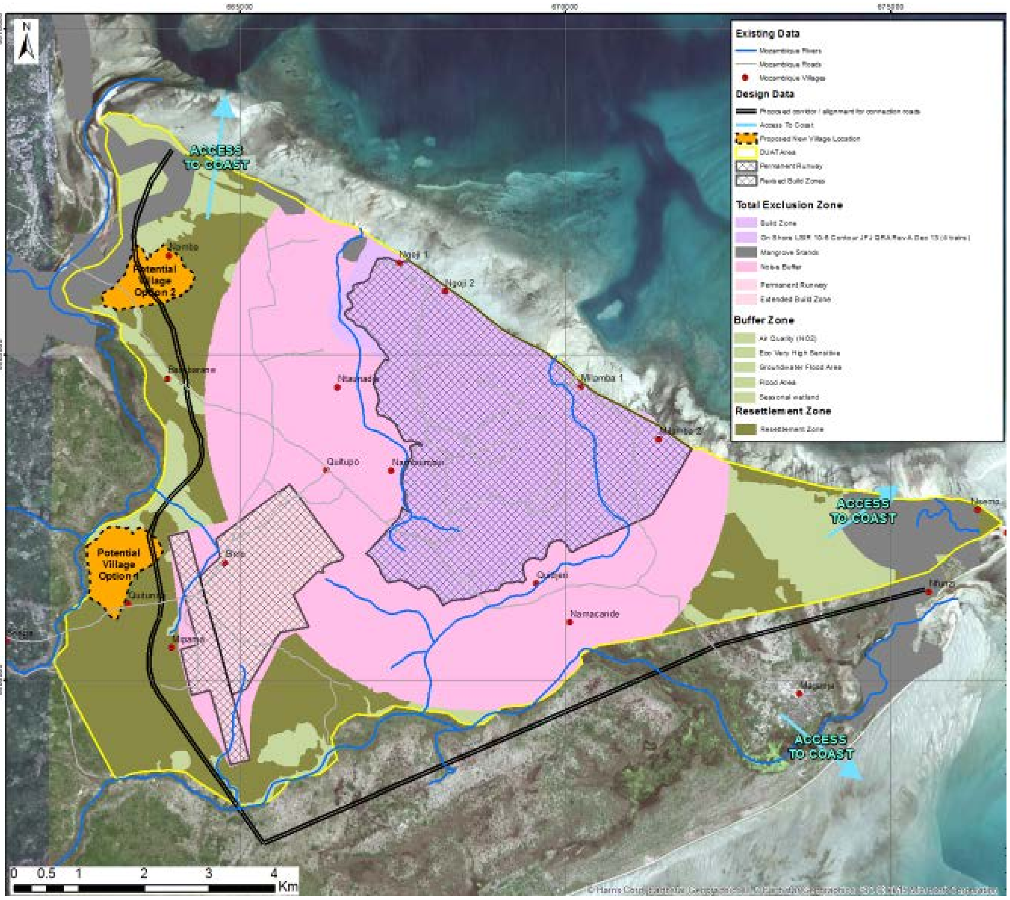


Figure 4-27 *Potential Sites*: Buffer Zone (light green)

4.4.5 Offshore Constraints

Some offshore areas will also be restricted for the Local Communities due to safety and security reasons. In other words, some *Constraints* apply offshore. This means that the Local Communities will not be authorized to carry out their subsistence activities (fishing and intertidal collection) inside the constrained areas.

Although these *Constraints* affect directly the areas for livelihood development only, they influence the *adequacy* of the *Potential Sites* since it is desirable that these are located close to areas not constrained in such a way that poses difficulties to livelihood development. This aspect shall be taken into account in the *Site Screening Process*.

The reason this analysis was not conducted at the same time as the analysis of the onshore *Constraints* was that the information regarding the parameters in question was only very recently made available.

The parameters that pose serious constraints to the use of the off shore areas (*Constraints*) have been identified in Table 4-4.

Table 4-4 Relevant off shore *Constraints* (*no-go* areas)

PARAMETER	CONSTRAINT (NO GO)	RELEVANT CONSTRAINTS	ZONING
On Shore Explosion Risk Areas (QRA)	Areas inside the LNG Plant Explosion Risk Boundary (QRA) - extended off shore	✘	TOTAL EXCLUSION ZONE
Marine Exclusion Zone	Areas inside the Minimum Marine Exclusion Zone (500 m)	✘	
Marine Exclusion Zone	Areas inside the Maximum Marine Exclusion Zone (1,500 m)	✘	Indicative

The areas that correspond to each of the relevant *Constraints* have been mapped and *blocked out*, as they are deemed *unavailable* and/or *unsuitable* for the conduction of livelihood development activities. The areas that correspond to these *Individual Constraints* are represented (in different colours) in Figure 4-28.

Although a decision has not yet been made with regards to the extension of the *Marine Exclusion Zone*, the minimum distance to the offshore structures (of 500m) has been considered as "*Total Exclusion Zone*". For illustrative purposes only, a wider area has also been represented, presently considered as the *Maximum Marine Exclusion Zone* (1,500m distance to the offshore structures). This allows a better understanding of the maximum areas that may become unavailable for livelihood purposes should the Project decide to extend the current *Minimum Exclusion Zone*.

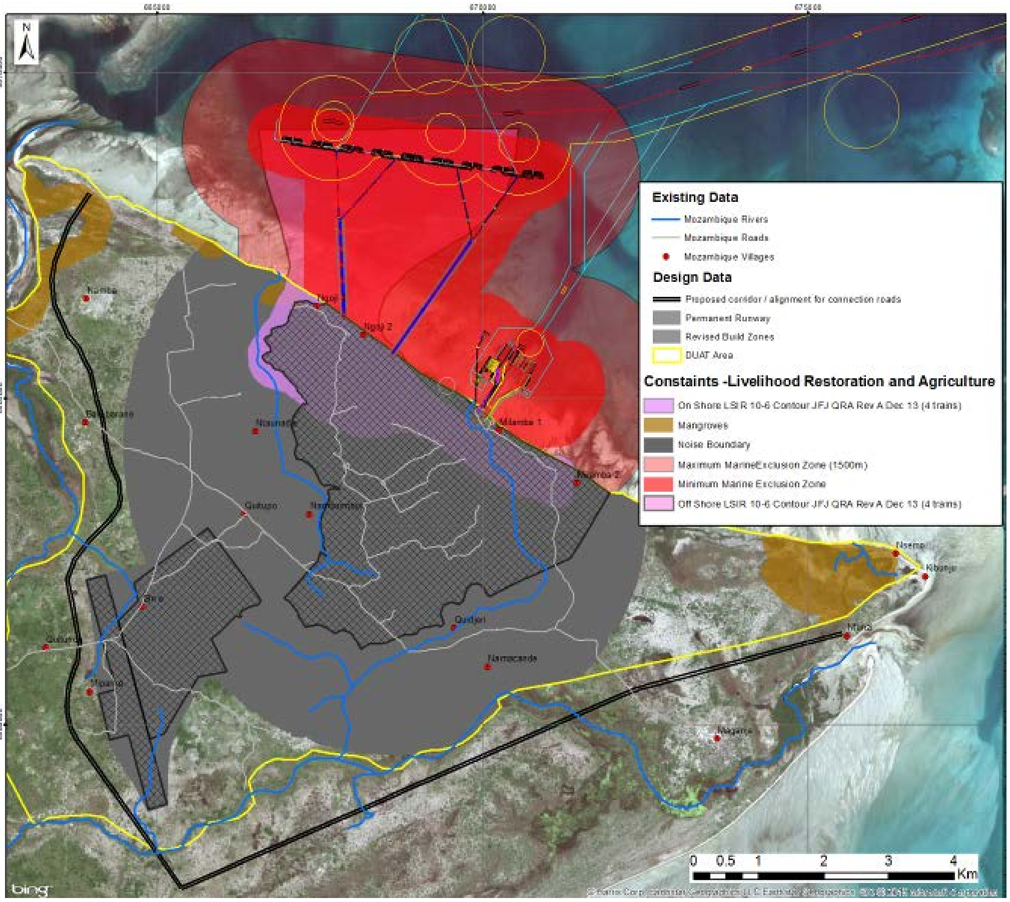


Figure 4-28 *Individual constraints* – Livelihood Restoration (off shore)

The total areas that are deemed *unavailable* or *unsuitable* for the conduction of livelihood restoration activities have been combined (*Combined Constraints*) and represented in grey in Figure 4-29. This representation also allows distinguishing the *Minimum* and *Maximum Marine Exclusion Zones*.

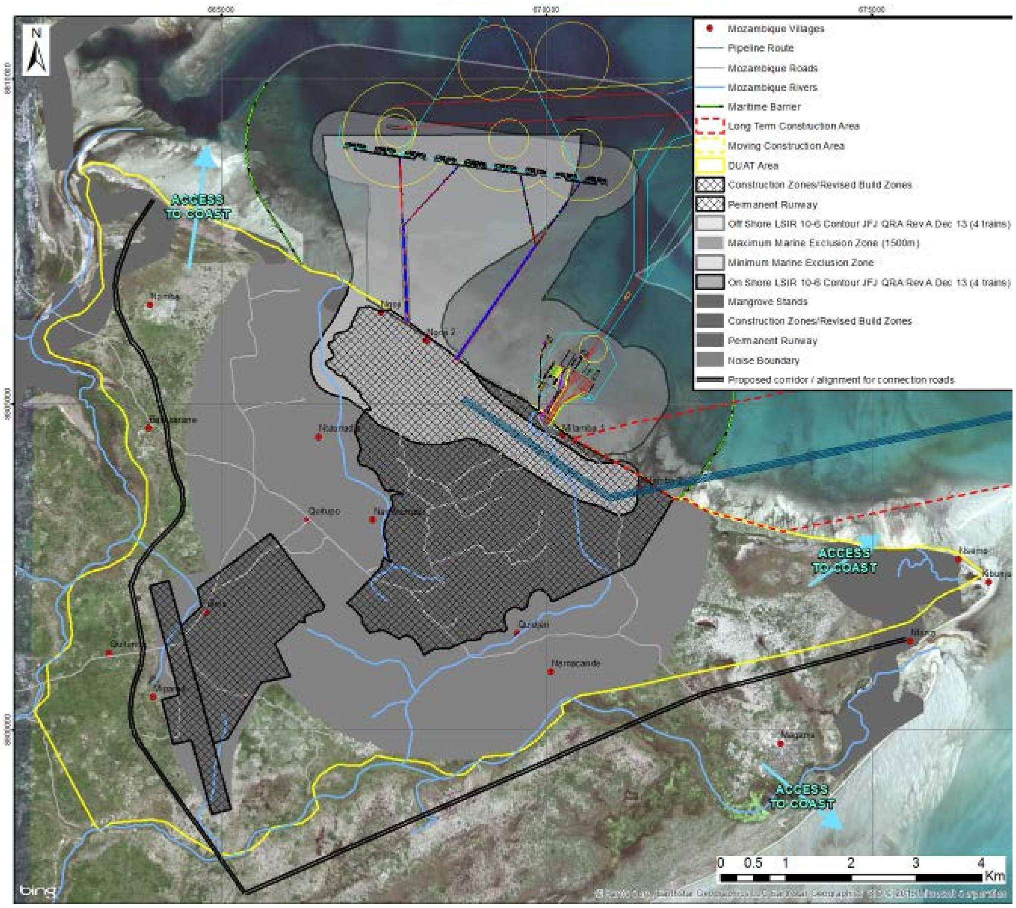


Figure 4-29 *Combined constraints* (in grey) - Livelihood Restoration (off shore)

In order to allow a better understanding of the way these offshore constraints relate to the pre-selected *Potential Replacement Sites*, which will in turn influence the magnitude of the impacts on livelihood restoration with respect to subsistence activities related to fisheries, Figure 4-30 represents the total constraints (on- and offshore) that apply to the *Livelihood Restoration / Agricultural Model*, overlapping the respective *Suitability Model*.

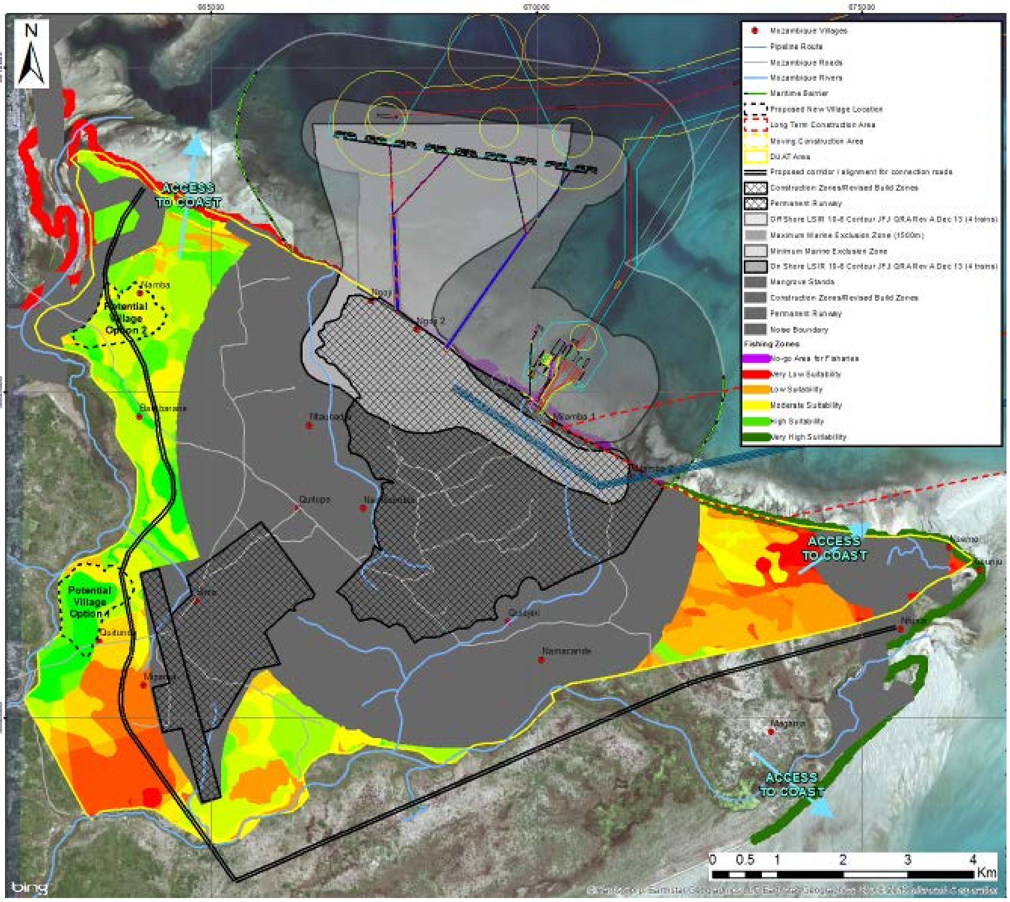


Figure 4-30 *Overall Suitability*: *Livelihood Development / Agricultural Model*

Updated *Zoning Maps*, representing the extension offshore of the *Total Exclusion Zone* as a consequence of considering the above mentioned offshore *Constraints*, are presented in Figure 4-31 and Figure 4-32.

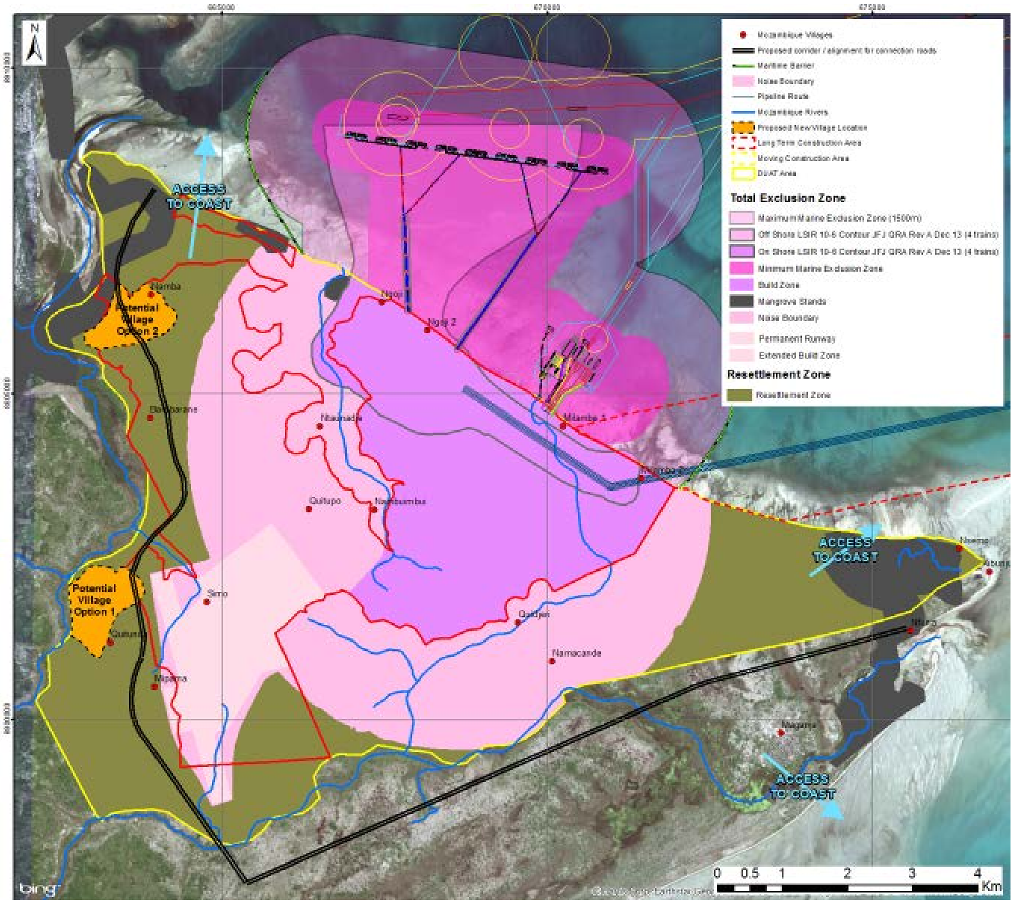


Figure 4-31 Total Exclusion Zone (pink) (off shore)

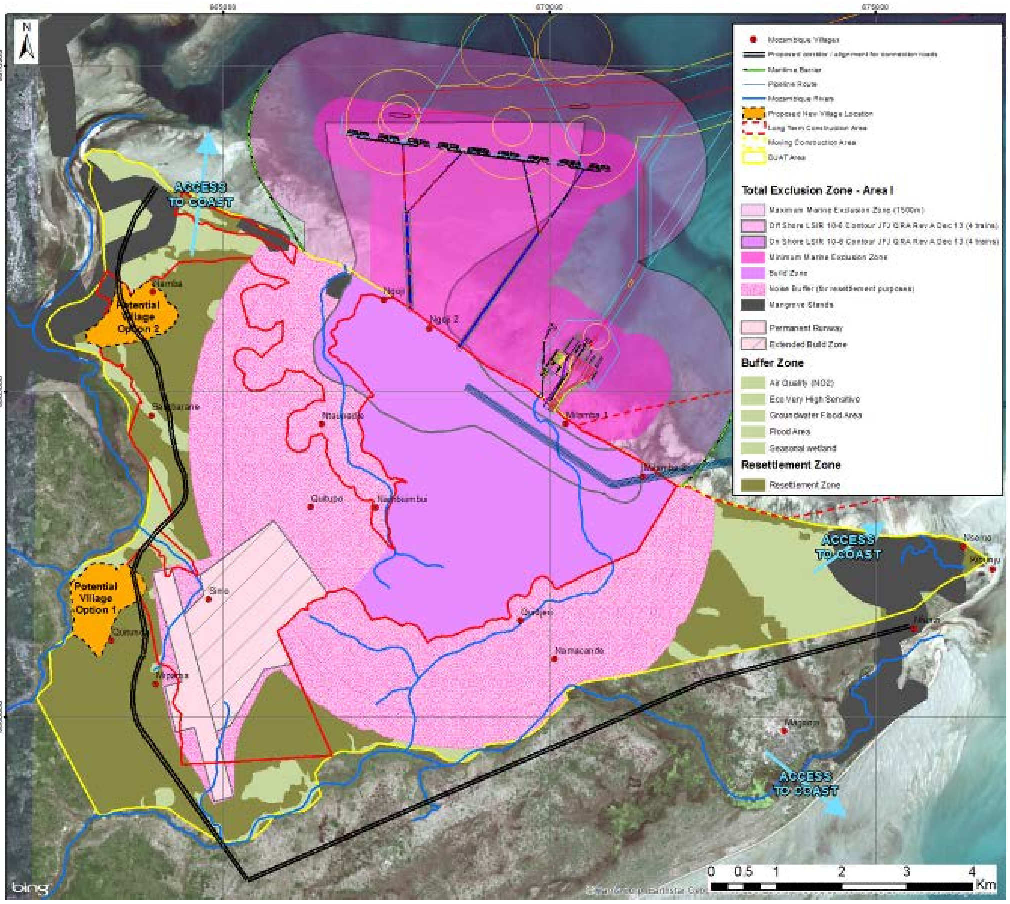


Figure 4-32 Buffer Zone (light green) (off shore)

5. CONCLUSIONS

The aim of the Multi-Criteria Assessment and Site Screening Studies conducted and presented in this report, is to propose sites for the construction of the *Replacement Village(s)* and for the restoration of the livelihoods of the households that will be displaced due to the construction and operation of the Mozambique Gas Development Project.

Two alternative *Potential Sites* have been proposed inside the DUAT Area, following AMA1's and EEA's decision to locate the *Replacement Village(s)* within this area.

The *Site Screening Methodology* developed and applied to the DUAT Area as the *Study Area*, allowed the identification and exclusion of areas considered unsuitable and/or unavailable for resettlement, and the identification of the two alternative *Potential Sites* within the *most suitable* areas for both the construction of the villages and associated infrastructure, and the location of the agricultural plots.

The location of the proposed alternative sites is presented in the two figures below, Figure 4-24 illustrating the context of the *Potential Sites* for livelihood development purposes, and Figure 4-25 in the context of the construction of the Replacement Village(s) and associated infrastructure.

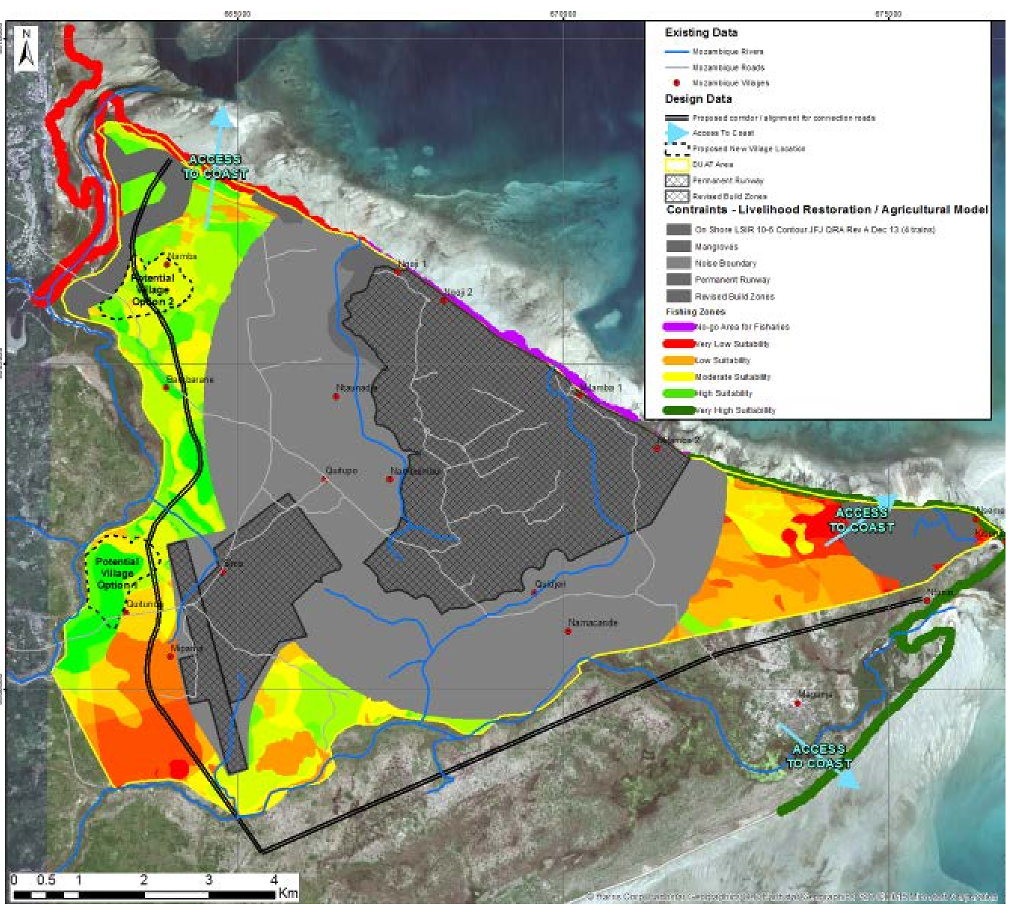


Figure 5-1 *Overall Suitability*: Livelihood Development / Agricultural Model

The grey areas in the *Livelihood Development / Agriculture Model* correspond to the areas that are not available due to the LNG Project (Construction/Project Areas) and those considered unsuitable for safety (QRA) or environmental reasons (mangroves).

The green areas in the *Livelihood Development / Agriculture Model* correspond to the areas that maximize the suitability in terms of the parameters considered adequate for livelihood development activities: access to suitable agricultural land, to water (in quantity and quality), to areas where services and markets are available, and distant from the areas of higher ecological sensitivity.

The fact that the proposed *Potential Sites* are not located in these grey areas immediately accounts for the main aspects to consider (above mentioned) and prevents major social, health and environmental impacts. On the other hand, the location close to green areas in this model means that the villages would be located close to areas particularly suitable for the livelihood development activities.

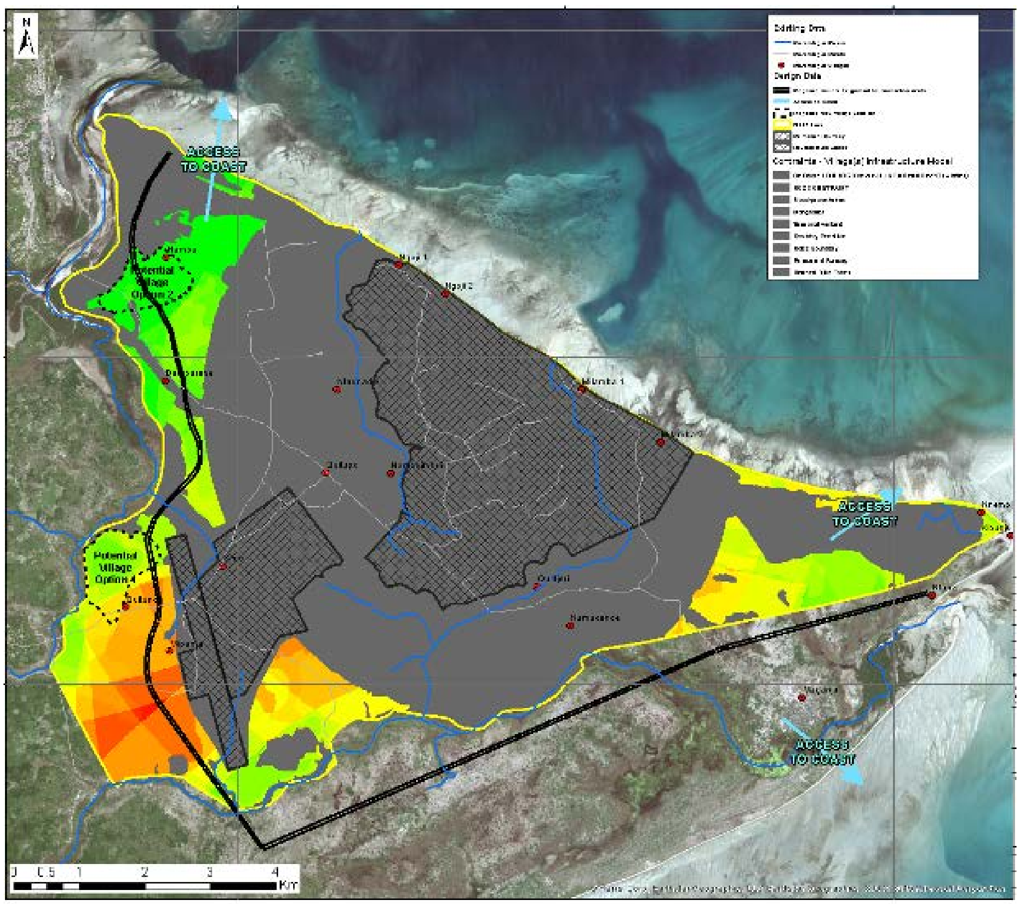


Figure 5-2 *Overall Suitability*: Village(s) Infrastructure Model

The grey areas in the V*illage(s) / Infrastructure Model* correspond to the areas that are not available due to the LNG Project (Construction/Project Areas) and those considered unsuitable for safety (QRA), health

(noise levels and air quality), technical (flood-prone areas) or environmental reasons (mangroves, wetlands and areas of very high ecological sensitivity).
The green areas in the V*illage(s) / Infrastructure Model* correspond to the areas that maximize the suitability in terms of the parameters considered adequate for the construction of the *Replacement Village(s)* and associated infrastructure: access to the sea; to areas where services and markets are available, to water (in quantity and quality), located in a quiet environment (in terms of noise), and distant from the areas of higher ecological sensitivity, etc.

The fact that the proposed *Potential Sites* are not located in these grey areas immediately accounts for the main aspects to consider (above mentioned) and prevents major impacts social, health and environmental impacts. On the other hand, its location close to green areas in this model means that these areas are particularly suitable for the construction of the *Replacement Village(s)*.

The outcomes of the models only hold if the parameters considered in the models (*Constraints*, *Criteria* and *weights*) correspond to those the Affected Communities consider relevant and valuable. Although the parameters used in the models include social / socio-economic considerations that, from an expert judgement point of view, are thought to be in line with likely community views and opinions with regards the siting of *Replacement Village(s)*, such assumptions can only be verified through community consultation.

A critical step in the way forward of the *Site Screening Process* is to seek inputs from the resettlement-affected households and communities on whether they agree with the sites proposed, their reasons for (dis)agreeing, and/or whether they have a preference for a different location. The *Site Screening Process* followed so far, as well as its outcomes (the *Suitability Models* and, in particular, the pre-selected *Potential Sites*), will be presented and discussed, under such *Stakeholder Engagement Process.*

The inputs provided by communities will be taken into account in the *Site Selection Process* going forward. This can result either in the confirmation of the proposed sites or slight adjustments to its location, or in the proposal of new sites. The results of this process shall then be presented to the Government in order decide on the final locations for the *Replacement Village(s)*.

APPENDIXES

APPENDIX A – ROAD MAP OF THE SITE SELECTION PROCESS PROGRESSION FOR THE REPLACEMENT VILLAGE(S) PROJECT

CONTENTS

ROAD map of THE site selection PROCESS progression for the REPLACEMENT VILLAGE(S) project

A.1 Site Selection Outside the DUAT Area

The sort-listing of *Potential Sites* where to build the *Replacement Village(s)* was achieved through an interactive process adjusted to the context and reality of the Project in terms of its dynamics and level of detail of the information available at each moment. As the *Study Area* evolved, and additional or further detailed data and information become available, the *Site Selection Methodology* was implemented and the respective *Suitability Models* produced and/or reviewed.

The present Appendix presents in detail the road map of the *Site Selection Process* followed until the short-listing of the *Potential Sites* presented to the Government of Mozambique (the outcome of the Studies presented in this report).

A.1.1 Circular Study Area: Implementation Exercise of the Site Selection Methodology (Desktop Suitability Models)

The first approach to the *Site Selection Process* was to apply the *Site Selection Methodology* developed to a Circular *Study Area* around the DUAT Area. The purpose was to short-list a number of *Potential Sites* within this *Study Area* for the construction of the *Replacement Village(s)* to accommodate the above mentioned households.

This was done using exclusively readily available (desktop) data and information about an initial set of parameters defined (*Constraints* and *Comparison Criteria*).

It has been presented and described in detail in **Appendix B – Report: "***Replacement Village Multi-Criteria Assessment & Site Selection Study*" (WorleyParsons, June 2013): Desktop Data Model:

- the detailed *Site Selection Methodology* followed;
- the reasoning behind the definition of the initial *Study Area*;
- specifics regarding the implementation of the *Site Selection Methodology* to this initial *Study Area* (namely the *Constraints*, *Comparison Criteria* and weights considered);
- the output of the implementation of the methodology: the first two *Suitability Models* generated (desktop data models), one for *Fishing Villages* and another for *Agricultural Villages*; each of these models ranks the *Potentially Suitable Areas* according to their *Overall Suitability* for the purpose of identifying, respectively, the most suitable areas where to locate the *Fishing Village(s)* and the *Agricultural Village(s)*; and
- the use of the *Suitability Models* in the preliminary identification of a number of *Potential Sites* where to locate the Fishing *Village(s)* and the *Agricultural Village(s)*.

An initial *Site Appraisal Visit* – a *fly-over* and a drive through the Palma area – had previously been conducted from March 15th to 19th 2013. The main purposes of this visit were to get the team familiarized with the general area. It was also aimed at supporting the definition of the initial *Study Area* and the identification of adequate parameters to consider in the subsequent analysis.

The results of the *Site Appraisal Visit*, together with the first impressions with regards to the site, have been reported in the "*Resettlement Project: Afungi Peninsula Site Appraisal Visit Report March 15 – 19 2013"* (WorleyParsons, April 3, 2013), presented in appendix to the above mentioned report (also included in Appendix B).

It is important to highlight that the main purposes of this *exercise* of implementing the proposed *Site Selection Methodology* to this initial *Study Area* were:

- to *test* the methodology developed (from theory to practice) in the most realistic possible way: implementing it to the actual Project Area and using real data regarding the Project Area and its surroundings; as mentioned, this was done using exclusively readily available / desktop data and information because, at that stage, this was the only information that was possible to gather; this *level* of information was, however, considered adequate for the purpose of this test / exercise;

- to understand the adequacy of the resulting *Suitability Models* for the purpose of supporting the identification of *Potential Sites* for the *Replacement Village(s)* within the *most suitable areas*.

May Workshop – Maputo
A workshop was held in Maputo on the 3rd and 4th of May 2013 in order to present to the wider Resettlement and Project Teams the *Site Selection Methodology* developed, both "in theory" and "in practice".

After describing the reasoning behind the methodology, the *exercise* carried out was used to illustrate the way of implementing the methodology *step by step* until the generation of the *Suitability Models*.

A preliminary version of the report presented in Appendix A was actually compiled as preparatory material for this workshop.

It was also purpose of the workshop to promote a wider discussion around the methodology developed and the general assumptions made in the *implementation exercise* carried out, so as to reach a consensus with regards to:

- the reasoning behind the definition of the initial *Study Area*:

- the parameters defined for the initial *Constraints Mapping*, and the need to include additional parameters;

- the parameters defined as initial *Comparison Criteria* (to be used to compare the *Potentially Suitable Areas*), and the need to include additional ones;

- the *Classification Systems* defined (categories to be used to classify the *Potentially Suitable Areas* with regards to each *Comparison Criterion*);

- the weights assigned to each *Comparison Criterion* – in order to reflect the relative importance of each *criterion* in the overall comparison.

Limitations

The *limitations* of the *Suitability Models* (desktop models) that resulted from the *implementation exercise* carried out have also been identified, presented and discussed during the workshop. The main limitations identified were:

1. the information used regarding the parameters considered (*Constraints* and *Comparison Criteria*) would be inadequate for the level of analysis required to properly identify the best areas for the location of the *Replacement Village(s)*, for the following reasons:
   - o relevant information was not available at this stage (land use, soil types / suitability for agriculture, geo-hydrology, vegetation, …)
   - o only readily available / desktop data and information was available (no primary data is available);
   - o most information was only available at a very low resolution (at small scale);
   - o information available may have been incomplete and out of date;
   - o no ground truthing of the data / information used was carried out.

2. the initial set of *Site Selection Parameters* (*Constraints* and *Comparison Criteria*) defined for the *implementation exercise* carried out had not been widely discussed within the broader Resettlement and Project Teams; as a consequence, this set of parameters might not have been consensual and other relevant *parameters* might not have been identified (it was intended to overcome this limitation by promoting this discussion during the workshop);

3. the work completed thus far had not had the benefit of input from community-based Stakeholder Engagement; no consultation had been possible due to the fact that the Government of Mozambique had not yet officially announced that a Resettlement Project would need to be undertaken as part of the LNG Project.

As mentioned, these aspects have significantly compromised the outcome of this *implementation exercise*, namely with regards to the quality and accuracy of the resulting *Suitability Models*, with implications on the adequacy of the *Potential Sites* identified for the location of the *Replacement Village(s)*. These limitations would need to be overcome in order to progress the *Site Selection Process*.

As a matter of fact, the second main objective of the workshop (the first being seeking buy in / approval, from the Project, with regards to the *Site Selection Methodology* developed) was to gather first comments on the way forward, namely with regards to the strategies to overcoming the limitations identified.

Way Forward

In line with the mentioned objectives, the main outcomes / decisions of the workshop were:

1. Validation of the *Site Selection Methodology* (as long the *methodology* was approved, it could then be implemented to different *Study Areas* and further refined, considering a gradually more comprehensive set of parameters and increasingly accurate and detailed data / information);

2. Decision to extend the *Study Area* further north and south (definition of the *Extended Study Area*);

3. Awareness of the limitations presented regarding the *desktop Suitability Models* and outline of strategies to overcoming these in order to take the *Site Selection Process* forward:
   - o Decision to conduct a *Rapid Assessment Field Study* (RAFS) to address the above mentioned information limitations;
   - o Define and agree with the wider Resettlement and Project Teams on a more comprehensive set of *Site Selection Parameters* (*Constraints* and/or *Comparison Criteria*) following conduction of the RAFS;
   - o Only after the public announcement of the LNG Project by the GoM, namely of the need to resettle the Affected Communities, will it be possible to overcome the present lack of engagement with the relevant stakeholders, namely the Affected Communities. As soon as possible, the Project shall start engaging with these stakeholders in order to seek and integrate in the *Site Selection Process* their inputs with regards to:
     - The *Parameters* considered for *Site Selection* (*Constraints* and *Comparison Criteria*);
     - Inclusion of any additional community socio-economic parameters / community aspirations;
     - Ranking / weights to be assigned to the *Comparison Criteria*.

4. Decision to develop new *Suitability Models* by applying the approved *Site Selection Methodology* to the *Extend Study Area* and considering an agreed upon (with the wider Resettlement and Project Teams) *new* set of *Site Selection Parameters* (*Constraints* and/or *Comparison Criteria*), using the information obtained from the RAFS.

Summary

It was not intended to come up with the definition of actual *Sites* for the *Replacement Village(s)* based on the results of the first *Suitability Models* presented in the workshop.

On one hand, the limitations identified with regards to the quality of the data / information used were considered to be serious enough, to the point of compromising the output of the models.

On the other hand, although the assessment parameters included social / socio-economic considerations that, from an expert judgement point of view, considered likely community views and opinions with regards the siting of *Replacement Village(s)*, it was immediately assumed that such assumptions needed to be verified via community consultation, namely to confirm views on current and potential future living arrangements and sources of livelihoods.

It was therefore recommended that, in general, all information and data used in this first *exercise* of *Site Selection* were validated, confirmed, updated and complemented through primary data collection on-site. It was also considered critical to increase the level of detail and accuracy of the "high level" spatial information used thus far.

Additional and more refined information would also have to be collected in order to complement the existing baseline information (both through additional desktop investigation, and field work), namely to obtain information about possible constraints that had been overlooked or other parameters (*Comparison Criteria*) relevant for comparing the *Potentially Suitable Areas*.

On a different note, the quality of the data / information used in this *implementation exercise* was considered good enough to test the *Site Selection Methodology*. The results of the exercise demonstrated the adequacy of the methodology for its purpose (provided the limitations identified were overcome), which led to the approval of the *Site Selection Methodology*.

A.1.2 Rapid Assessment Field Study

The decision to conduct a *RAFS* came as a consequence of realizing that the quality of the *readily available* data and information used in the first exercise of Site Selection was not adequate and would therefore compromise the output of the resulting *Suitability Models*.

It would then be necessary to gather information directly from the site, which was done by means of a RAFS. This study was conducted by **Coastal & Environmental Services (CES)** following field work conducted during a site visit that took place between June 18th and July 5th.

All information available thus far, particularly that used in the development of the first *Suitability Models*, was provided to CES prior to the site visit, so that it could be validated / corrected based on the observations on-site (ground-truthed).

The RAFS was therefore designed in order to:

- validate, confirm and update, through primary data collected on-site, the *readily available* data and information used in the first exercise of Site Selection regarding the parameters (*Constraints* and *Comparison Criteria*) considered for the development of the first *Suitability Models*;
- ground-truth conclusions drawn from remote sensed imagery used and increase the level of detail and accuracy of the “high level” spatial information used, namely the boundaries of each parameter considered, in order to allow mapping of all parameters at a more precise (larger) scale;
- identify possible constraints that had been previously overlooked;
- collect and provide additional and more refined information (both through additional desktop investigation, and field work), with regards to the parameters considered and/or additional parameters to include in the analysis, in order to complement the existing baseline information;
- correct any errors in assumptions and/or information used in the first exercise of Site Selection.

Appendix C – “Rapid Assessment Field Study Report” (September 2013); Coastal & Environmental Services (CES) contains the report produced to present the results of the RAFS.

A.1.3 Extended Study Area (Updated Suitability Models)

As agreed during the May Workshop, the *Site Selection Methodology* would be applied to the *Extend Study Area* (oval shape around the DUAT Area) using the updated information compiled in the RAFS *Report*, and considering a revised set of *Site Selection Parameters* (*Constraints* and *Comparison Criteria*) agreed upon with the wider Resettlement and Project Teams. The purpose was to produce new *Suitability Models* based on real, larger scale data, and ground-truthed information.

The idea of developing different models for *Fishing Villages* and *Agriculture Villages* was abandoned, as it was considered that all communities, although to different extents, depend on both fishing and agriculture.

On the other hand, it was noted that some parameters that represent *Constraints* for the construction of the infrastructure associated with the villages (e.g. wetlands and flooded areas) do not prevent agricultural activities to take place. Additionally, the *criteria* for identifying the *most suitable areas* for the construction of the *Replacement Village(s)* are different (and/or have different weights) to those that shall lead to the identification of the *most suitable areas* for agriculture.

The methodology adopted initially had therefore to be adjusted according to these observations, and two separate models were developed:

- Village(s) / Infrastructure *Suitability Model* – to support the identification of the *most suitable areas* for the physical infrastructure (building the villages and associated infrastructure);

- Livelihood Development / Agricultural *Suitability Model* – to support the identification of the *most suitable areas* for livelihood development activities, namely the agricultural plots.

The way found to ensure that the location of the *Replacement Village(s)* would consider the need of the fishing communities to continue carrying out their subsistence activity with the least disruption possible, was to assign a high weight was to the *Comparison Criterion* “Proximity to the coast” (the highest weight assigned), in the *Village(s) / Infrastructure Model*.
In order to “sort list” a number of *Potential Sites*, the process followed was to search for areas suitable for building the villages (as per indicated by the *Village(s) / Infrastructure Model*) that are close enough to areas suitable and apparently available for agriculture (as per indicated by the *Agricultural Model*) and, additionally, taking into consideration (although qualitatively) the assessment carried out on the *Suitability of the Fishing Grounds* (as *suitability lines* along the coast).

A workshop was held in Maputo on the 27th of August, 2013, in order to present and discuss with the wider Resettlement and ProjectTeams the new (post RAFS*) Suitability Models* developed. Some adjustments were proposed, namely with regards to the inclusion of additional *Comparison Criteria*, which were incorporated into updated *Suitability Models*.

In Appendix D – Post *Rapid Assessment Field Study* Models, specifics regarding the implementation of the *Site Selection Methodology* to the *Extended Study Area* have been presented and described in detail, namely:

- the Site *Selection Parameters* considered: *Constraints* and *Comparison Criteria*;

- the *Classification Systems* defined (categories to be used to classify the *Potentially Suitable Areas* according to each *Comparison Criterion*);

- the *weights assigned* to each *Comparison Criterion* – in order to reflect the relative importance of each *criterion*;

- the output of *the* implementation of the methodology: the two *Suitability Models* generated, ranking the *Potentially Suitable Areas* according to their *Overall Suitability*, respectively, for the purpose of identifying the *most suitable areas* where to build the *Replacement Village(s)* and to locate the agricultural plots;

- the use of the *Suitability Models* in the identification of a number of *Potential Sites* where to locate *Replacement Village(s)*.

The updated *Suitability Models* and the proposed *Potential Sites* were then presented, at a higher level within the Project (including the LNG Project Director), on another workshop held in Centurion, on the 6th of September, 2013.

The main purposes of this presentation at the workshop were:

- to obtain approval of the results of the implementation of the *Site Screening Methodology* to the *Extended Study Area*: the *Suitability Models* and the *Potential Sites*; and

- to authorize WP to start engaging with:
  - o the *Affected Communities* and the *Government of Mozambique* with regards to *Site Selection Process* conducted thus far, and to obtain inputs from this *Consultation Process* in order to proceed the *Site Selection Process*;
  - o MICOA with regards to the links between the *Site Selection Process* under way and the overall *Environmental Impact Assessment* Process for the *Replacement Village(s)* Project.

In fact, this lack of engagement, previously identified as one of the limitations of the first *Suitability Models* developed, had remained as the main limitation of the updated models.

It was therefore important to obtain authorization from the Project to start this *Consultation Process*, crucial for obtaining the necessary inputs from the communities and other relevant stakeholders that would allow updating the *Suitability Models* including additional community socio-economic parameters and the communities' aspirations.

A.2 Site Selection Inside the DUAT Area

Following the presentation of the *Post Rapid Assessment Field Study Suitability Models* to the Project at the workshop in Centurion, and in order to seek compliance with the IFC Performance Standard 5, namely to minimize involuntary resettlement wherever feasible, AMA1 and EEA have decided investigate the feasibility of reducing the LNG Project footprint.

Not only would this have the potential to reduce the number of households requiring physical displacement, but would also open up space so that the *Replacement Village(s)* and agricultural land could be located closer to the current location of the Affected Communities, specifically inside the DUAT Area, thus minimizing the disruption associated with the resettlement.

In fact, this would be in line with the preferences stated by the Affected Communities during a survey conducted under the LNG Project Environmental Impact Assessment. According to this survey, over 60% of the total households surveyed in the Afungi Project Site and surrounds stated that they would prefer to be resettled to a "nearby" location, with regards to the location where they currently reside. According to the same survey, more than 75% of the total households surveyed stated they would prefer to live in a "concentrated village" and over 70% in a "formally organized settlement".

The Project has therefore explored alternative project designs for the LNG facility and, as a result, it was possible to significantly reduce the Project footprint to an area that is much smaller than originally envisaged: the *Revised Build Zone*.

A number of households will still be directly and/or indirectly affected by the LNG Project and require physical and/or economic displacement to one or more *Replacement Village(s)*. In question are the households situated inside the Project's *Revised Build Zone* and those located in the surrounding areas that are found to be significantly affected by the Project. Nevertheless, the number of households that would still need to be physically displaced was estimated to reduce from 750 to approximately 450 households (to be confirmed by the census).

This approach (reduction of the Project footprint) would also have the potential to reduce the interference with the existing agricultural areas, once part of the areas currently in use for agriculture (outside the *Revised Build Zone* and areas constrained under the *Agricultural / Livelihood Development Model*) might possibly remain in use for livelihood development activities.
However, a number of households (those situated inside the Project's *Revised Build Zone* and those located in the surrounding areas that are found to be significantly affected by the Project) would still be directly and indirectly affected by the Project and would require physical and/or economic displacement. The physically displaced households would need to be relocated to one or more *Replacement Village(s)*.

It was therefore decided to assess the DUAT Area in an attempt to identify a number of alternative *Potential Sites* where to build the *Replacement Village(s)* to accommodate the households that will still need to be displaced, and establish a Livelihood Development Zone.

The *Site Selection Methodology* was therefore applied to the DUAT Area (as the "new" *Study Area*) and two new *Suitability Models* were developed: *Village(s) / Infrastructure* and *Livelihood Development / Agricultural*. Based on these models, it would be possible to understand whether there are, inside the DUAT Area, areas suitable for the construction of the villages / infrastructure and the associated agricultural plots. If so, a number of *Potential Sites* would then need to be identified, following the already explained process to do so.

Similarly to what happened during the whole *Site Selection Process*, this was achieved following a number of steps and iterations.

With regards to the process followed, WP started by gathering all data and information available pertaining all known *Constraints* inside the DUAT Area, mostly from the draft version of the LNG Project EIA. New

Constraints Maps were produced for both the construction of the physical infrastructure and the location of the agricultural plots and sent to the Project for preliminary approval.

These *Constraints Maps* have revealed the existence of some *Potentially Suitable Areas* for both the village(s) and the agricultural plots, which indicated that the *Resettlement Inside the DUAT Area* might be a feasible alternative to consider and further investigate.

It was therefore decided to proceed the implementation of the *Site Selection Methodology*, for what an initial set of *Comparison Criteria* had to be defined, along with the respective *Classification System* and weights, in order to allow the comparison of the *Potentially Suitable Areas* and identify the *most suitable areas* (development of the *Suitability Models*).
It is important to note that due to the limited period of time allowed for the development of these preliminary *Inside the DUAT Area Suitability Models*, the parameters used (*Constraints* and *Comparison Criteria*), as well as the *Classification Systems* and weights assigned to each *Comparison Criterion*, could not have been extensively discussed with the wider team (the way this had happened for the previous models) and that the data and information that was possible to use was exclusively that already available.

As a matter of fact, the parameters defined as initial *Comparison Criteria* were also determined by the data and information already available, again, mostly from the draft version of the LNG Project EIA.

Nevertheless, this was a first approach to the *Resettlement Inside the DUAT Area* Option and, at that moment, other discussions and negotiations were taking place in order to understand whether other aspects (namely legal aspects) might render this option as non-viable.

These preliminary *Suitability Models* for *Site Selection Inside the DUAT Area* have, however, revealed the existence of some apparently *suitable areas* for both the *Replacement Village(s)* and the agricultural plots. This again suggested that this *Resettlement Option* would be worth considering and further investigate, for what these preliminary *Suitability Models* were presented to the Project, on the 19th of September 2013.

Appendix E – Paper: "Resettlement Replacement Village – Resettlement Inside the DUAT Area"is presented a paper prepared in order to summarize the preliminary findings of the implementation of the *Site Selection Methodology* to the "*Inside the DUAT Area*" and to present a number of issues requiring a position / decision from AMA1 and EEA that would allow the *Site Selection Process* to move forward.

A wider discussion of the *Site Selection Parameters* (*Constraints* and *Comparison Criteria*) took place with the wider Resettlement and Project Teams, and additional parameters were introduced. In addition, new studies were carried out and new sources of information were used (Quantitative Risk Assessment, Noise Modelling specific for Resettlement purposes and air quality modelling) to complement the data previously used, and the *Suitability Models* were reviewed accordingly.

In Appendix F – Decision Paper – Summary: "Resettlement: *Replacement Village(s)* Site Selection" is presented a summary version of the above mentioned paper, prepared in order to obtain final approval from AMA1 and EEA with regards to the option of resettling inside the DUAT Area.

It is important to highlight that the idea of assessing the alternative of resettling *Inside DUAT Area* during the Centurion Workshop, in early September 2013, put on hold the start of the *Consultation Process* with the Affected Communities and the Government of Mozambique with regards to *Site Selection Process* until a decision was made with regards to whether the *Replacement Village(s)* would be located inside or outside the DUAT Area.

This means that, from that moment on, the *Site Selection Process* progressed as per described, again, without the benefit of any desirable input resulting from this *Consultation Process*.
In the following chapter, will be presented and described in detail the specifics regarding the implementation of the *Site Selection Methodology* to the *DUAT Area*, namely the final (prior any engagement):

- *Site Selection Parameters* considered: Constraints and *Comparison Criteria*;
- *Classification Systems* defined;
- weights assigned to each *Comparison Criterion*;
- output of the implementation of the methodology: the two *Suitability Models* generated (*Village(s) Infrastructure* and *Livelihood Development/ Agriculture*);
- the use of the *Suitability Models* in the identification of a number of *Potential Sites* where to locate *Replacement Village(s)* inside the DUAT Area.

The above mentioned lack of engagement, also identified as the main limitation of the previous *Suitability Models* developed (for the *Extended Study Area* around the DUAT Area), remains as the main (very significant) limitation of the *Final Suitability Models* presented in this report.

It has also been strongly recommended thatthe Project / WP meet with MICOA in order to discuss the way forward, namely with regards to the *Environmental Impact Assessment Process* and, in particular, the way the on-going *Site Selection Process* for the *Replacement Village(s)* should “fit” in the overall EIA Process.

APPENDIX B – REPORT: "REPLACEMENT VILLAGE MULTI-CRITERIA ASSESSMENT & SITE SELECTION STUDY" (WORLEYPARSONS, JUNE 2013): DESKTOP DATA MODEL

Replacement Village Multi-Criteria Assessment & Site Selection Study

MOZAMBIQUE GAS DEVELOPMENT

CONTENTS

Figures

Tables

1 INTRODUCTION

WorleyParsons was awarded the Afungi Replacement Village Project by Anadarko Petroleum Corporation (APC) in February 2013. As part of the contractual scope of work, WorleyParsons is to provide advice on potential sites for the construction of Replacement Village(s) for an estimated 700 households which will be displaced by Anadarko Mozambique Area 1 (AMA1) and Eni East Africa (EEA) proposed Liquefied Natural Gas (LNG) facility on the Afungi peninsula near Palma, Northern Mozambique. The LNG Project site is illustrated in Figure 1-1.

Figure 1-1 LNG Project Site

This report presents the methodology inherent to the Site Selection Multi-Criteria Assessment process undertaken by WorleyParsons on behalf of APC. The methodology developed clearly and transparently communicates how the potential Replacement Village sites will be selected based on the availability and suitability of land in a defined Study Area.

This methodology was implemented using readily available data and information regarding the area that surrounds the project area, and the preliminary indicative results are also presented in this report. The methodology developed will be presented and discussed during a Workshop to be held in Maputo in early May 2013.

The main purpose of this exercise (implementation of the methodology using readily available data) is to better illustrate the methodology followed and to allow a more comprehensive discussion around itsprinciples during the Workshop. The present report has been compiled as a preparatory material for the Workshop.

It is important to highlight that, due to the nature and scale of the information used in this exercise, and also to the unavailability of information considered relevant, it is not intended to come up with the definition of actual sites for the Replacement Villages, based on the results presented.

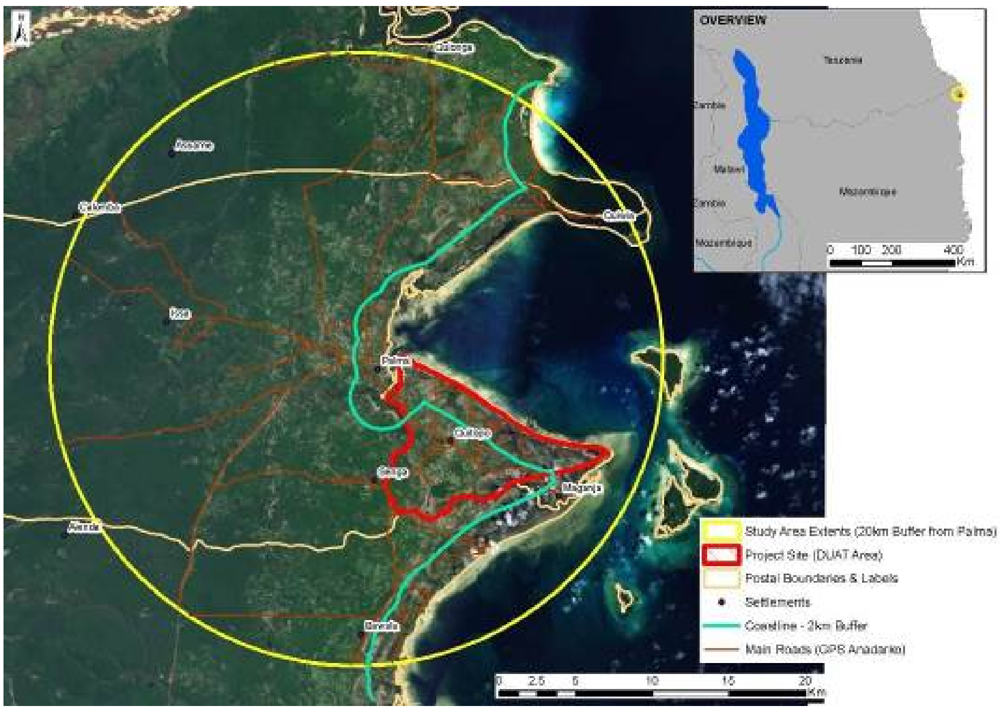


Figure 1-2 Study Area

This report also makes recommendations in regards to further investigations which are considered necessary to allow a proper identification of sites for the Replacement Villages, based on the general methodology proposed.

The key assumptions to this study include:

- The Study Area (i.e. area in which potential Replacement Village site(s) are to be identified) is defined as that area within a 20km radius around Palma based on the fact that the furthest household within the LNG Project Area (that corresponds to the DUAT Area (Direito de Uso e Aproveitamento da Terra: Land use agreement) is approximately 20km from Palma;

- Two types of villages will need to be resettled namely those with livelihoods predominantly based on fishing and those predominantly based on agriculture; and

- While existing fishing villages are likely to be, in the main, located very close to Palma Bay coastline, it is deemed acceptable to locate fishing Replacement Village(s) within 2km of the coastline noting that preference will be given to siting fishing Replacement Villages within similar distances of the coastline as they presently are.

Broadly speaking and taking into account areas near to Palma, the DUAT Area and the area designated by the Government of Mozambique for potential future industrial development, there are *Potentially Suitable* Areas for Replacement Village(s) to the north of Palma and south of the Industrial Zone for fishing Replacement Villages. Other relatively large areas would also appear to be available to the west of Palma for agricultural Replacement Village(s).

It is noted that a Rio Tinto Exploration Concession lies over a significant proportion of the areas identified as *Potentially Suitable* for the Replacement Village(s). This Concession expired in 2003 but it is presently not known whether the licence has been renewed. In the event that it has been renewed (to be confirmed), it may leave only: an area in the North East of the Study Area as a candidate area for Replacement Village(s), potentially suitable for both agricultural and fishing communities; an area further west only suitable for agricultural communities; and an area towards the south, on first assessment, only suitable for fishing communities.

It is noted however, that the possible existence of an Exploration Concession does not necessarily imply that an industrial development will take place over the entire Concession area. Therefore, the likelihood that all areas identified as *Potentially Suitable* for the Replacement Village(s) that also lie within the Concession area become unavailable is considered remote.

The Site Selection work completed to date has not had the benefit of input from community-based stakeholder engagement as no consultation has been possible due to the fact that the Government of Mozambique had not, at the time of writing, officially announced that a resettlement project was necessary and would be undertaken as part of the LNG development. It is considered that soliciting community views in respect Replacement Village Site Selection is an imperative.

While the Site Selection process completed to date has, from an expert judgement point of view, considered likely community views and opinions in regards the siting of Replacement Villages (i.e. the defined assessment parameters include social / socio-economic considerations), these assumptions need to be verified via community consultation to confirm views on current and potential future living arrangements and sources of livelihoods.

It is recommended that:

- Further site investigations including field surveys to ground-truth conclusions drawn from remote sensed imagery and potentially intrusive investigations to confirm assumptions concerning groundwater reserves, soil types and geotechnical slope stability at a minimum be undertaken to inform final Site Selection process; and

- Community consultation via representative “steering committees” be undertaken to ascertain iews and opinions in regards siting of the Replacement Village

2 REPLACEMENT VILLAGE SITE IDENTIFICATION

2.1 SITE APPRAISAL VISIT

A Site Appraisal Visit was conducted in support of the Replacement Village Site Selection Study from March 15th to 19th, 2013. The visit included a fly-over and a drive through the Palma area, with the main purposes of getting the team familiarized with the general area and to support the definition of the potential Study Area.

In preparation for the site visit, seven broad areas considered to be possibly suitable for Replacement Village(s) were defined based on a visual assessment of remote sensed imagery using the following basic suitability criteria:

- Proximity to Palma;
- Proximity to the ocean;
- Proximity to access roads;
- Absence of large settlements or other existing infrastructure; and
- Absence of large hydrological features (e.g. flood plains).

The results of the Site Appraisal Visit are reported in the Resettlement Project: Afungi Peninsula Site Appraisal Visit Report March 15 – 19 2013 (WorleyParsons, April 3, 2013), in appendix.

The Site Appraisal Visit evaluation resulted in the seven sites being ranked as *suitable* (green), *possibly suitable* (yellow) and *not suitable* (red). One site was identified as *suitable* and four potential sites were identified as possibly suitable as summarised in Table 2-1 below.

Table 2-1 Summary of Site Appraisal Visit Site Rating

Site #	Site Name	Rating	Commentary
1	Olumbe		Access to Palma is a concern. Site is located closer to Mocimboa da Praia, which could serve as an alternative economic hub. Community opinion and preference will be critical.

Site #	Site Name	Rating	Commentary
2	Industrial Zone		Access to Palma is a concern. Site is located closer to Mocimboa da Praia, which could serve as an alternative economic hub. Community opinion and preference will be critical. Access to fuel source might be limited. Limited vegetation concern for agriculture potential. Wetland areas on-site are a concern.
3	West Industrial Zone		Access to coast is a concern. Sparse vegetation for fuel and limited wetland/floodplain areas available for rice cultivation may be a concern. Suitable on all environmental and technical criteria. Possible site amendment to include area further north.
4	West of Palma Road		Site is generally suitable in terms of environmental and technical criteria without major concerns. The distance to the ocean as well as to Palma are major concerns.
5	North west Palma		Site is generally suitable in terms of environmental and technical criteria without major concerns. The distance to the ocean is a concern.
6	Palma North		Site is generally suitable in terms of environmental criteria without major concerns. The sparse vegetation may however be a concern in terms of soil suitability. The distance to the Palma is a major concern.
7	Extension of Palma Town		Site is generally suitable in terms of environmental criteria without major concerns. Limited agricultural options with possibilities south and southwest.

The Site Appraisal Visit Report recommended that these potential sites be further evaluated using a more robust multi-criteria assessment approach in order to short-list some sites. The recommendation was that a Workshop should be held in early May in order to discuss the findings of the adopted approach (multi-criteria assessment) and to agree on a short-list of sites along with housing design concepts and local content opportunities.

The Site Appraisal Visit Report notes that more detailed vegetation, land use, flood risk and existing infrastructure desktop analyses will need to be undertaken using the latest aerial imagery available. Finally, the report recommends that field investigations on the short-listed sites be undertaken after the short-listing Workshop.

In group discussions after the Site Appraisal Visit, WorleyParsons concluded that a more robust and defensible methodology for Site Selection needed to be developed in order to clearly and transparently communicate how the potential Replacement Village sites will be selected based on the availability and suitability of land in a defined Study Area. A more comprehensive set of Site Selection criteria also needed to be developed in order to take the Site Selection process forward. The criteria needed to be defensible and allow for replicate assessments of alternative areas should the need arise. It was also concluded that a wider Study Area needed to be defined and the proposed new set of Site Selection criteria should be applied to the whole Study Area (and include all the areas surrounding the DUAT Area and Palma) and not just to the seven areas pre-selected for appraisal during the Site Appraisal Visit.

The results of this work are presented in Section 3.

3 SITE SELECTION MULTI-CRITERIA ASSESSMENT

3.1 METHODOLOGY

The Site Selection Multi-Criteria Assessment ranks *Potentially Suitable Areas* for the Replacement Village in terms of their overall suitability based on the consideration of a number of defined criteria. The methodology proposed includes three key tasks:

1. An initial demarcation of areas that are deemed *unsuitable* for Replacement Village(s) based on a number of defined parameters (hereafter referred to as “constraints”) which leads to the identification the of areas that are *Potentially Suitable* for the Replacement Village(s);

2. An analysis that ranks the *Potentially Suitable Areas* based on defined criteria; and

3. Identification of specific sites, within the *Potentially Suitable Areas*, where the Replacement Village(s) could be constructed (assuming relevant permits are obtained) based on the previous ranking (to be confirmed via field-based investigations, yet to be completed).

The ranking of the *Potentially Suitable Areas* in terms of their overall suitability is achieved by:

a) Identifying appropriate *Comparison Criteria*;

b) Defining a classification system to classify each area, according to each *Comparison Criteria*, in a scale from **1** from ("least suitable") to **5** ("most suitable"); and

c) Agreeing on the relative weighting each *Comparison Criteria* should have in the comparison of the Potentially Suitable Areas (in the percentage scale).

According to the multi-criteria assessment methodology, each *Comparison Criteria* is captured as a thematic layer in a geospatial database. A map output from the database graphically represents the information regarding each parameter.

By classifying each *Potentially Suitable Area* in accordance with defined classification system for each *Comparison Criteria* and by agreeing the relative weight each criterion should have, it is possible to determine, for each area, the *weighted average* of the classifications given to all *Comparison Criteria*. The weighted average corresponds to the *overall suitability* of each area and the results are also presented as a map. In this map, *Potentially Suitable Areas* are ranked from "*most suitable*" (higher scores) to "*least suitable*" (lower scores).

Once the comparative ranking of *Potentially Suitable Areas* is completed and once the required area for a Replacement Village is better understood, specific sites within the most suitable area(s) can be selected.

The proposed Site Assessment methodology and the approach leading to the identification of potential sites for the Replacement Village(s) will be presented and discussed during the Workshop to be convened on May 3rd and 4th. The main topics for discussion include:

- Confirmation of the method used to define the Study Area;
- Parameters defined for initial *Constraints Mapping* (which leads to the dismissal of some areas from further consideration) and the need to include additional parameters (particularly those that will expectedly be raised during community stakeholder consultation);
- Defined "Comparison Criteria", to be used to compare the *Potentially Suitable Areas*, and the need to include additional ones;
- Defined "Classification Systems" (categories to be used to classify the *Potentially Suitable Areas*
according to each Comparison Criterion);
- Weights to be assigned to each "Comparison Criterion" – in order to reflect the relative importance of each criterion;

Other issues to be discussed relate to:

- General assumptions made in the development of the Site Selection methodology and execution of the multi-criteria assessment;
- Limitations of the information considered (i.e. its origin, which is mostly desktop, and the scale of the geo-referenced information) and the implications for the outcome of the present exercise of Site Selection; and
- Further information requirements in order to facilitate mapping at an increasingly more precise scale including field validation of information used to date and secondary data requirements, including on-site studies.

3.2 ASSUMPTIONS

3.2.1 DUAT Area

The DUAT Area is the area granted to RBLL, on a preliminary basis, for the implementation of the LNG Project. This is the site of origin for the resettlement and is hence excluded as a candidate site for the Replacement Village(s).

3.2.2 Proximity to Service and Trading Centres

The location of the Replacement Village(s) will ideally offer equal or closer proximity to the larger service and trade centres, Palma Town, to maintain comparable levels of access to markets and services for those communities that are to be resettled.

3.2.3 Proximity to the Coast

In order to minimise changes to the livelihoods of fishing communities, fishing villages should be resettled in areas close to the coast. It is considered that resettlement in an area no further inland than
2km of the Palma Bay coastline will preserve current levels of amenity for fishing livelihood dominated communities.

3.3 STUDY AREA DEFINITION

A radius of 20km around Palma, being the furthest distance a target resettlement household presently is from Palma, was defined as the Study Area. This radius was determined by calculating the straight line distance between the subject household and Palma (i.e. 17.5km) and adding a 15% contingency to account for additional distance an individual from the household would likely actually have to travel given that tracks / roads are not actually straight and direct to Palma.

It is acknowledged that a more informed parameter on which to define the Study Area may be *time* required to travel as it is understood that various modes of transport are used to access local markets (walking, bicycles, scooters/motorbikes, car/truck). It is expected that this information will be acquired through community consultation, to be undertaken as part of the Site Selection process.

3.4 CONSTRAINTS MAPPING

The Study Area was assessed in terms of "constraints" to the location of the Replacement Village(s).
Constraints
include:

1. Existing and Potentially Protected Areas;
2. Areas of Cultivation, Settlement and Existing Infrastructure;
3. Waterways and Wetlands;
4. Soils and Agricultural Suitability;
5. Topography;
6. Geotechnical Stability;
7. Proposed Industrial Zone; and
8. Potential Mining Concession Area.

Mapping of these parameters in the Study Area led to the identification and subsequent exclusion of areas deemed *unsuitable* for the location of the Replacement Village(s). The remaining areas are deemed *Potentially Suitable*.

3.4.1 Existing and Potentially Protected Areas

Existing and potential future Protected Areas, including aspects such as Coastal Dry Forests, game reserves, mangroves, wetlands, coral reefs, turtle beaches and elephant corridors have been investigated and mapped, whenever identified. The corresponding areas are considered *unsuitable* for the location of the Replacement Village(s).

According to the information available (further investigation required), there are currently no Protected Areas within the Study Area.

Coastal Dry Forests and mangroves have been mapped. Wetlands have been identified and mapped as hydrological features. Turtle beaches and elephant corridors need to be further investigated and, if present, mapped.

- There are no current formal **Important Bird Areas** in the direct vicinity of Palma (http://www.birdlife.org/datazone/userfiles/file/IBAs/AfricaCntryPDFs/Mozambique.pdf accessed 18.04.2013);

- There are no Ramsar sites within the Study Area (http://www.ramsar.org/cda/en/ramsar-pubs-notes-annotated-ramsar-16507/main/ramsar/1-30-168%5E16507_4000_0 accessed 18.04.2013

- There appear to be no **marine protection areas** adjacent to the Study Area (Websearch 18.04.2013);

- There appear to be no **forest concessions** within or adjacent to the Study Area (Dobbin International Inc. Anadarko LNG Presentation, 2012);

- There appear to be no **game reserves** within or adjacent to the Study Area (Dobbin International Inc. Anadarko LNG Presentation, 2012); and

- There appear to be no **coral reefs** in the coast adjacent to the Study Area (Dobbin International Inc. Anadarko LNG Presentation, 2012).

All of the above need to be confirmed during additional site investigations, following short-listing of potential Replacement Village areas.

3.4.2 Areas of Cultivation, Settlement and Existing Infrastructure

Areas that are already settled, host existing infrastructure including their respective legal buffer zones or are cultivated are considered *unsuitable* for the Replacement Village(s).

Mapping of these areas has only been achieved at a small scale resolution. Demarcation of relevant areas is based upon existing high level (and somewhat out of date) land use maps covering agriculture, homesteads and villages within the Study Area. Larger scale mapping is required in order to confidently identify all agricultural, settled and existing infrastructure areas.

The extent to which previously disturbed but not presently cultivated areas represent *Potentially Suitable Areas* will be discussed at the Workshop. Demarcation of such areas will depend on obtaining detailed information for the Study Area, likely only available via field work. If a disturbed area is found to be currently in use it will be deemed *unsuitable*. If a previously disturbed area is found not to be in use (presently or for the foreseeable future), it may be deemed *Potentially Suitable*.

3.4.3 Waterways and Wetlands

Any waterway or wetland at a time of highest flooding during the year and respective legal buffer zones is deemed *unsuitable* for Replacement Village(s).

Which flood event to be applied needs to be discussed and agreed during the Workshop. In addition, it is considered pertinent to discuss the potential implications of climate change on the frequency and severity of flooding and how this could be taken into consideration on the Site Selection process.

3.4.4 Soils and Agriculture Suitability

Any area with soils unsuitable for the type of agriculture people have access to at their current location will be mapped and deemed as *unsuitable* as potential sites for farms associated with the Replacement Village(s).

Additional information needs to be obtained to enable such mapping. Such mapping will only be undertaken for those areas deemed *Potentially Suitable* for the Replacement Village(s).

3.4.5 Topography

Replacement Village(s) will only be built in areas and at sites where construction is technically viable. Areas with slope gradient of more than 10% shall be deemed *unsuitable* for the Replacement Village(s), as per Decree 31/2012, of 8 August. Such areas have been mapped.

All areas with slopes *unsuitable* for cultivation need to be identified and will similarly be deemed *unsuitable*. What constitutes a too steep a slope for agriculture will be discussed at the Workshop and the mapping of such areas will be undertaken subsequently.

Implementation of the above will facilitate Site Selection where Replacement Village(s) can be built on slopes of less than 10%, regardless of the fact that areas with steeper gradient will also be present but will potentially be used for agriculture.

3.4.6 Geotechnical Stability

Replacement Village(s) will only be built on ground that has suitable geotechnical stability to ensure structure foundation integrity. Areas where ground conditions are unstable will be deemed as *unsuitable* for the Replacement Village(s).
At the time of writing, no geotechnical information was available for the Study Area. It is recommended that field investigations be conducted in *Potentially Suitable Areas* to ascertain suitability of ground conditions. In the event that ground conditions are proven to be *unsuitable*, then the subject area(s) will need to be removed from the *Potentially Suitable Areas*.

3.4.7 Industrial Zone

Two different versions of the Industrial Zone exist. It needs to be established which one, if either, of these areas is going to be declared an Industrial Zone by the Government of Mozambique.

If either of the two potential Industrial Zones is declared, a significant area within the Study Area will no longer be available as a potential Replacement Village(s) location and the area(s) will need to be deemed *unsuitable*.

It is recommended that consultation with the Government of Mozambique be undertaken to determine the likelihood of the potential Industrial Zones being declared in the foreseeable future and if so, approximately when this may occur.

3.4.8 Mining Concession Area

A Mining Concession area has been identified in the Study Area, issued to Rio Tinto. Construction of the Replacement Village(s) has to take this aspect into account.

According to the information available, the license expired in 2003. Nevertheless, it needs to be confirmed whether this license has been reissued and, in that case, what the expiry date is. It is also considered prudent to ascertain the exact nature of the licence (e.g. exploration versus development). In the event it is a current licence, it is recommended that consultation with Rio Tinto be undertaken to ascertain its plans for conducting works in the area and the potential timing of the works.

If a valid license exists for the Concession area, a vast area within the Study Area may no longer be available for resettlement and the area will likely need to be deemed *unsuitable* for the Replacement Village(s).

3.5 COMPARISON CRITERIA, CLASSIFICATION SYSTEM AND WEIGHTING (RANKING)

Following the completion of the *Constraints Mapping*, the areas identified as *Potentially Suitable* for the Replacement Village(s) are assessed in terms of their *overall suitability*. In order to do so, it is necessary to:

- Identify appropriate *Comparison Criteria*; these are the parameters that will be taken into account in order to compare and ultimately identify the most suitable areas;
- Define a *Classification System* to classify each area according to each of the *Comparison Criteria* defined, in a scale from 1 to 5 (i.e. the more suitable the areas is with regards to each *criterion*, the higher the score);
- to each of the *Comparison Criteria* defined;
- Agree on the *Relative Weight* each *Comparison Criterion* should have in the comparison of the Potentially Suitable Areas (in the percentage scale: i.e. the more important the *criterion* is, the higher percentage receives);
- For each area, determine the *weighted average* of the classifications given to all *Comparison Criteria*, which will correspond to the *overall suitability* (rating) of each area (with the higher scores corresponding to the most suitable areas);

Thus:

- **Environmental Criterion:**
  EC_1, EC_2, … EC_n;
- **Social Criterion:**

SC_1, SC_2, … SC_n;

- **Classification for each area for each Environmental Criterion:**
  $C(EC_1)$, $C(EC_2)$, … $C(EC_n)$;

- **Classification for each area for each Social Criterion:**
  $C(SC_1)$, $C(SC_2)$, … $C(SC_n)$;

- **Weighting for each Environmental Criterion:**
  $W(EC_1)$, $W(EC_2)$, … $W(EC_n)$; and

- **Weight assigned to each Social Criterion:**
  $W(SC_1)$, $W(SC_2)$, … $W(SC_n)$;

For each area, the weighted average is determined as follows:

$$\frac{C(EC1) \times W(EC1) + C(EC2) \times W(EC2) + \ldots + C(ECn) \times W(ECn) + C(SC1) \times W(SC1) + C(SC2) \times W(SC2) + \ldots + C(SCn) \times W(SCn)}{W(EC1) + W(EC2) + \ldots + W(ECn) + W(SC1) + W(SC2) + \ldots + W(SCn)}$$

This means that a weighted average is calculated for each Potentially Suitable Area, by applying to each layer (each layer corresponding to the classifications for a given *Comparison Criterion*), the respective weight, and determining the respective overall suitability.

The calculations are automatic within the geodatabase GIS application, and the results can then be presented as a final / global map, representing the overall suitability of each *Potentially Suitable Area*.

Based on this Map of Overall Suitability, sites of adequate size can be identified (and outlined) within the areas of highest *overall suitability*. This ensures that the overall suitability of these short-listed sites is maximised.

If the Replacement Village(s) areas are to fall within one single Administrative Post (as per the Site Visit Report), the above mentioned identification of optimum *potential site(s)* must be carried out within each Administrative Post. This may result in the identification of one or more possible sites within each Administrative Post.

The short-listed sites can then be further investigated, knowing that the main constraints (no-go areas) have been avoided and the best conditions (as based on the defined criteria) will be met.

Further investigation on the existence of areas ruled by different *Régulos* should be carried out and be taken into account (qualitative assessment, when identifying *potential site(s)*). It needs to be investigated whether it would be preferable that the site should or not be totally included in the area ruled by one single *Régulo*. This will allow consideration of both the political (Administrative Posts) and traditional leaderships.

Based on information provided by the Project, there is an estimated 750 households within the DUAT Area that require resettlement. The total area of the *potential site(s)* where the Replacement Village(s) are to be build must ensure that the requirements of the Decree 31/2012, of 8 August, are met in terms of the minimum area for replacement households.

It is considered that, ideally, existing communities should be kept together as they are at present to minimise disruption to community social fabric. As the Site Visit Report specifies, Barabarane, which is included in the Palma District Urbanization Plan, may want to be resettled to Palma Town. Patacua may have, as an option, resettlement within its own community located outside the DUAT or to Maganja. The latter may also be a destination for Malimba 2. There is, however, a possibility that roughly a further 1,000 households may require resettlement (Maganja, Nsemo / Kibundju and Senga) due to economic implications of the resettlement of neighbouring villages and / or restrictions to fishing. In order to implement the proposed methodology, a discussion on the *constraints*, *Comparison Criteria, Classification Systems* and *weighting* to be considered must be held. In order to illustrate the implementation of the methodology and make it easier this discussion during the Workshop, initial thoughts on this are presented ahead and the discussion shall be initiated at the Workshop.

3.5.1 Technical Criteria

Unless otherwise agreed during the Workshop, no technical *criteria* are to be considered, as all previously identified technical issues have been taken into account during the *Constraints Mapping*.

3.5.2 Financial Criteria

Services and facilities that the Project will be obliged to provide regardless of the final Replacement Village(s) location (e.g. phone coverage, electricity and access to potable water) are considered to be financial criteria. Financial decision making is out of the scope of the Site Selection Study and hence these criteria have not been included in the current evaluation.

As continued access to services such as energy and water are essential with regards to quality of life and livelihoods, non-company provided services and facilities have, however, been taken into account in the *Constraints Mapping*.

This approach has been adopted on the basis that, even if the Project provides connection to mains electricity and water, the question remains whether people will actually be able to pay for these services in the long-term (i.e. they cannot be resettled to a location at which they can live a good quality life only if they can afford to pay for services which enable them to do so).

3.5.3 Environmental Criteria

The following *Environmental Criteria* have been considered in order to compare the Potentially Suitable Areas:

Presence and / or Proximity to Environmentally Sensitive Areas

- Some parameters have been considered as constraints (refer Sections 3.4.1, 3.4.2 and 3.4.3);
- Workshop Discussion:
  - Have any been overlooked?
  - What additional information is required?
  - Are there any potential ecosystem services which require consideration?

Disturbed Areas

- Disturbed areas have been considered as a potential constraint (refer Section 3.4.2)
- Workshop Discussion:
  - What additional information needs to be obtained with regards to disturbance of vegetative cover in non-agricultural areas?

Wildlife

- The presence of fauna has not explicitly been taken into consideration as a potential constraint;
- Workshop Discussion:
  - Should wildlife be considered more fully as a constraint?
  - What sources of information on incidences of human / wildlife conflict is there that would facilitate mapping of the constraint?

3.5.4 Socio-Economic Criteria

The following *Socio-Economic Criteria* have been considered in order to compare the Potentially Suitable Areas:

Access to and availability of services and markets

- Access to and availability of services and markets has been considered as a *Criterion*.
- The way used to compare the areas according to this parameter was the "Distance to Palma town" – the closest town that, presently, consists a hub to services, markets and trade.

- Workshop Discussion:

  - Is it OK how this parameter was addressed (including the "way to compare" and classification system used)?

Proximity to Ocean

- The proximity of households to Palma bay coastline has been considered as a *Criterion*.

- The way used to compare the areas according to this parameter was the "Distance to the ocean" – the closer the Replacement Village(s) are to the sea, the better.

- Workshop Discussion:

  - Should agricultural and fishing villages have different Classification Systems (different classes of suitability);

  - Agree on the weighting assigned to this criterion, for fishing and agricultural villages.

Access to main access road

- Access to main access roads has been considered as a *Criterion*.

- The way used to compare the areas according to this parameter was the "Distance to main access roads" – considering that the areas closer to the main access roads are more suitable and therefore should be better ranked than those further away.

- Workshop Discussion:

  - Access to and availability of transport infrastructure? How to address?

Access to quality groundwater

- Access to and availability of good quality groundwater have been considered as *Criteria* (availability and quality separately).

- The way used to compare the areas according to this parameter was via mapping the areas with different aquifer productivity and ranking better the areas where the aquifer is more productive, as well as mapping the areas with different expected groundwater quality and ranking better the areas where the water quality is expected to be better.

- Workshop Discussion:

    - Proposed Classification System needs to be agreed upon, namely the definition of classes up to 3,000 m away from the nearest free public fresh water source.

Access to surface water (rivers)

- Access to and availability of fresh water has been considered as a *Criterion*.

- The way used to compare the areas according to this parameter was the "Distance to main rivers" – considering that the areas closer to the main rivers grant a better access to this resource (are more suitable) and therefore should be better ranked than those further away.

- Workshop Discussion:

    - Proposed Classification System needs to be agreed upon, namely the definition of classes up to 3,000 m away from the nearest free public fresh water source.

Access and Availability of Suitable Arable Land

- The requirement to access land at least as fertile as that within the DUAT Area has been discussed. Limited information is available, though, to define this as a *Comparison Criterion* and include in the overall assessment (limitation).

- Workshop Discussion:

    - It is necessary to investigate the soils and their agricultural suitability, both within the DUAT Area and at the potential Replacement Village(s) areas identified. A map with the soils classified from 5 through (best soils) to 1 (worst soils) will need to be generated in order to inform further Site Selection.

Cultures

- To date, cultural issues have not explicitly been considered, neither in the *Constraints Mapping*, nor as a *Criterion*.
- Workshop Discussion:

    - How to address cultural issues as a criterion?

    - Do pastoralist people use the proposed resettlement area in Northern Mozambique?

    - Which areas do they use?

    - Even if use is seasonal, should it be taken into account?

Others

- With regards to access to and availability of fuel wood, care needs to be taken in order to balance the energy requirements of the communities in the Replacement Village(s), with the conservation objectives regarding surrounding environmentally sensitive sites, such as the Coastal Dry Forests.
- Workshop Discussion:
  - Are there any viable options which can compete with free firewood in the area?

4 PRELIMINARY RESULTS

The methodology described in Section 3 was applied and a model developed, using the information available. The purpose of this exercise is to illustrate the proposed methodology in order to allow the necessary discussion during the Workshop. The preliminary results are presented in the following sections.

For the purpose of this exercise, some of the parameters identified and discussed in the previous sections (constraints and criteria) were not considered, as sufficient information is not available at this stage.

4.1 STUDY AREA

The coastline of Mozambique within a 20km radius around Palma Town, with the exception of the DUAT Area, was defined as the Study Area (see yellow circle in Figure 4-1). For the Site Selection of potential fishing villages, a smaller Study Area was considered, comprising a strip 2 km wide along the coast, inside the broader Study Area (represented in green in Figure 4-1).

Figure 4-1 Study Area for Site Selection

4.2 CONSTRAINT MAPPING

The Study Area was assessed in terms of suitability for the construction of the Replacement Village(s), taking into account the existing conditions and associated *constraints*, as per the information available. *Potentially Suitable Areas* were identified within the Study Area through a systematic exclusion of areas deemed *unsuitable* for the Replacement Village(s). Several parameters were identified as *constraints* (corresponding to no "go areas") and mapped. This "process" is referred to as *Constraints Mapping*.

The following constraints were mapped, and the respective areas excluded as *Potentially Suitable*:

- floodable areas (buffers along rivers and hydrological features);
- mangrove areas;
- densely forested areas (including the Dry Coastal Forest); and
- buffer around existing social and transport infrastructure.

Each one of these individual constraints is represented in Figure 4-2. This representation allows an understanding of the reason why a given area is deemed unsuitable for the construction of the Replacement Village(s).

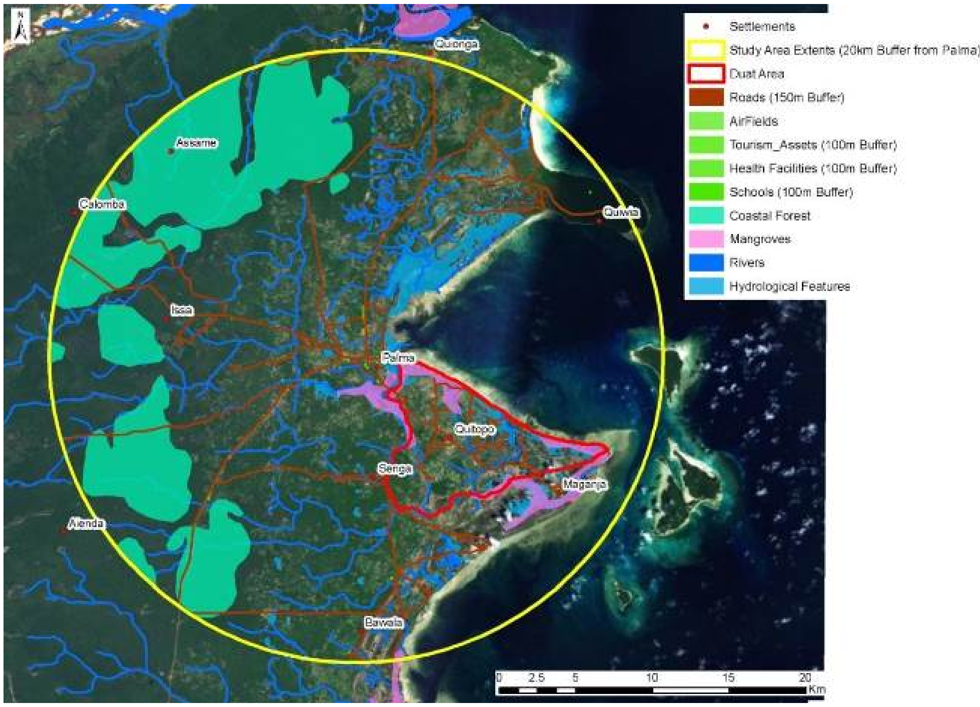


Figure 4-2 – Individual Constraints

The total areas that, for some reason (one or more constraints apply), are deemed *unsuitable* for the construction of the Replacement Village(s) are presented in Figure 4-3, coloured in red, representing the combined constraints.

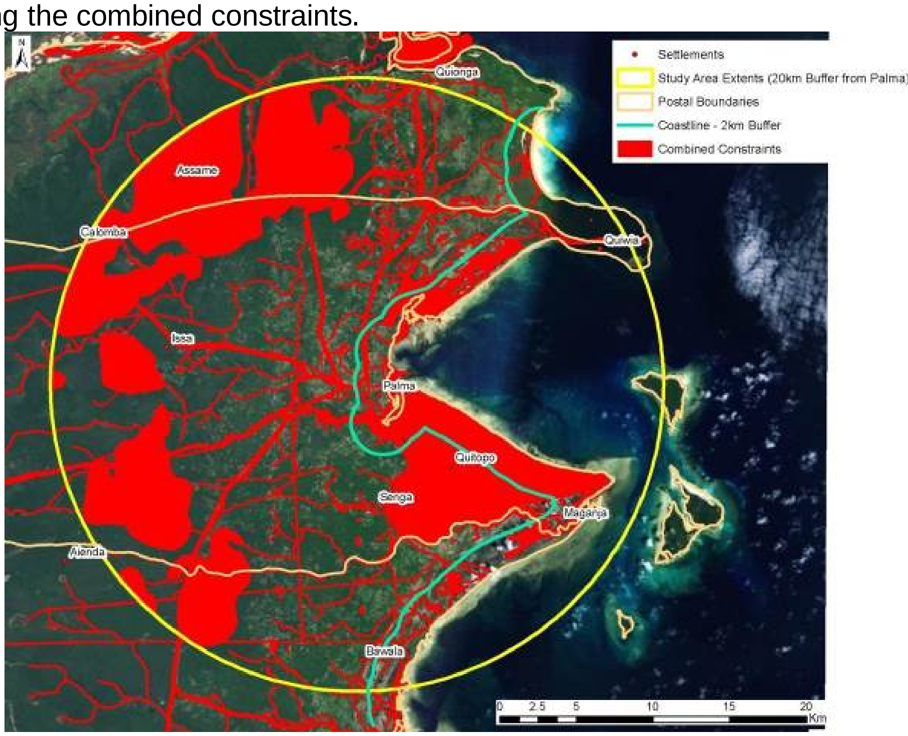


Figure 4-3 Combined Constraints (in red) and *Potentially Suitable Areas*

Potential constraints such as Protected Areas (Marine Protected Areas / Game Reserves) and Forest Concessions were not identified in the Study Area (for the time being) for what they were not mapped. Further investigation with regards to these and other potential constraints must be conducted.

As discussed before, the proposed Industrial Zone and the potential Mining Concession (Rio Tinto) were also not considered in the present exercise (were not considered, so far, no-go areas and included in the combined constraints). For information purposes, these areas are represented in Figure 4-4, together with the combined constraints.

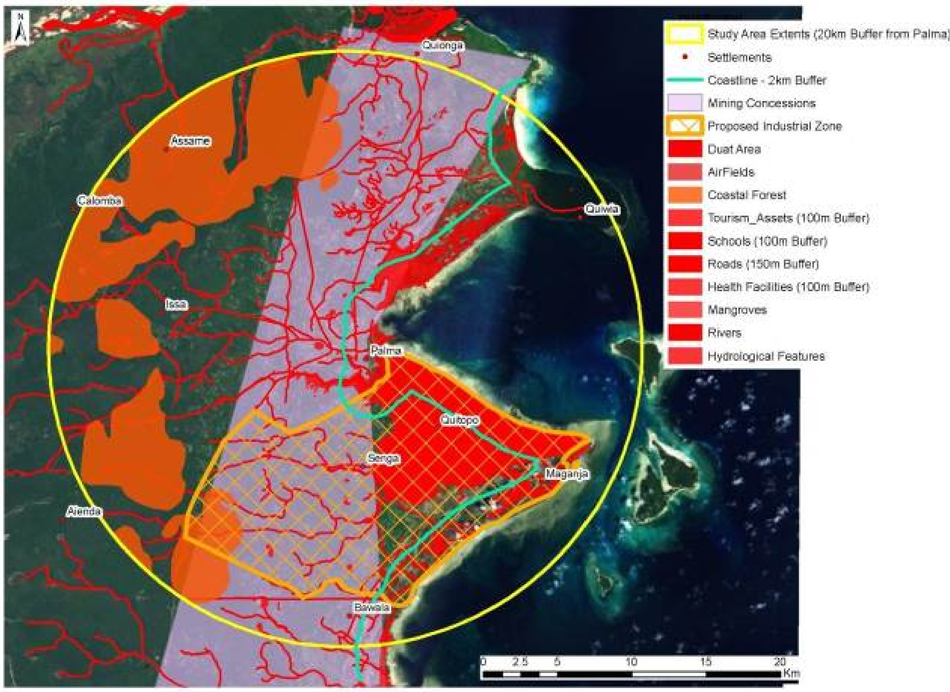


Figure 4-4 *Potentially Suitable Areas* Showing the Proposed Industrial Zone and Potential

Mining Concession

Bearing in mind the possibility that an Industrial Zone may be declared to the south of the DUAT Area, *Potentially Suitable Areas* can be found north of Palma and south of the Industrial Zone for fishing Replacement Village(s). Relatively large areas would appear available to the west of Palma for agricultural Replacement Village(s) with additional smaller areas to the north and south of Palma.

Nevertheless, as discussed in Section 3.4.8, if the Rio Tinto Mining Concession is renewed, *Potentially Suitable Areas* for Replacement Village(s) would be limited to the northeast of the Study

Area towards the Afungi peninsula (suitable both for agriculture and fishing), the west of the Study Area (only for agriculture) and to an area towards the south near Olumbe (potentially only for fishing).

4.3 OVERALL SUITABILITY

4.3.1 Comparison Criteria, Classification System and Weights

Several parameters identified in Section 3.5 were used during this preliminary exercise as criteria for comparison of *Potentially Suitable Areas*. For each *Comparison Criteria*, a classification system was developed in order to classify the *Potentially Suitable Areas*.

Five classes were defined, ranging between (5), classification attributed to the "best suitable areas" and (**1**), attributed to the "least suitable areas", according to each *criterion*.

The different classes were represented using different colours, varying between green representing the "best" class and red representing the "worst". All areas are "graded" by degree of suitability, based on each criterion.

A weight was then assigned to each *Comparison Criterion*. Different weights were attributed to the criteria considered for "fishing villages" and "agriculture villages", in order to reflect the relative importance each represents for the two different types of villages.

Table 4-1 summarises the *Comparison Criteria* used in this exercise, as well as the classification systems developed for each *criterion* and its associated weights, for both the fishing and agricultural villages (reflecting respective main livelihood).

Table 4-1 *Comparison Criteria*, Classification System and Weights used for the Models for Fishing Villages and Agriculture Villages

CRITERIA	CLASSIFICATION SYSTEM		WEIGHT (%)	
			Fishing	Agricultural
Access to and availability of services and markets / trade	**"Distance to Palma"**	0 - 4 km = 5 4 - 8 km = 4 8 - 12 km = 3 12 - 16 km = 2 > 16 km = 1	10	10
Proximity to the sea (fishing)	**"Distance to the coast"**	0 - 400 m = 5 400 - 800 m = 4 800 - 1200 m = 3 1200 - 1600 m = 2 > 1600 m = 1	30	10
Access to main access road	**"Distance to the closest main access road"**	0 - 600 m = 5 600 - 1200 m = 4 1200 - 1800 m = 3 1800 - 2400 m = 2 > 2400 m = 1	10	10
Access to groundwater	**Classes of aquifer productivity**	1 - Very Low (<0.1 L/s) 2 - Low / Seasonally productive (<0.5 L/s) 3 - Moderately productive (0.5 to 3 L/s) 4 - Productive (3 to 15 L/s) 5 - Highly Productive (>15L/s)	15	15
Groundwater Quality	**Classes of groundwater quality**	1 - Bad 2 - Poor 3 - Fairly good 4 - Good 5 - Very Good	15	15
Access to surface water (rivers)	**"Distance to the closest river"**	0 - 600 m = 5 600 - 1200 m = 4 1200 - 1800 m = 3 1800 - 2400 m = 2 > 2400 m = 1	10	10

Availability of suitable arable land	no information available	10	30

4.3.2 Classification of Potentially Suitable Areas

In this section, is detailed the Classification System developed for the classification of the *Potentially Suitable Areas*, for each of the *Comparison Criteria* considered in this exercise (presented in Table 4-1), and presented the maps that correspond to that classification.

Access to and Availability of Services and Markets / Trade

"*Distance to Palma*" was the classification system defined to assess the "ease of access to and availability of services and markets / trade" of the *Potentially Suitable Areas* for the construction of the Replacement Village(s). Five classes of "Distance to Palma" were defined in order to classify the *Potentially Suitable Areas*: circles around Palma Town, 4, 8, 12 and 16 km radius. The classification of (5) was attributed to the areas within the 4 km radius circle, closest to Palma Town (the most suitable according to this *criterion*), …, and the classification of (1) attributed to areas outside the 16 km radius circle, further away from Palma Town (the least suitable according to this *criterion*).

Figure 4-5 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Access to and availability of services and markets / trade*", *using the Classification System:* "*Distance to Palma*".

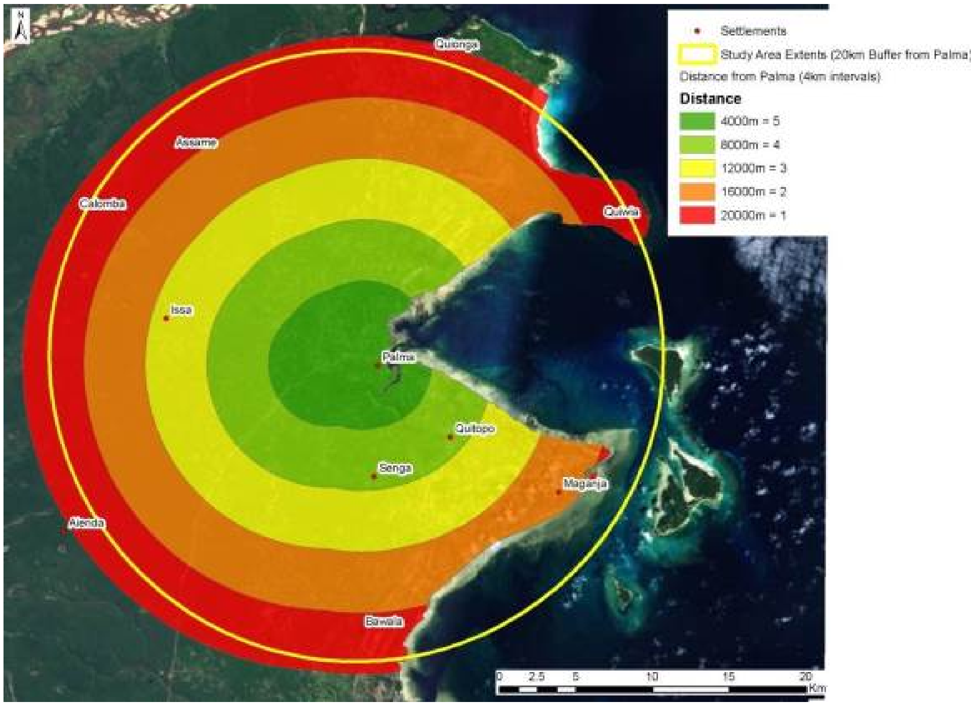


Figure 4-5 Classification of the Potentially Suitable Areas according to its "Access to and Availability of Services and Markets / Trade"

Proximity to the Sea (Fishing)

"*Distance to the coast*" was the classification system defined to assess the "proximity to the sea (fishing)" of the *Potentially Suitable Areas* for the construction of the Replacement Village(s). This is an important parameter for the location of the Replacement Village(s), due to the fact that the livelihood of the communities to be resettled is closely related with fishing.

Five classes of "*Distance to the coast*" were defined in order to classify the *Potentially Suitable Areas*: areas which distance to the coastline is up to 400, 800, 1,200 and 1,600 m or greater than 1,600 m. The classification of (5) was attributed to the areas within the 400 m closer to the coastline (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas further away than 1,600 m from the coast (the least suitable according to this *criterion*).

Figure 4-6 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Proximity to the sea (fishing)*", *using the Classification System:* "*Distance to the coast*".

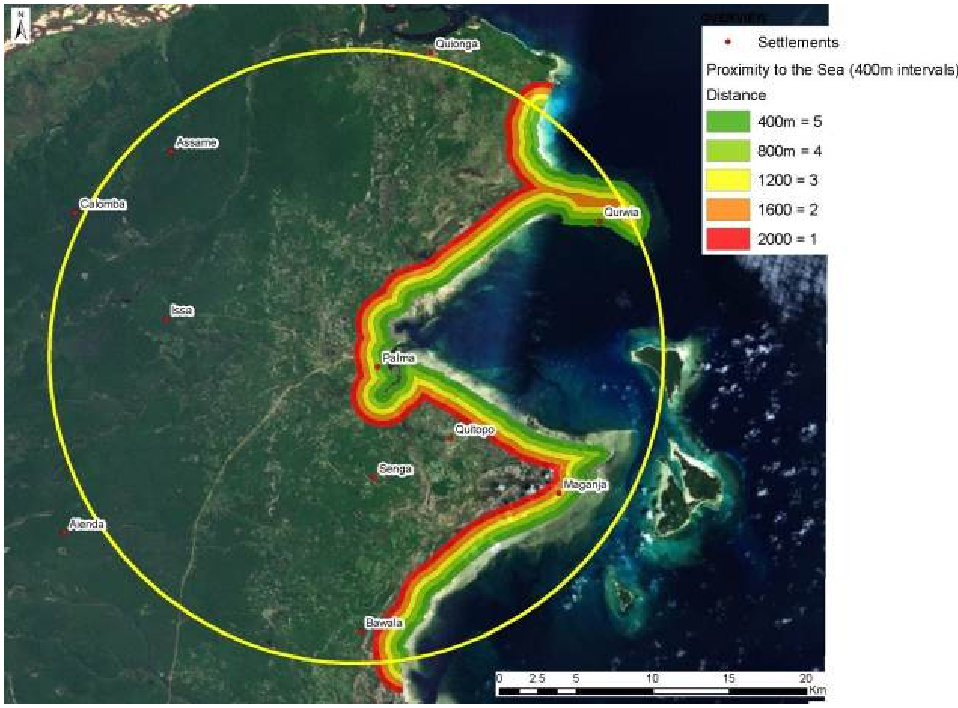


Figure 4-6 Classification of the Potentially Suitable Areas according to its "*Proximity to the Sea*"

Access to Main Access Roads

"*Distance to the closest main access road*" was the classification system defined to assess the "accessibility" of the *Potentially Suitable Areas* for the construction of the Replacement Village(s).

Five classes of "*Distance to the closest main access road*" were defined in order to classify the *Potentially Suitable Areas*: areas which distance to the "closest main access road" is up to 600 m, 1,200 m and 1,800 m, 2,400 m or greater than 2,400 m. The classification of (5) was attributed to the areas within the 600 m closer to the "closest main access road" (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas further away than 2,400 m from the "closest main access road" (the least suitable according to this *criterion*).

Figure 4-7 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Access to main access roads*", *using the Classification System:* "*Distance to the closest main access road*".

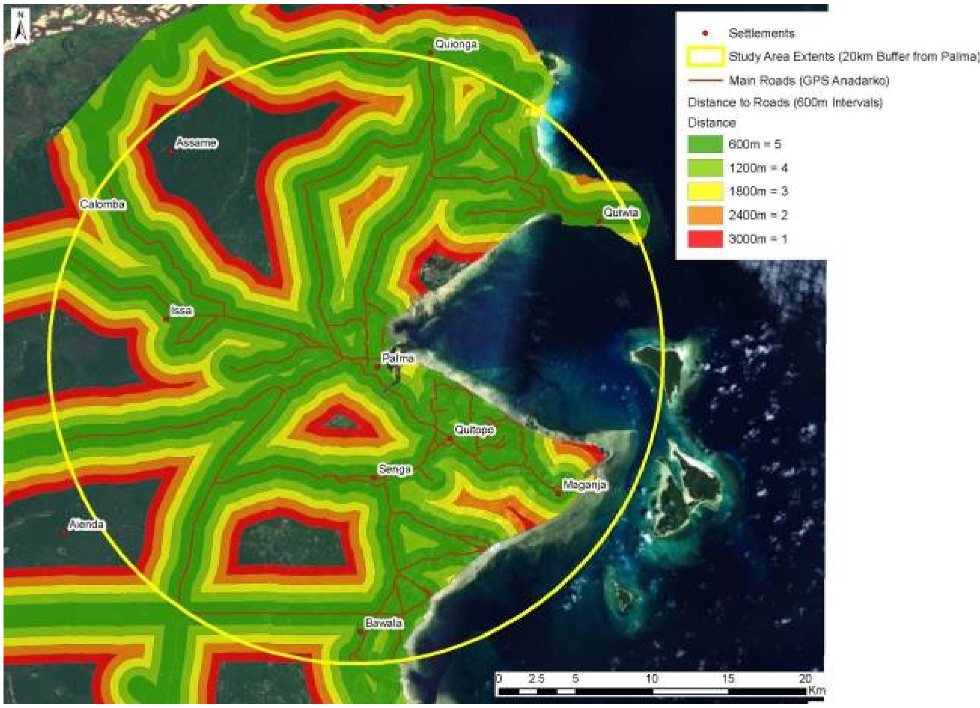


Figure 4-7 Classification of the Potentially Suitable Areas according to its "*Accessibility*"

Access to Quality Groundwater

The classification system defined to assess the "access to groundwater" of the *Potentially Suitable Areas* for the construction of the Replacement Village(s) consisted in the definition of five classes of "Aquifer productivity". The five classes defined are presented in Table 4-1. The classification of (5) was attributed to the areas with "Highly Productive (>15L/s)" aquifers (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas with "Very Low (<0.1 L/s)" aquifer productivity (the least suitable according to this *criterion*).

Figure 4-8 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "access to groundwater", *using* "*Classes of aquifer productivity*" as *Classification System*.

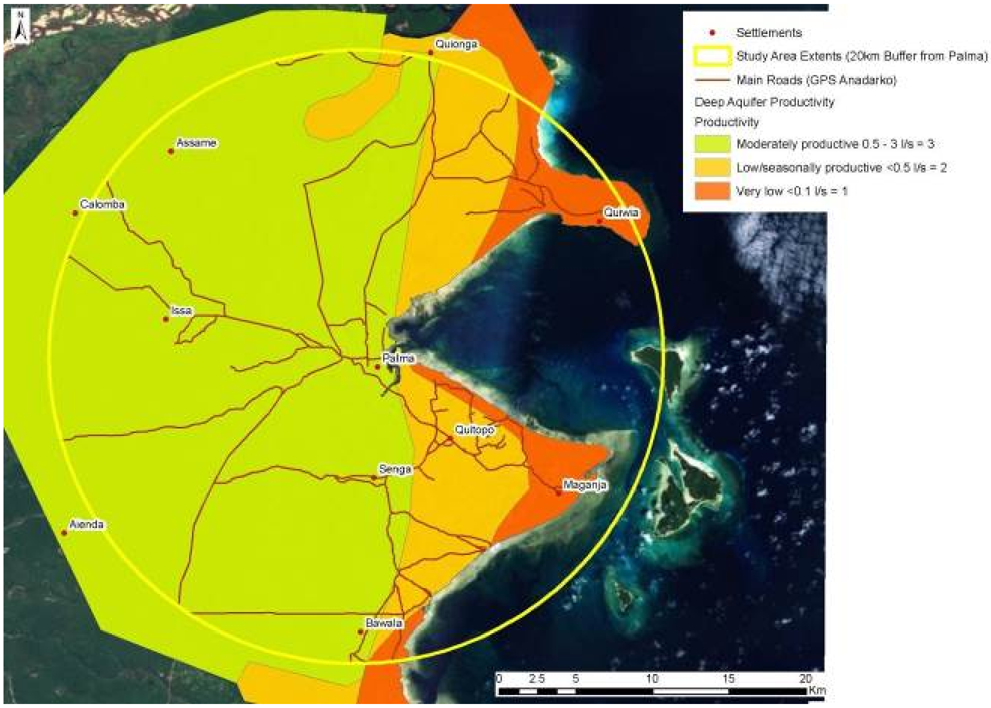


Figure 4-8 Classification of the Potentially Suitable Areas according to "*Classes of Aquifer Productivity*"

Similarly, the classification system defined to assess the *Potentially Suitable Areas* for the construction of the Replacement Village(s) in terms of the "groundwater quality" consisted in the definition of five classes of "groundwater quality". The five classes defined are presented in Table 4-1. The classification of (5) was attributed to the areas with "Very Good" groundwater quality (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas with "Bad" groundwater quality (the least suitable according to this *criterion*).

Figure 4-9 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "groundwater quality", *using* "*Classes of groundwater quality*" as *Classification System*.

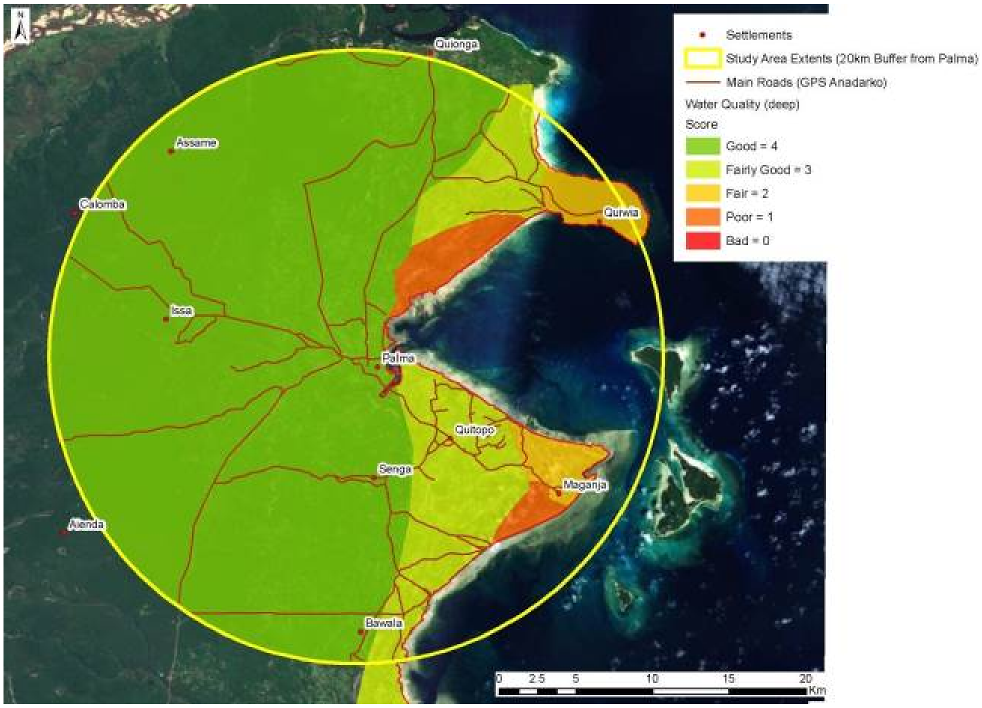


Figure 4-9 Classification of the Potentially Suitable Areas according to "*Classes of Groundwater Quality*"

Access to Surface Water (Rivers)

"*Distance to the closest river*" was the classification system defined to assess the "access to surface water" of the *Potentially Suitable Areas* for the construction of the Replacement Village(s).

Five classes of "*Distance to the closest river*" were defined in order to classify the *Potentially Suitable Areas*: areas which distance to the closest river is up to 600 m, 1,200 m and 1,800 m, 2,400 m or greater than 2,400 m. The classification of (5) was attributed to the areas within the 600 m closer to the closest river (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas further away than 2,400 m from the closest river (the least suitable according to this *criterion*).

Figure 4-10 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Access to surface water*", *using the Classification System:* "*Distance to the closest river*".

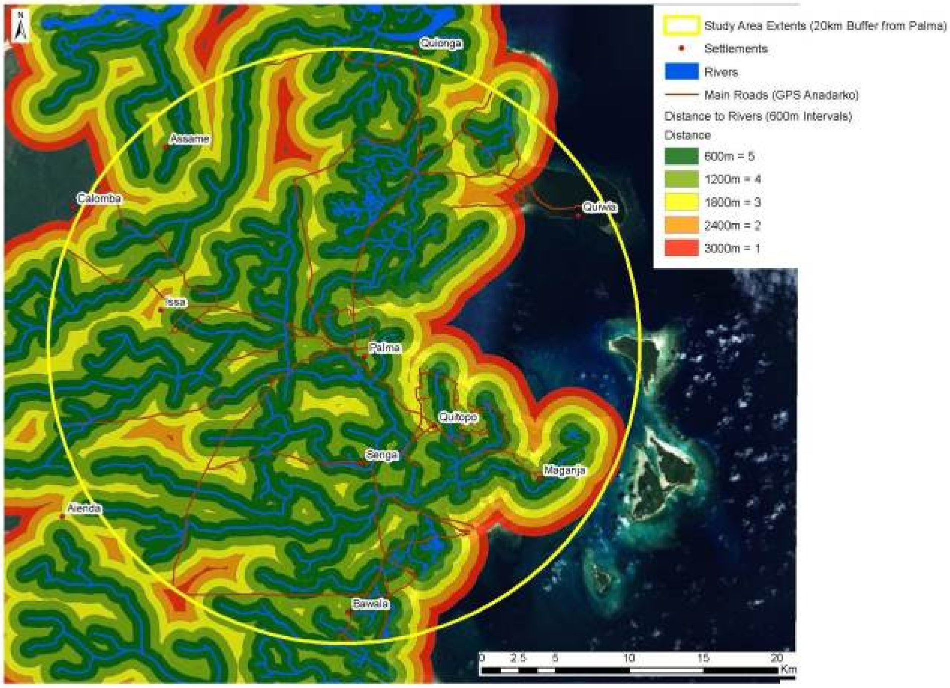


Figure 4-10 Classification of the Potentially Suitable Areas according to its "*Access to Surface Water*"

Availability of Suitable Arable Land

As mentioned, it is important to grant to the communities access to land at least as fertile as that within the DUAT Area, for what "availability of suitable arable land" is considered a very important *Comparison Criterion* to consider in the identification of the "Most Suitable Areas" for the Replacement Village(s). Limited information is, however, available to allow a proper classification of the Potential Suitable Areas according to this *Criterion* for the time being.

It is therefore necessary to investigate the areas within the Study Area that may be available to support the livelihood of the communities to be resettled, as well as the characteristics of the soils and their agricultural suitability. A map of the soils suitability for agriculture, classified from 5 (best soils for agriculture) through to **1** (worst soils for agriculture) will need to be generated in order to allow the integration of this criterion in the present analysis, and further inform the Site Selection process.

4.3.3 Ranking of Potentially Suitable Areas

After classifying the *Potentially Suitable Areas* for all the *Comparison Criteria* (according to the respective *Classification Systems*), the GIS program, considering the weights assigned to each *criterion*, calculates a weighted average classification for each area in the map. The *Potentially Suitable Areas* can then be represented "ranked" according to its *Overall Suitability*.

The preliminary results of the model are presented below, for fishing villages (Figure 4-11) and agricultural villages (Figure 4-12). As per the classification system defined for individual *criterion*, green areas correspond to the areas of best "*overall suitability*" and red areas to the areas of worst "*overall suitability*".

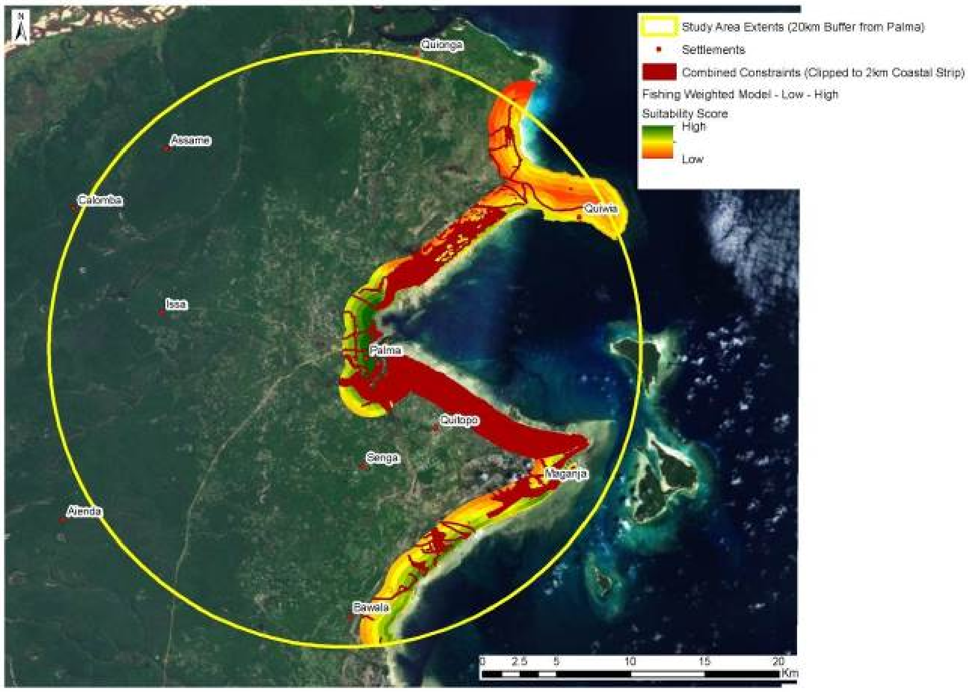


Figure 4-11 *Overall Suitability*: Model for Fishing Villages

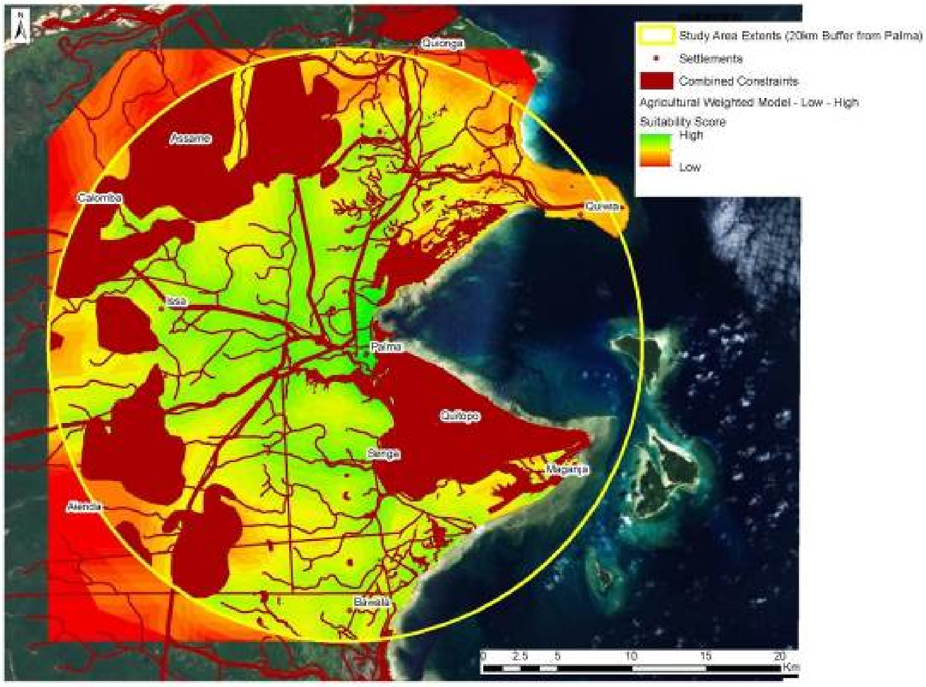


Figure 4-12 *Overall Suitability*: Model for Agricultural

5 LIMITATIONS

The methodology developed and described in Section 3 was applied using readily available data and information about the Study Area, with regards to the *parameters* identified, either as *constraints* or as *Comparison Criteria*. Two models, one for fishing villages and another for agricultural villages, have been produced in order to rank the *Potentially Suitable Areas* according to its *Overall Suitability*. Although the results of the methodology applied (these two models) have been presented in this report, they are considered "preliminary indicative results" only. It is not intended to come up with the selection of actual sites for the Replacement Village(s), based on these results.

A Workshop will be held in Maputo in early May 2013 in which it is intended to present/explain the methodology developed, as well as to discuss it in detail so as to reach a consensus about the approach to follow. Therefore, the main purpose of this exercise (implementing the methodology and developing these models) is to, by illustrating how the methodology can be used to support Site Selection, allow a broader discussion around its principles and a better explanation of how it works.

The main reasons why these results should be regarded as "preliminary" are two-fold:

- The information used (readily available) is considered inadequate for the level of analysis required to inform the location of the Replacement Village(s):
    - only desktop information (no primary data) is available;

- information is only available at a very low resolution (small scale);
- information available may be incomplete and out of date;
- relevant information is not available at this stage – e.g. availability of suitable arable land;
- other relevant parameters, either constraints or comparison criteria, may not have been identified.

These aspects were regarded as serious limitations on the quality of the data used, which compromises the outputs of the model.

- No engagement and/or consultation with the Government of Mozambique and/or Community leaders were conducted so far.

The Site Selection work completed to date has not had the benefit of input from community-based stakeholder engagement as no consultation has been possible due to the fact that the Government of Mozambique had not, at the time of writing, officially announced that a resettlement project was necessary and would be undertaken as part of the LNG development.

It is considered that soliciting community views in respect Replacement Village Site Selection is an imperative. While the Site Selection process completed to date has, from an expert judgement point of view, considered likely community views and opinions in regards the siting of Replacement Village(s) (i.e. the defined assessment parameters include social / socio-economic considerations), these assumptions need to be verified via community consultation to confirm views on current and potential future living arrangements and sources of livelihoods.

6 RECOMMENDATIONS

The “next steps” recommended aim to address the limitations identified in Section 0.

It is recommended that, in general, all information and data used in this first *exercise* of “Site Selection” (the models presented in this report) are validated, confirmed, updated and complemented through primary data collection on-site. It is also critical to increase the level of detail and accuracy of the “high level” spatial information used.

Additional and more refined information must also be collect in order to complement the existing baseline information (both through desktop investigation and field work), namely to obtain information about possible constraints that have been overlooked or other parameters relevant for comparing the Potentially Suitable Areas.

Further site investigations including field surveys to ground-truth conclusions drawn from remote sensed imagery and potentially intrusive investigations to confirm assumptions concerning groundwater reserves, soil types and geotechnical slope stability at a minimum must be undertaken to inform final Site Selection process. It is recommended that, at a minimum, the following site investigations and further data collection needs to take place:

- **Ecological Site Survey:**
  - Ground water investigations;
  - Surface water and flood modelling; and
  - Ecology surveys - survey for Important Bird Areas (IBA) trigger species and presence of IUCN Red Listed species.

- **Agricultural Assessment:**
  - Soil survey and soil classification;
  - Investigation of soil suitability for agriculture and pre-existing soil contamination, including unexploded ordinance and land mines;
  - Suitability of the areas for agriculture.

- **Social Site Survey:**
  - Land use mapping, with Community Liaison Officer (CLO)'s determine current land use and map;
  - Land ownership / tenure, investigation of traditional ruler (Régulo) areas and their relationship to people within their areas:
    - Are any areas taboo?
    - Are there any cultural / historic sites?
    - Are there any pastoralist peoples moving through the area?
  - Will large groups of people be allowed to fish in a new area? What is the existing use of destination area by artisanal, semi-industrial and industrial fishermen?
  - Is there a major road which will eventually be tarmacked which villagers will have to cross all the time increasing the hazard of road accidents - in particular between potential Replacement Village(s) sites and the ocean?
  - How often do people go to Palma now and for what purposes?
  - Is the area lived in now relatively windy (i.e. less hot in the hottest time of the year and the wind may help blow mosquitos away)? Will the new proposed area be relatively less windy and hot? Will the new area be more prone to malaria due to less wind or closer proximity to a swamp up?

On the other hand, community consultation must be undertaken to ascertain views and opinions in regards siting of the Replacement Village(s), via representative "steering committees".

APPENDIXES

Appendix 1 – Report "Afungi Peninsula Site Appraisal Visit Report March 15 – 19 2013 – Site Appraisal Visit", WorleyParsons, April 3, 2013

Resettlement Project: Afungi Peninsular Mozambique

Site Visit Report 15 – 19 March 2013

3 April 2013

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SYNOPSIS

Between 15 and 19 March, 2013, WorleyParsons completed a visit to the Project site on the Afungi peninsular northern Mozambique. The purpose of the visit was to provide key members of the WorleyParsons project team with the opportunity to familiarize themselves with the site environment and disposition of the affected households to be resettled and in so doing, assist the team in developing potential relocation sites for the households.

Disclaimer

CONTENTS

EXECUTIVE SUMMARY

WorleyParsons undertook a site visit of the LNG project site in northern Mozambique between 15 and 19 March, 2013. The purpose of the visit was to enable key members of the resettlement project team to familiarize themselves with the project area and the disposition of villages. The resettlement project comprises the resettlement of approximately 700 households to location/s outside the project area (the DUAT).

Ahead of the site visit, a desk-top study of the project area was undertaken using Google maps and a generic set of environmental indicators to 'screen' the project area resulting in seven potential replacement sites.

The site visit included road and aerial surveys and meetings with Project personnel and the government officials. The information gathered during the site visit assisted with a deeper evaluation of the previously 'screened' sites by informing the technical, environmental and socio-economic criteria to compare the sites. This resulted in the sites being ranked as 'suitable', 'possibly suitable' and not suitable.

From the site visit, four potential sites have been recommended for further evaluation using a multi criteria site assessment (MCSA) approach. The MCSA is to be undertaken to achieve a short-list of sites that will be work-shopped and agreed (along with housing design concepts and local content opportunities) at meetings in early May.

1. INTRODUCTION

The objective of the resettlement project is to provide approximately 700 households with alternative accommodation in order for the Project to establish and operate their LNG facility and attendant infrastructure. In addition, the resettlement project will include a study to identify potential local content opportunities for affected households to be resettled.

These 700 households are currently located in or in close proximity to the DUAT (the right to use land that is inheritable and transferable), the area that the Mozambique government and the Project have agreed for the Project's LNG operations. The affected households are widely dispersed throughout the area and account for approximately eight villages, each comprising 5 to approximately 273 households to settlements of small family groupings.

This report provides an overview of the approach and methodology of selecting seven sites for possible resettlement, and a ranking of these sites according to technical, environmental, and socio- economic criteria. In addition, the style of homes and villages were assessed to inform the housing and village design. This report summarizes the main style of houses people in and around the DUAT area typically occupy.

2. PURPOSE

The purpose of the site visit was to provide first-hand information of the project area to enable:

- The team to familiarize itself with the project site and its environs;
- The team to observe the villages and their geographic disposition;
- The further evaluation of the notionally selected (screened) sites to provide a short list of alternative sites for more intensive investigation; and
- To observe the construction material for used for houses and other structures, as well as the common features of fishing and inland villages.

3. APPROACH AND METHODOLOGY

Site visit participants included:

- Rodney Broedelet Project Manager
- Richard Kruger – Planner

- Francois Humphries – Environmental Manager
- Susan Arthur – Local Content
- Andre Pinheiro – Architect, Mesch Architects

The approach and methodology for the site visit to assist the overall site selection process included:

- From the initial site screening (undertaken ahead of the site visit) based on broad environmental indicators, develop a preliminary selection of potential resettlement sites
- Confirmation of regulatory requirements and standards for resettlement site selection
- On available information, develop an understanding of location and key characteristics of villages to be resettled
- Development of site selection criteria
- Site analysis against criteria
- Conclusions and recommendations

The visit included a full day of driving the affected area followed by an aerial reconnaissance tour of the entire area. A meeting was convened with the (acting) District Administrator. The meeting record is at Appendix 1. In addition, following the road and aerial surveys, meetings and discussions were held with the Project's resettlement managers Stuart Duncan and Chris Antrobus.

3.1 INITIAL SCREENING OF PROJECT AREA

Preparation for the site visit included a desk-top study of the project area, using Google maps and broad environmental indicators for the conduct of an initial high-level 'screening' of the area that resulted in a list of seven potential sites that could provide the basis of a short-list of sites for further intensive investigation. The initial site selection included areas of various sizes. The various options can be altered depending on further investigations to ensure that the sites meet the required size needed. These seven potential sites included:

1. Olumbi
2. Industrial zone – on the peninsular
3. West industrial zone

4. West of Palma road

5. North-west Palma

6. Palma North

7. Palma infill sites 1, 2 & 3

3.2 STANDARDSAND LEGISLATION RELEVANT FOR SITE SELECTION

There are two important sources of obligations to consider in the resettlement site selection: the IFC Performance Standard 5 on involuntary resettlement (updated in 2012), and the Decree 31/2012 of the Republic of Mozambique (dated August 8, 2012). Both sources contain guidance and requirements directly or indirectly related to site selection:

Relevant requirements from IFC Performance Standard 5 are as follows:

- The livelihoods and standards of living of displaced persons must be improved or restored, and opportunities to improve and restore income-earning capacity, production levels and standards of living must be provided;

- For persons whose livelihoods are land-based, replacement land that has a combination of productive potential, locational advantages, and other factors at least equivalent to that being lost should be offered;

- For persons whose livelihoods are natural resource-based, measures should be made to allow continued access to affected resources or provide access to alternative resources with equivalent livelihood-earning potential and accessibility;

- Displaced persons' preferences regarding relocating in pre-existing communities and groups will be taken into consideration;

- Existing social and cultural institutions of the displaced persons and host communities should be respected;

- States that displaced persons should be offered choices among feasible resettlement options (including replacement housing); and

- Collaboration with the government is required where land acquisition and resettlement are the responsibility of the government, to the extent permitted, to achieve outcomes that are consistent with this Performance Standard. In addition, where government capacity is limited, the client will play an active role during resettlement planning, implementation, and monitoring.

Relevant requirements from Decree 31 are the following:

- Principle of Social Cohesion – the resettlement must ensure the social integration and restore the living standard of those ones affected, to a better living standard;

- Principle of Social Equality – in the resettlement process all those ones affected are entitled to restoration or creation of conditions equal or above the previous living standard;

- Principle of Social Equity – in the settlement of the populations in the new areas the access to the means of subsistence, social services and available resources must be taken into account;

- Principle of Non-Change of the Income Level – enable that those ones resettled have a possibility to re-establish their previous basic income;

- Principle of Public Participation – in the resettlement process the hearing of the local communities and other interested parties affected by the activity must be ensured;

- Principle of Social Responsibility – the investor has to create social infrastructures, which promote the learning, leisure, sport, health, culture and other projects of community interest;

- The rights of the population directly affected area are:

  - To have re-established their income level, to equal or higher than that before the resettlement;

  - To have restored their living standard to equal or higher than before the resettlement;

  - To be transferred with their goods to a new place of residence;

  - To live in an infrastructured physical space, with social facilities;

  - To have space to perform their subsistence activities; To give opinion in the whole resettlement process.

- Environmental characteristics of the resettlement plot:
    - Soil permeability
    - Ground-water level
    - Slope
    - Storm water drainage
    - Fertility of the soil
- Resettlement is prohibited in:
    - Areas with significant environmental impacts such as the occurrence of erosion, flooding risk, etc.
    - Protected areas
- Criteria for the definition of the housing plot in the new area:
    - To provide a regularized and infrastructure housing plot with a housing typology with minimum characteristics of type III (three bedrooms), with an area of 70 m^2, built resorting to conventional material and according to the approved design.
    - Suitability for construction, with a sloping equal or less than 10%, areas without high ground-water level;
    - In the urban areas must not have an area less than $800m^2$;
    - In the rural areas must not have an area less than $5,000m^2$;
    - Frontal access to the link road;
    - Access to water and other infrastructure;
    - Access to social facilities;
    - In case of the physical-natural conditions non favorable for the establishment of a drinking water supply system, the construction of the improved latrine must respect a minimum

distance of 10 meters separating from the house;

- In the rural areas physical spaces for the production of horticulture and breeding of poultry and other animals must be insured.

3.3 CURRENT LOCATIONS AND KEY CHARACTERISTICS OF VILLAGES TO BE RESETTLED

The location of villages to be resettled in and around the DUAT area (marked by the yellow line) is shown at Figure 1. The areas marked in green are inhabited. Two villages are missing from the map: Nsemo and Kibunju are located along the coast East of Milamba 2 and North-East of Maganja in the corner of the peninsula, falling just outside the DUAT area.

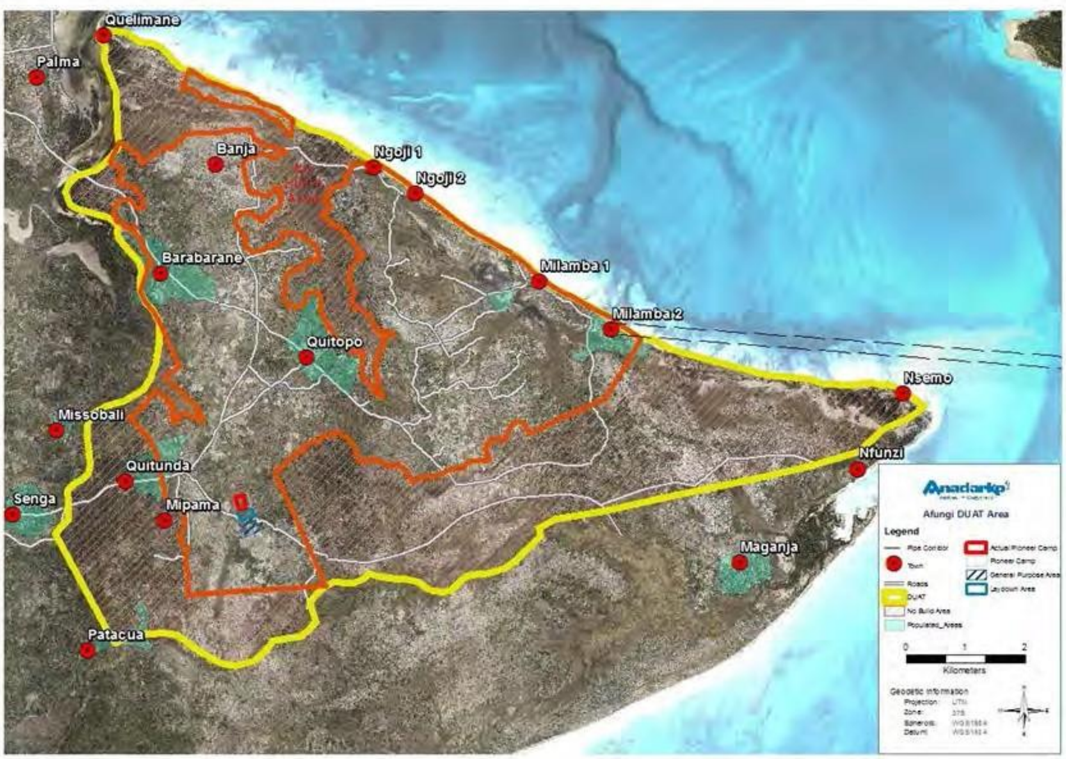


Figure 1 Map of villages to be resettled in and around DUAT area

An overview of the villages to be resettled, their estimated population, number of households, and public and social infrastructure (based on currently available information), is shown at Table 1. The table is based on the latest information available from RS2 and information provided by Impacto for the Environmental Impact Assessment.

Most houses in the area are earthen huts with large, overhanging palm or grass thatched roofs. They are constructed using wattle and daub/sticks, building a frame out of timber and bamboo, and then filling it with earth. Sometimes the buildings are built of earth blocks, and sometimes they have corrugated iron roofs. The shady areas under the straw roofs are used as living quarters, social gathering spots and space to work, cook or sell goods and villagers spend a lot of time there. The interior of the house is generally used to sleep and to store products. Infrastructure supporting the households is rudimentary, i.e. shared wells, tracks and unpaved roads, and no electricity network.

Table 1 Villages to be Resettled

Villages	Population	Public/Social Infrastructure
Milamba 2	488 people 130 households	1 fishing centre 1 school 1 traditional well 1 mosque
Barabarane	200 people 50 households	NA
Quitopo	1022 people 273 households (Village Authority) 1500 people 402 households (RS2) (estimate includes Ngoji 1 and 2 and Milamba 1)	1 school 2 water wells 1 market 1 soccer field 3 mosques
Ngoji 1	Estimate included in Quitupo	
Ngoji 2	Estimate included in Quitupo	
Milamba 1	Estimate included in Quitupo	No school
Quitunda	230 people 46 households	1 mosque
Mipama	5 households	NA

Villages	Population	Public/Social Infrastructure
Nambuimbui	0	2-3 dwellings
Ntaunadje	0	2-3 dwellings
Nacabande	0	2-3 dwellings
Quidjeri	0	2-3 dwellings
Namacande	0	2-3 dwellings
Banja	0	2-3 dwellings
Total	1955 – 2433 people 504 – 633 households	

Based on current estimates 1955 to 2433 people corresponding with 504 to 633 households need to be resettled. More detailed and accurate information will become available from the planned census and asset surveys, which are likely to commence early April.

Ngoji 1, Ngoji 2, Milamba 1 and Milamba 2 are fishing villages in which some of the houses are only seasonally inhabited.

Barabarane is a production zone of Palma Town and is included in the Palma District Urbanization Plan. It is expected that the villagers from Barabarane might want to be resettled to Palma Town.

Patacua is a village located partly inside and partly outside the DUAT area. The expectation is that those living inside the DUAT area will want to be resettled with the rest of the community outside the DUAT area. Another option for Patacua is to be resettled to Maganja as they seem to have strong affiliations with Maganja. This will be clarified through community consultations.

It is expected that Milamba 2 might want to be resettled to Maganja. However Maganja might need to be resettled in case expected economic impacts from fishing restrictions turn out to be severe. This would add another estimated 2532 people/526 households to the resettlement. Nsemo/Kibunju is currently not included on the resettlement list but might need to be resettled in case economic impacts from fishing restrictions are expected to be severe. This would add another 1000-1900 people/269 households to the resettlement. The resettlement of Maganja and Nsemo/Kibunju depends on the size of the exclusion zone as well as estimated economic impacts.

- Senga falls just outside the DUAT area, but analysis of the economic impacts from the project and the resettlement of the other villages might prove to be severe, in which case Senga might have to be resettled as well. That would add another 864 people/186 households. As the Mozambique government is yet to formally announce that the LNG project will include resettlement, the household census, socio economic and asset surveys have not commenced and therefore were not available to inform the site visit. More information will become available from the census and other surveys to be conducted in the DUAT area starting late April. Important and currently available information to be taken into consideration in the selection process of resettlement sites includes the following: Palma is a significant fishing and maritime transport hub. The resettlement villages depend on Palma for fish trade. Palma is also the closest location for amenities such as a health center and petrol station. The resettlement villages are located close to the coast and relatively close to Palma. Transportation via boat to Palma and Tanzania is common because of poor road networks. Beyond Maganja fish is traded by boat to Mocimboa da Praia rather than Palma.

- The main land use within the Afungi area is subsistence agriculture (including cassava, rice and coconut) and minimal livestock grazing. Small scale farms or 'machambas' (fragmented cultivated lands) are evident across the Afungi Project Site between open savannah woodland/bushland. Rice is cultivated in wetlands situated in lowlands along waterways. It is apparent that local livelihood is dependent on the soil resource for their livelihood.

- Agriculture is the most common livelihood, followed by the fisheries. The villages located more inland trade crops for fish with the villages located along the coast. Highlands and lowlands are used for different crops and cropping cycles. Some agriculture takes place close to the home. Large plots are located away from the villages in the high and lowland areas accessible to the villagers.

- Most villages are located along roads for access reasons.

- There is no electricity in the villages. Some solar panels are used for power generation.

- Besides Senga the majority of people are Muslims. There are some Christians living in the area as well. There are no problems between religions although some villages have stated that 'no- one should come and build a church here'.

- The river is important for water collection and agricultural purposes.

- The various habitat types present within the Afungi Project Site are ecologically linked and are largely dependent on the surface water flow regime. All fauna groups are reliant on the attributes these freshwater wetlands provide (i.e. habitat for feeding, breeding, nesting, migration and refugia). Amphibians (primarily frogs) occupy the base of the food chain for a majority of the species in the area. Short closed woodlands occurring in the riparian areas adjacent to wetlands and large contiguous woodland areas provide more value to the faunal communities than do smaller or isolated woodland areas. The mangroves are essential foraging habitat for the sunbird taxa and the mangrove kingfisher.

- The dominating soil occurring in the Survey Area is deep sand, low in soil fertility and well drained. The average rainfall in the area is very high and this specific climate and soil combination results in low arable agricultural potential due to low fertility.

- The soils in the Afungi peninsula comprise of two soil units of significance:

- A large area comprising all land outside the wetland zones (sand units or 'S-Units', comprised by deep grey/white sands). The sand cannot be regarded as a high-potential crop production medium

- Wetland zones which include the estuaries, marshes and drainage course zones (wetland units or 'W-Units'). W-Units normally supports vegetation typically adapted to life in saturated soil (rice). W-Units are highly sensitive due to their important function in the ecosystem as they play an important role in surface drainage and serve as a mechanism to recharge the groundwater system. Contamination of wetlands may lead to transportation of potentially hazardous elements to the soil resource adjacent to and beneath, posing potential risk to groundwater resources and the nearby coastal waters.

3.4 EVALUATION OF SEVEN SITES

From the high-level screening exercise, conducted prior to the site visit, the resulting seven potential resettlement sites were further evaluated following the site visit against key technical, environmental and socio-economic site assessment criteria with the objective of:

- Using a more robust assessment criteria, identify key constraints and characteristics that allow the seven sites to be compared and ranked as suitable, possibly suitable or not suitable resettlement sites

- Identifying favorably ranked sites as potential locations for resettlement, and

- Making recommendations for further intensive site investigations and assessments.

3.4.1. Development of the Site Selection Criteria

The criteria developed for selection for the evaluation of the sites were a combination of the regulatory requirements and standards from Decree 31 and the IFC Performance Standards the key characteristics of the DUAT area, summarized as follows:

- Availability of vast areas of uncultivated land, similar or larger in size to the current area and without large existing settlements. Based on the number of households in the DUAT area and the requirements for land size in Decree 31 the minimum total size of the land for 700 households is approximately ($5000m^2$ x 700) = 350ha. However, the Environmental Impact Assessment refers to households using more than one plot with an average size of 2.4ha. In order to provide people an area of at least the same size as the land they have lost we will assume an area of 3ha per household. This totals 3ha x 700 = 2100ha, which includes contingencies for unsuitable areas, infrastructure, community facilities, etc.

- Proximity to Palma or other hub for access to trade and amenities;

- Accessibility and proximity to the ocean to provide access to fisheries;

- Area falling within one District Administrative Post only;

- Area not falling within any protected areas as per current legislation, and likely not to become a protected area in the future;

- Area with vegetation indicating potential suitability of soil for agriculture;

- Areas not dominated by rivers, wetlands, and coastal lagoons, although proximity of rivers and wetlands is desirable for agriculture purposes; and

- Suitable surface topography for establishment of human settlement.

3.4.2. Assumptions

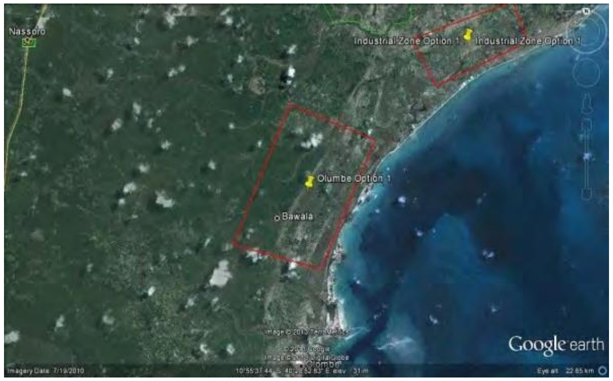
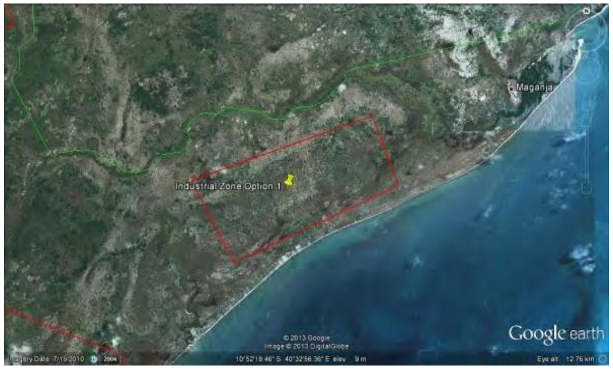
A number of assumptions have been made:

- All 8 villages be moved to the same area (government and/or community consultations however, are likely to confirm or contradict this assumption);
- More than one of the seven potential sites might be selected and/or the community determine this);
- Site areas capture both space for settlement as well as space for agriculture activities; and
- No public/social infrastructure currently exists at the potential sites. In line with Decree 31 this infrastructure will need to be built.

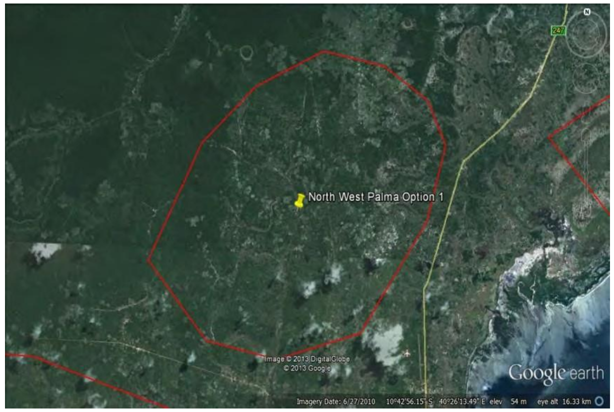
A map showing the location of the seven sites is at Figure 2. The size of these sites is shown in Table 2.

Figure 2 Map of Seven Potential Sites

Table 2 Seven Selected Sites

Name	Area/Coordinates	Size
Olumbi Site 1 (north of Olumbi)		Site Size:2387 ha Possible extension towards the west to accommodate settlement and agricultural activities. Would accommodate all resettlement in one village
Industrial Zone Site 2 (south of the DUAT on peninsula)		Site Size: 897 ha. Would accommodate all resettlement in one location

Name	Area/Coordinates	Size
West Industrial Zone Site 3 (west of DUAT)		Site Size: 1829 ha. Possible extension towards the west to accommodate agricultural activities. Would accommodate all resettlement in one village
West of Palma Road Site 4 (west of road 247)		Site Size: 4806 ha. To include both village and agricultural activities.

Name	Area/Coordinates	Size
North West Palma Site 5 (northwest of road 247 north of Palma)		Site Size: 5349 ha. To include both village and agricultural activities.
Palma North Site 6 (northeast of Palma towards peninsula)		Site Size: 1665 ha Possible extension to the north west to accommodate settlement and agricultural activities.

Name	Area/Coordinates	Size
Palma North Site 6 (northeast of Palma towards peninsula)		Site Size: 1665 ha Possible extension to the north west to accommodate settlement and agricultural activities.

3.4.3. Site Assessment Ranking

Expanded technical, environmental and socio-economic criteria were established for the physical evaluation of the seven sites. The criteria were assigned a qualitative 'value' that allowed for the sites to be assigned a ranking of 'Suitable', 'Possibly Suitable', or 'Not Suitable'. The main purpose of the assessment is to compare and rank the seven sites. The technical, environmental and socio- economic criteria are listed in Tables 3, 4 and 5 respectively and rankings of 'suitable', 'possibly suitable' and 'not suitable' color-coded as shown.

Color-Coded Rankings

Suitable	
Possibly Suitable	
Not Suitable	

Table 3 Technical Criteria for Physical Evaluation

Category	Issue	Criteria	Comment	Rating	1	2	3	4	5	6	7	Future investigations
Technical	Geotechnical stability	Existence of high slopes / gradient	Addresses the environmental characteristics regarding suitability for construction. Slopes equal or less than 10% are suitable, higher will impose restrictions to construction. This also relates to storm water drainage potential (flooding risk)	Slope lower than 5% and no evidence of the development of erosive processes								- Site visit to assess in further detail the slopes and identify the development of erosive processes - Geotechnical investigation to understand the geology and other aspects that will influence the foundations and the stability of the structures to be built
				Slope between 5 and 10% and some evidence of the development of erosive processes								
				Slope higher than 10% and clear evidence of the development of erosive processes								
	Flooding risk	Presence and proximity of big rivers, flood lines and floodplains	Addresses the environmental characteristics with regards to the restrictions it may impose to construction, related to flooding risks (rivers, flood lines and floodplains)	Absence of big rivers, flood lines and floodplains, making it an area not susceptible to flooding								- Site visit to assess in further detail the presence, proximity, "magnitude" and characteristics of the rivers, flood lines and floodplains, in order to better estimate the flood risk - Hydrogeological investigation to determine the depth of the water table
				Presence and proximity of big rivers, flood lines and floodplains, making it an area susceptible to flooding during heavy storms								
				Presence and proximity of big rivers, flood lines and floodplains, making it an area highly susceptible to flooding								

Table 4 Environmental Criteria for Physical Evaluation

Category	Issue	Criteria	Comment	Rating	1	2	3	4	5	6	7	Future investigations
Environmental	Ecosystems and biodiversity	Presence or proximity of Protected Areas or sensitive ecosystems / habitats	Addresses whether there is any particularly sensitive habitat, different from the surrounding areas[1]	Site not interfering with a Protected Area nor with areas with sensitive ecosystems / habitats								-Confirmation of the presence or likely future presence of protected sites. -Site visits to identify the presence in the area and surroundings of particularly sensitive ecosystems / habitats worth preserving, and / or the presence of endangered of protected species
				Site not interfering with a Protected Area but partially interfering with areas with sensitive ecosystems / habitats								
				Site interfering with a Protected Area or mainly included in areas with particularly sensitive ecosystems / habitats								
		Level of disturbance of the original habitat	Addresses whether the area has already been disrupted due to human activities or if it is pristine by looking at the disturbance of the habitats / vegetation	Site located in areas showing clear signs of disturbance of the original natural habitat by human activities and surrounded by also disturbed areas								Site visits to identify the presence in the area and surroundings of particularly undisturbed original natural habitats that should be preserved
				Site partially located inside a completely undisturbed area (original natural habitat) and partially in areas showing signs of disturbance by human activities; high potential to induce significant interference / destruction of the surrounding natural habitats								
				Site fully located inside a completely undisturbed area (original natural habitat) with potential to induce further interference / destruction of the surrounding natural habitats								
	Conflict human/ animal	Presence or proximity of Migration Corridors (Wildlife)	Addresses whether the area is used / crossed by migratory species (e. g. elephant corridors), which would induce impacts over both environment (interference with migration routes) and socio-economy (animals destroying crops)	No evidence of the presence of Migration Corridors (Wildlife) and low probability in the surroundings								Investigation of the eventual presence of Migration Corridors (Wildlife) by speaking to DA, MICOA, and visiting the sites
				No evidence of the presence of Migration Corridors (Wildlife), but considerable probability in the surroundings								
				Clear evidence of the presence or proximity of Migration Corridors (Wildlife)								

Table 5 Socio-Economic Criteria for Physical Evaluation

Category	Issue	Criteria	Comment	Rating	1	2	3	4	5	6	7	Future investigations
Socio-economic	Livelihood-earning potential and accessibility	Accessibility and proximity to the ocean	Addresses the location in terms of easy access to the sea to perform the communities' subsistence activities associated with fishing	Site located directly along the coast								-Site visit in order to establish walking distance to coast, presence of any sand roads leading to the coast, presence of vegetation limiting access to the coast.
				Site not located along the coast, distance about 5km								
				Site located further away from the coast than the current resettlement villages located inland, distance >5km								
		Access to and availability of fertile land	Addresses the environmental characteristics of the area with regards to agricultural potential of the soils, such as fertility and permeability of the soil, as well as the availability of space for agricultural activities	Existing agriculture activities and vegetated areas (as indication of fertile land) and vast areas within and surrounding the site, that can be used for agriculture								-Site visit for soil fertility and permeability testing, ground water level testing
				Sparse vegetation, little existing agriculture activities (possibly indicating that the land is not particularly fertile) and/or presence of some areas within and surrounding the site, that can be used for agriculture								
				No vegetation, no existing agriculture activities, (possibly indicating that the land is not particularly fertile) and/or absence of areas within and surrounding the site, that can be used for agriculture								
	Access to natural resources	Accessibility and proximity to water source	Addresses the environmental characteristics of the area with regards to water availability (ground water and surface water) and access to water (presence of groundwater and depth and of the water table and presence of rivers/streams), in quantity and quality, for human consumption and the practice of agriculture	Near rivers / streams (preferably perennial, but also intermittent) and easy access to existing ground water								-Site visit to establish ground water levels, surface water, nature of streams, exact proximity of streams and wetlands
				Near rivers / streams mostly intermittent and difficult access to ground water (little amount or at big depth)								
				Away from rivers / streams (perennial and intermittent) and absence and/or difficult access to ground water								
		Accessibility and proximity to dense forest for firewood	Addresses the environmental characteristics of the area with regards to the access to natural/energy resources	Close to sizeable dense forest								-Site visit to determine size and exact proximity of forest
				Close to sparse forest								
				No forest area nearby								

Category	Issue	Criteria	Comment	Rating	1	2	3	4	5	6	7	Future investigations
	Access and connectivity	Accessibility and proximity to Palma (or other hub) and road network for amenities and trade	Addresses the location of the resettlement villages in terms of connectivity to Palma or other trade hubs, where communities have access to public and social facilities as well as commercial activities	Located adjacent to main road network and/or sea transport, located close to Palma or Mocimboa da Praia Somewhat close to road network and/or sea transport, located somewhat close to hubs Isolated location with no access to roads and/or sea transport, located far away from hubs								-Site visit to determine exact distance in km and in hours (on foot, by bike, by scooter, by boat) to Palma and/or Mocimboa da Praia

4. CONCLUSIONS

Table 6 summarizes the final ratings of the seven sites. An equal value/weight was applied to each of the criteria. The final ratings/colors were based on an 'average' of colors: if a site's assessment shows more 'green' than 'yellow' ratings a final rating of 'green' was applied and vice versa. However, in addition, the assumption was applied that if a site was assessed as 'not suitable' against one or more of the critical criteria, the site in general would be rated as 'not suitable'. This means that in cases were a 'red' rating was given to one or more criteria a final rating of 'red' was applied.

In this initial assessment the critical criteria selected were weighted equally. For further investigations additional criteria are being developed, and they will be weighted based on their relative importance. For example, flood plains are rated as 'not suitable' as an environmental and technical criterion as they are sensitive areas. However, at the same time the presence of flood plains are positive and thus 'suitable' socio-economic criteria as they provide fertile grounds for agriculture. Attributing weights to each individual criterion will address this, as it will show if more 'importance' is given to socio- economic, environmental, or technical issues.

Further investigations will likely eliminate more sites using the current and an additional number of weighted technical, environmental, and socio-economic criteria. The options that are deemed suitable will be discussed during government and community consultations.

Olumbi and the Industrial Zone sites are located south of the DUAT area. The closest hub will be Mocimboa da Praia rather than to Palma. If studies show that Maganja will need to be resettled due to severe negative economic impacts regarding fishing activities, then the Olumbi and Industrial Zone sites need to be closely assessed regarding potential fishing activities.

Table 6 Summary of Final Site Rating

Name of Site	Rating	Comments and Concerns
1-Olumbi		-Access to Palma is a concern. Site is located closer to Mocimboa da Praia, which could serve as an alternative economic hub. Community opinion and preference will be critical.
2-Industrial Zone		- Access to Palma is a concern. Site is located closer to Mocimboa da Praia, which could serve as an alternative economic hub. Community opinion and preference will be critical.

Name of Site	Rating	Comments and Concerns
		-Access to fuel source might be limited -Limited vegetation concern for agriculture potential -Wetland areas on site are an environmental concern
3-West Industrial Zone		-Access to coast is a concern -Sparse vegetation for fuel and limited wetland/floodplain areas available for rice cultivation may be a concern -Suitable on all environmental and technical criteria -Possible site amendment to include area further north
4-West of Palma Road		-Site is generally suitable in terms of environmental and technical criteria without major concerns. -The distance to the ocean as well as to Palma are major concerns
5-North West Palma		-Site is generally suitable in terms of environmental and technical criteria without major concerns. -The distance to the ocean is a concern.
6-Palma North		-Site is generally suitable in terms of environmental criteria without major concerns. -The sparse vegetation may however be a concern in terms of soil suitability. -The distance to the Palma is a major concern.
7-Extension of Palma Town		-Site is generally suitable in terms of environmental criteria without major concerns. - Limited agricultural options with possibilities south and southwest.

5. RECOMMENDATIONS

From the conclusions, we make the following recommendations:

- The 7 sites shall be further evaluated using a more quantitative multi-criteria assessment (MCA) to confirm a short-list of sites ranked 'suitable' and 'possibly suitable'
- A more detailed vegetation, land use, flood risk and existing infrastructure desktop analysis shall be undertaken using the latest aerial imagery (awaiting this from the Project)
- Confirm the short-list of sites – at Resettlement Village Workshop
- Undertake field investigations on short-listed sites after workshop.

Appendix 1 - Minutes of Meeting with Palma District Administration Planning Meeting

Date:	18 March 2013		
Time:	08.00-08.45		
Venue:	Palma District Administration Office		
Attendees:	Name	Designation	Contact details
	Rachide Picones	Deputy District Administrator	N/A
	Acacio Ntauma	CLO Coordinator	acacio.ntauma@anadarko.com
	Rodney Broedelet	WP Project Manager	rodney.broedelet@worleyparsons.com
	Richard Kruger	WP Planning Manager	richard.kruger@worleyparsons.com
	Andre Pinheiro	Mesch Architects	andre@mesch.co.mz
	Stuart Duncan	RAP Manager	sduncan@rsrisksolutions.com
Apologies:	NA		

Item	Action
1. Welcome / Opening	
• We thanked deputy DA for taking time to meet us and explained that we were hoping to gather general information in relation to proposed development plans for Palma and the surrounding area.	
2. Previous Minutes	
None	
3. Topics discussed • At the outset Mr Rashide Picones (RP) mentioned that Government at national & district levels is working on planning for land use. This will probably be completed by mid-2013. He stated that many of these plans potentially involved resettlement (we had not raised the subject of resettlement in the welcome/opening). He stated that specialist companies had been invited to produce resettlement plans/procedures and carry out surveys and that he awaited information on these. Local Development Plans • RP was asked if there were any current local development plans. • RP stated that locally the District Government is only implementing contingency planning when needed to accommodate people coming into the area, or in relation to emergency infrastructure works.	

Item	Action
• Some future development areas have already been identified around the new Petrol station in the Palma town area (exiting Palma going left on road to Mocimboa da Praia). • District Government does not have plans of existing urban or rural development. • District Government has been receiving pressure from the local population regarding land allocation. They have been unable to allocate land because they do not have land use plans and they await the details in relation to the planned development/industrial zone (as noted earlier) • District Government is aware that there will be an area around Palma designated for industrial use, but they have no maps locally. • RP also recommended that we may be able to obtain further information/plans from the regional office in Pemba in regards to possible planning schemes. • We thanked RP for his cooperation and he, in turn, stated that the DA office was happy to cooperate at any time.	
4. AOB • None	
5. Next meeting None	

Appendix 2 – Photos of the area

DWELLING TYPES IN PALMA AND SURROUNDINGS

POSSIBLE RESETTLEMENT SITES

Olumbi

Area North of Olumbi 1

Area North of Olumbi 1

Area South of Afungi Industrial Zone

Area North of Palma 1

Area North of Palma 2

Area North of Palma 3

Infill Area Palma Option3

Infill Area Palma option 2

APPENDIX C – "RAPID ASSESSMENT FIELD STUDY REPORT" (SEPTEMBER 2013); COASTAL & ENVIRONMENTAL SERVICES (CES)

Replacement Village - Rapid Assessment Field Study Report

MOZAMBIQUE GAS DEVELOPMENT

TABLE OF CONTENTS

APPENDIXES

FIGURES

TABLES

1 INTRODUCTION

1.1 Project Rationale

WorleyParsons was awarded the Afungi Replacement Village Project by Anadarko Petroleum Corporation (APC) in February 2013. As part of the contractual scope of work, WorleyParsons (WP) is to provide advice on potential sites for the construction of Replacement Village(s) for an estimated 700 households. These households have to be resettled by Anadarko Mozambique Area 1 (AMA1) and Eni East Africa (EEA) due to the proposed development and construction of a Liquefied Natural Gas (LNG) facility on the Afungi Peninsula, situated in the Palma District, Cabo Delgado Province, in northern Mozambique.

In order to provide advice on potential sites for the construction of Replacement Village(s) within a designated Study Area (Figure 1), WorleyParsons has developed a three-phased GIS-supported Site Selection Multi-Criteria Assessment methodology. According to this methodology, after defining (and mapping) the Study Area (Phase 1), all known parameters that may pose serious constraints to the use of areas for resettlement (construction of the villages and associated areas for livelihood development) have to be identified. A constraints mapping exercise (Phase 2) will then involve mapping all areas that correspond to the identified constraints. These areas are then “blocked out” and deemed unsuitable for the purposes of the project.

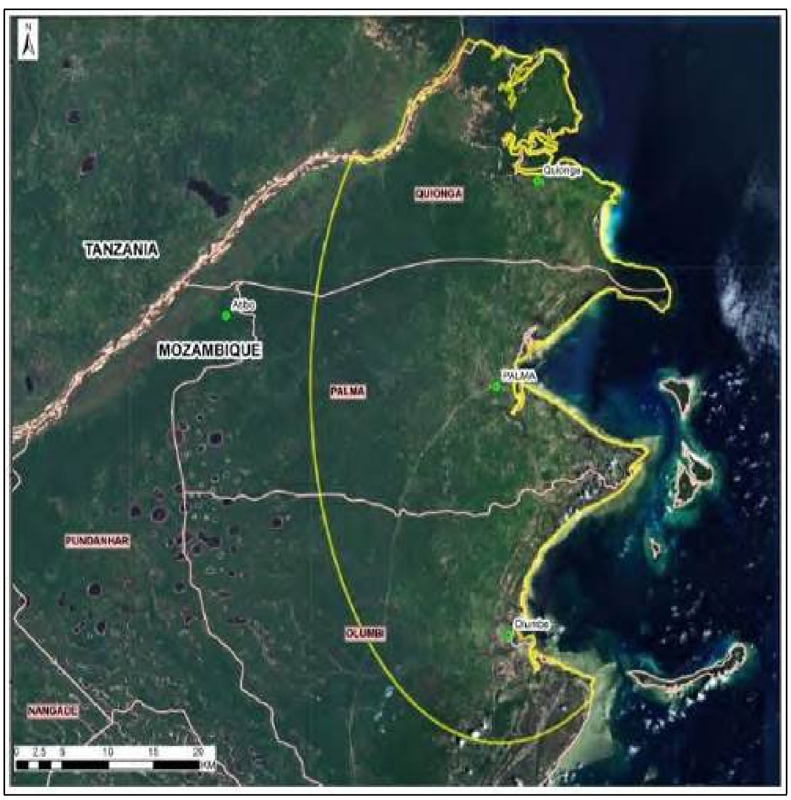


Figure 1.1: Designated Study Area of potential Replacement Village(s)

The remaining areas (Potentially Suitable Area) have then to be assessed using a number of parameters that allow a comparison between the areas available (comparison criteria) and the identification of the most suitable areas for the resettlement, through the development of a GIS – based model that would rank the Potentially Suitable areas in Classes of Overall Suitability (Phase 3). This ranking would take into account all the Comparison Criteria defined, each classified according to a pre- defined Classification System (on a scale from *1 – least suitable* to *5 – very suitable*) and also considering the relative importance of each criteria in the overall assessment (weights assigned to each criteria in a percentage scale).

The detailed methodology has been described in the report *Replacement Village Multi- Criteria Assessment & Site Selection Study* (WorleyParsons, May 2013).

The methodology described above was initially applied, by WP, to readily available data and information related to the identified constraints and Comparison Criteria. A model was then produced that ranked Potentially Suitable Areas in Classes of Overall Suitability.

Upon review of the output of the model, it was immediately recognized that:

- the information used may be have been incomplete (other important constraints to consider may not have been identified);
- most information was only available at low resolution (a large scale), and was thus inadequate for the level of analysis required to inform the location of resettlement areas;
- some of the information used may have been out of date.

The above mentioned aspects were regarded as serious limitations on the quality of the data which affected the output of the model. As such, it was decided that the next step would be to validate and confirm assumptions and data used in the model using information and data gathered directly from the site by means of a Rapid Assessment Field Study. This study was conducted by Coastal & Environmental Services (CES) in July 2013.

All information available, particularly that used in the model, was provided to CES prior to the site visit , so that it could be validated / corrected based on the observations on-site (ground truthed).

The Rapid Assessment Field Study was therefore designed in order to:

- Validate, confirm, update and complement, through primary data collected on-site, the information gathered by WP during the first exercise of “Site Selection”;
- Increase the level of detail and accuracy of the “high level” spatial information gathered and presented in the maps derived from the readily available data and information;
- Correct any errors in assumptions and/ or information used in the Site Selection Process.

Apart from this “validation” exercise of the available information, CES was requested to collect and provide additional and more refined information, in order to complement the existing baseline information. This was to be achieved not only through the field work, but also through desktopinvestigation, in particular, to obtain information about possible constraints that had been previously overlooked.

The parameters identified as constraints (corresponding to “no-go” areas) and mapped for the initial exercise of “Site Selection” were:

- floodable areas (rivers and hydrological features);
- wetlands and mangrove areas;
- densely forested areas (including the Coastal Dry Forest);
- buffers around existing social and transport infrastructure (schools and health facilities, main roads, airfields and tourism assets);
- protected areas e.g. National Parks, Game Reserves, World Heritage sites.

1.2 Assumptions and Limitations

A majority of the field work and site assessment was conducted by driving all the accessible roads in the Study Area (see Chapter 3). The amount of time and the extent of field work and site assessment conducted on foot was very limited. The restriction on being able to assess areas away from the limited road system, by foot or vehicle, was a result of the unknown landmine situation in the area. While some vegetation assessment was possible by using well-worn paths between villages, it was extremely time consuming and un-productive to explore more densely vegetated areas when all paths had to be first cleared by a de-mining officer.

Although local community members would have been able to provide useful information for the survey, communication between the CES RAFS team was restricted. The reason for this was the need to maintain discretion regarding the resettlement program as the Government of Mozambique had not yet announced the need to resettlement due to the LNG Project.

In addition to the limited accessibility, the Geohydrological assessment was also hampered by the fact that the survey was conducted in the dry season.

Due to restrictions on movements out of the camp after 16-00hrs each evening, there were no nocturnal faunal surveys conducted during this site visit.

Due to confidentiality restrictions regarding the resettlement process, the survey team was not allowed to engage in detail with the local communities about potential land use constraints and other aspects about which they may have provided useful information.

Obtaining additional information regarding DUATs/concession area and any other protected areas which may be designated under the Mozambique Land Act (Law 19/97) was difficult despite direct engagement with the appropriate national and regional authorities.

2 METHODOLOGY

In order to fulfil the objectives of the WorleyParsons Site Selection Study [Replacement Village Multi-Criteria Assessment & Site Selection Study (WorleyParsons, May 2013)], a survey methodology was developed in a way that would ensure compatibility with that study. Apart from aiming to confirm and eventually identify additional constraints, the methodology developed has therefore incorporated, where possible, the same Classification System for rating the Criteria (or graduating/ranking preferences), for each of the key aspects described below:

- Constraints and Land Use Planning;
- Hydrology and Geohydrology;
- Soils and Agricultural Potential;
- Vegetation and Ecology.

The approach to gathering the required data and information involved a combination of on-site field investigations as well as other research techniques including interviews and further desk top studies. Details of these investigations are provided in the sections below.

2.1 Rapid Assessment Field Survey and Team Composition

The Rapid Assessment Field Survey was conducted from 17th June to 5th July 2013 (this period included the required site induction and training processes). The areas of focus of the study team were the following:

- Constraints and Land Use Planning;
- Hydrology;
- Geohydrology;
- Vegetation;
- Soils;
- Agricultural potential;
- Ecology.

The Rapid Assessment Field Survey Team (RAFS Team) consisted of six study team members, namely:

1. **Mike Bailey** (CES), Project Manager: Mike is responsible for general project management and reporting. Mike focused on the Vegetation, Ecological and, along with Mr van Zyl, Land Use Planning and Constraints.

2. **Elisa Vicente** (CES), In-country project manager: During the field survey Elisa evaluated the marine/fisheries issues and associated Land Use considerations relevant to the Study Area (including identification of potential fishing village relocation sites), and assisted with the Land Use Planning and Constraints aspects, protected area considerations and engagement with local authorities.

3. **Bruce Kelbe** (CES External consultant), Geohydrology and Hydrology: Bruce was responsible for both the geohydrology and surface hydrology study aspects.

4. **Fredo van Zyl** (CES External consultant) Agronomist/Agricultural aspects: Fredo was responsible for Soils and Agricultural Potential, and, along with Mr Bailey, Land Use Assessment aspects of the study.

5. **José Sá Pereira and Francois Humphries** (WorleyParsons) accompanied the CES team for the duration of the survey. They were responsible for liaison between Anadarko/RS2 and CES and organised the daily logistics for the CES survey team.

Logistical support and back-up for the survey team was provided by the Project and Roos Social Risk Solutions (RS^2). They supplied two 4x4 vehicles along with two Community Liaison Officers (CLOs) and two De-mining Officers.

2.2 Mapping and Use of Aerial Satellite Imagery

WorleyParsons provided CES with maps depicting all areas that correspond to the identified constraints which had been developed by their constraints mapping exercise (Phase 2). In order to confirm and amend the information contained in these maps CES used available the most current and available aerial and satellite imagery.

Most of the information relating to the presence and extent of vegetation types in the Study Area, in particular, wetlands, mangroves and Coastal Dry Forests/Dense Forests was derived from Google Earth Pro (CES Licence Key JCPM6J2Q4D1**3G).

Prior to the site visit and in order to facilitate ground-truthing in the field, updated Google Earth maps of the Study Area and relevant coordinates were uploaded to Samsung electronic tablet devices using OruxMaps software (no licence required).

All maps produced by CES were created using ArcGIS10, for which CES has licenced software.

2.3 Pre-Survey Meetings with District and Local Authorities

Prior to the commencement of any field work, meetings were held with local authorities with jurisdiction over the Study Area. The purpose of these meeting was to introduce the CES RAFS Team and explain the work that the team were going to undertake in each Administrative post.

The first meeting took place on 21st June with the Permanent Secretary of the District of Palma Mr. Abdul Piconês. The meeting was attended by José Sá Pereira – WorleyParsons, Horácio Gervásio – Anadarko and Elisa Inguane Vicente – CES, Lda.

The second meeting took place in Olumbe on 23rd June, and was attended by José Sá Pereira of WorleyParsons, Elisa Inguane Vicente, Michael Bailey, Bruce Kelbe and Fredo van Zyl of CES, Lda. and the CLO from RS2.

The survey team tried to have an introductory meeting with the "Chefe do Posto" in Quionga on the morning of 25th June before commencing any activities in the area. The "Chefe do Posto" was not available at the time but agreed the survey team's work schedule via a telephone conversation and a meeting was held at the end of the day.

Minutes from the meeting held in Palma are included in Appendix C.

2.4 Constraints and Land Use Planning

The objective of the Constraints and Land Use Planning assessment was to confirm and validate, as far as possible, the following list of possible constraints, which had been identified by WorleyParsons prior to the field assessment, and also to add to this list if further constraints were identified during the survey:

- Wetlands;
- Mangroves;
- Coastal Dry Forest;
- Main towns, villages, settlements and infrastructure (e.g. social, transport and roads);
- Existing cultivated areas (existing agriculture);
- Conservation Areas (existing and potential Protected Areas);
- Game Reserves;
- Forest Concessions;
- Mining concessions;

- Coral reefs;
- Turtle beaches;
- Elephant corridors;
- Graveyards and other sacred areas.

In addition to this list further information was also investigated relating to existing Forest and Mining Concessions DUAT's in the Study Area. This was done through consultation with the local authorities as described in Section 2.3.

CES conducted further investigations regarding the existence of DUATs in the Study Area by checking on the public computers available at the Department of Mining Cadastre, Maputo. This information can be acquired by entering the coordinates in degree, minutes and seconds format, of the area being investigated. However, new DUATs are being applied for and some are issued at short notice so situations can change quickly (personal communication from staff at Department of Mining Cadastre).

2.5 Hydrology and Geohydrology

The primary objective of the hydrological and geohydrology assessment was to establish the water supply potential across the Study Area thus ensuring that any resettled community would be guaranteed access to water of similar or better quality and quantity to that currently available in the Afungi area. In addition, it was important to understand the extent of floodplains in the Study Area.

The Rapid Assessment Field Survey was aimed at gathering sufficient hydrological information to populate a preliminary ground water model which will inform whether potential resettlement sites will have access to a sufficient quantity of water and the extent of shallow water tables.

The information required to generate the baseline data was gathered from the site visit, desktop studies and previous groundwater investigations and EIAs done in the Afungi area (More, Spence & Jones, 2012, and ERM& Impacto 2012).

In addition, the survey included the collection of limited baseline data on the quantity and quality of the surface and groundwater and its use by the local inhabitants across the Study Area. During the EIA study of the LNG Project, in Afungi, by ERM (2012), 14 boreholes were tested and it was found that all samples, with one exception, exceeded the Mozambican water quality guidelines for a range of cations and anions. Based on these results the following constituents were analysed in this study: Sodium (Na), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Iron (Fe), Lead (Pb), Chlorine (Cl), Sulphates (SO4), Bicarbonates (HCO3) and Boron (B).

In order to evaluate the quality of the surface and groundwater across the Study Area twenty one (21)

500ml samples were collected in sealable sample bottles which were sent to an accredited water testing laboratory in South Africa, (Talbot & Talbot - see accreditation in Appendix D) for analysis. Only three samples were collected from flowing rivers with runoff, as all the others were dry at this time of year. The remainder samples were taken from hand pumps, shallow community wells and from open water pans.

A list of the number of boreholes and hand-pumps in the Study Area was acquired during a meeting held with the District Service for Planning and Infrastructure (Serviço Distrital de Planeamento e Infra- estrutura) in Palma on 27th June 2013. This meeting was attended by Bruce Kelbe and José Sá Pereira.

A follow-up survey was conducted by Fredo van Zyl and Francois Humphries of WorleyParsons to map the locations of all these borehole and hand-pumps and details are provided in Appendix E.

Mozambique has a modern and progressive waste management system regulation. However, despite a clear political objective, many people still do not have access to adequate and proper waste management and sanitation infrastructure while in remote parts of the country are in a dire state with a complete lack of waste infrastructure. Typically, the final destination of solid waste in rural areas, including the Palma district, consists of simple open air rubbish dumps. In these places, waste is burnt and buried causing a certain environmental and health concerns (Mozambique Country Report, Bertelsmann, 2012).

Observations from the survey revealed that there are many simple pit-latrines in the towns and villages but in other areas people have no sanitation points and just use the open countryside.

2.6 Soils and Agricultural Potential

The soil survey was designed to confirm and complement the soil type information in existing maps and aerial photographs of the Study Area. A general description of the soils in the Study Area was established from desktop studies and soil samples from across the Study Area were collected for laboratory analysis in order to confirm the findings of the original desktops studies. The objective of the soil assessment was to classify the soils of the Study Area according to their suitability for agriculture in order to aid in the selection of sites for resettlement villages. The agricultural potential of the preferred resettlement areas should be similar or better than that currently found in the Afungi area.

The information gathered from on-site observations combined with laboratory analysis was used to produce both a soil distribution map for the Study Area as well as a map illustrating agricultural potential areas classified on a scale from ‘unsuitable’ to ‘very suitable’.

A total of 74 samples were taken from 37 sampling sites across the Study Area. Sampling was carried out using a specialised soil auger (Figure 2.1).

At each of the 37 sampling sites, two x 500 gram samples were collected for laboratory analysis; one at a depth of 200mm and, from the same hole, another at 600mm. The latter represented crop root depth. All soil samples were carefully labelled and packed in plastic bags before being sent to a laboratory, Bemlab, in Cape Town for chemical analysis. A letter regarding the status of accreditation of this laboratory is included in Appendix F.

Besides the collection of samples for analysis, other observations of the soils and soil profiles were obtained from river valleys, culverts and road cuttings, dug outs, water holes, borrow pits and erosion pits (Figure 2.1). For example, by conducting a visual comparison of soil samples taken from the top of a river valley and then half way down the slope and again at the bottom, and repeated on the opposite bank, it was possible to determine that the soil composition along whole valleys was the same. It should be noted that where river valleys were examined in this way only one of the samples was collected and sent for laboratory analysis.

Figure 2.1: Collection of soil samples and observation of soil profile from a water hole

All soil samples were photographed for comparison of soil texture and colour (Figure 2.2). Soil colour in particular is indicative of the types of soils that exist in the Study Area.

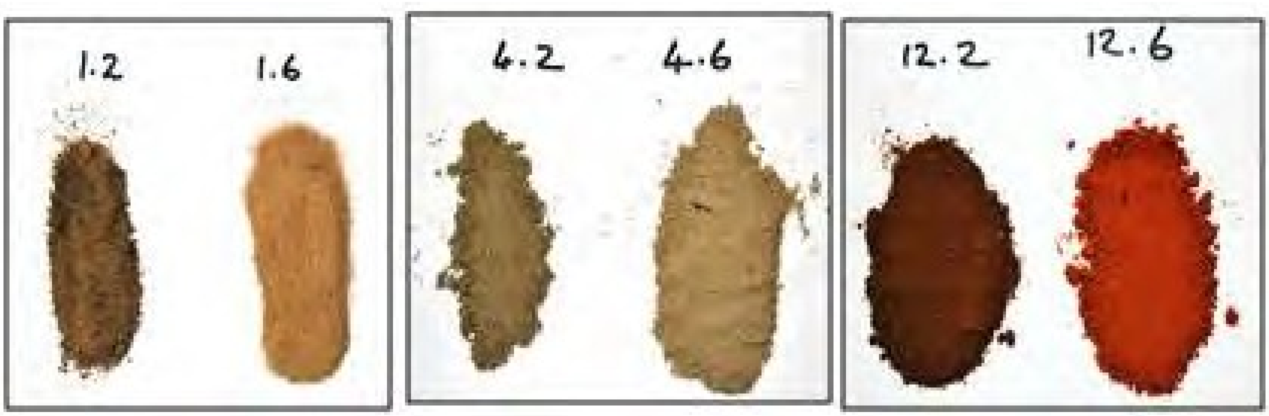


Figure 2.2: Examples of photographed soil samples from the Study Area demonstrating colour variations

Due to limited availability of roads which could be used by the survey team vehicles and the difficulties in accessing all areas of the site (walking off-road was restricted because of the threat of UXOs) almost all samples were collected within 100m of a road. However, this limitation was not considered to have affected the sampling strategy which led to a reliable confirmation of the nature and extent of the soil types found across the Study Area.

2.7 Vegetation and Ecology

The main objective of the Vegetation and Ecology assessment was to identify and delineate sensitive and/or protected vegetative biomes and habitat types, and faunal populations which could act as constraints to the selection of resettlement site/s. This was done to confirm / adjust the limits of some of previously identified vegetative biomes and habitat types, or to identify new ones.

Vegetation

The most recent reports from survey conducted in the Palma area describing the vegetation habitats and species composition were consulted. These included the vegetation assessment surveys conducted as part of the ESIA for the Afungi peninsular (ESIA conducted by ERM & Impacto 2012) and the Site Selection Report for the onshore LNG Plant, conducted by Enviro-Insight and Impacto (October 2011).

In order to ensure consistency with the previous surveys conducted in the area (Enviro-Insight & Impacto, October 2011 and ERM & Impacto, 2012), the vegetation habitats used in this report were described using the same 'regional structural vegetation units derived from remote sensing imagery and ground-truthing' used in the ERM & Impacto ESIA (2012).

Following the desktop analysis and ground-truthing exercise of representative sites of all the vegetation types within the Study Area, each was assigned a sensitivity rating using a CES-developed rapid assessment sensitivity analysis checklist (Figure 2.3 below). This is a very simple method of analysis that provides a reliable, yet conservative and precautionary assessment of the vegetation sensitivity.

SENSITIVITY ANAL YSIS OF:

DATE: ..... SITE NO:

SENSITIVITY		LOW SENSITIVITY (minimum = 0)	MODERATE SENSITIVITY (median = 5)	HIGH SENSITVITY (maximum = 10)	SCORE
1	Topography	Level, or even	Undulating; fairly steep slopes	Complex and uneven with steep slopes	
2	Extent of vegetation or habitat type in the region	Extensive	Restricted to a particular region/zone	Restricted to a specific locality/ site	
3	Conservation status of fauna/ flora or habitats	Well conserved independent of conservation value	Not well conserved, moderate conservation value	Not conserved – has a high conservation value	
4	Presence and number of species of special concern	None, although occasional regional endemics	No endangered or vulnerable species, some indeterminate or rare endemics	One or more endangered and vulnerable species, or more than 2 endemics or rare species	
5	Habitat fragmentation leading to loss of viable populations	Extensive areas of preferred habitat present elsewhere in region not susceptible to fragmentation	Reasonably extensive areas of preferred habitat elsewhere and habitat susceptible to fragmentation	Limited areas of this habitat, susceptible to fragmentation	
6	Contribution to biodiversity	Low diversity, or species richness	Moderate diversity, and moderately high species richness	High species diversity, complex plant and animal communities	
7	Visibility of the site or landscape from other vantage points	Site is hidden or barely visible from any vantage points with the exception in some cases from the sea.	Site is visible from some or a few vantage points but is not obtrusive or very conspicuous.	Site is visible from many or all angles or vantage points.	
8	Erosion potential or instability of the region	Very stable and an area not subjected to erosion	Some possibility of erosion or change due to episodic events.	Large possibility of erosion, change to the site or destruction due to climatic or other factors.	
9	Rehabilitation potential of the area or region	Site is easily rehabilitated.	There is some degree of difficulty in rehabilitation of the site.	Site is difficult to rehabilitate due to the terrain, type of habitat or species required to reintroduce.	
10	Disturbance due to human habitation or other influences (e.g. alien invasives)	Site is very disturbed or degraded.	There is some degree of disturbance of the site.	The site is hardly or very slightly impacted upon by human disturbance.	
				Sensitivity Index (Percentage)	

Comments:

Figure 2.3: CES-developed vegetation sensitivity analysis form

Once the Study Area was assessed, the information was used to produce two maps: a vegetation map illustrating each of the vegetation types found in the area, and a second map showing the sensitivity of each of the vegetation types, using the sensitivity criteria described above. The ecological sensitivity was classified as VERY LOW, LOW, MODERATE, HIGH, or VERY HIGH. This vegetation sensitivity map was designed to aid in the selection of resettlement areas such that areas considered being of vegetation sensitivity or ecological importance could, where possible, be avoided.

Fauna

The identification of the faunal species present in the area was made from direct field observations and field signs (tracks and droppings), as well as from anecdotal information provided by local inhabitants.

This information was coupled with desktop studies in order to identify the faunal species likely to be present in the area (for example, internet search - www.iucn.org). The survey was designed in particular to look for faunal species which are listed as being of conservation importance and/or as listed on the IUCN Red Data lists of threatened species (Appendix G). It should be noted that there have been very few intensive faunal surveys preformed in this part of Mozambique and, as such, reliable literature on the distribution of faunal species of special concern in the region is limited. In addition, due to the limited accessibility to the site during the field survey, first hand observation of fauna was low.

Avifauna at this time of year (the dry season) always represents a small proportion of the species that may be found in the area over the course of a full year. There are many Palearctic and intra-Africa migratory bird species which are only found in the area during the rainy season (Sinclair & Ryan 2010). As a result there are many bird species which have been recorded in this area which were not observed during this survey period.

3 STUDY AREA

3.1 Study Area

The Study Area for this Rapid Assessment Field Study (i.e. area in which potential Replacement Village site(s) are to be identified) is defined as the area located in the north-eastern part of Mozambique, in Cabo Delgado Province and which surrounds the town of Palma and is limited to the north by the Rovuma River (Tanzanian border) and extends southwards to approximately 10kms south of Olumbe (Figures 3.1. and 3.2).

Figure 3.1 & 3.2: Location of the Study Area in northern Mozambique, and the extent of the Study Area

3.2 Topography

The Palma area is mostly contained within a large sedimentary isocline that slopes upwards and westwards to a height of 180m. This isocline ends abruptly along its north-western edge where it drops dramatically to the Rovuma River, but is otherwise characterised in the Palma area by a general slope southeast to the Mocímboa basin (Clark 2011).

To the east of the Palma–Mocímboa road the land drops down to a narrow coastal plain consisting of recent sediments. Much of the interior plateau, as seen from Landsat imagery, acts as a 'sponge' with pans and edaphic grasslands (a result of seasonally-poor drainage) and numerous drainage lines flowing to the south-east or, in the northernmost section, to the north-east.

3.3 Climate

The area has a humid tropical monsoon climate that is influenced by movements in the Inter-Tropical Convergence Zone (ITCZ). There are two seasons per year, a cool and dry season (May to October) and a hot and humid season (November to April). This area has one of the driest climates recorded along the eastern African coast, with mean annual rainfall of about 1100 mm. The greater proportion of rain (between 85-90%) is concentrated in a 5 to 6 month period of the year, generally between the months of December and April, inducing a severe water stress for plants over the rest of the year (Clark 2011).

The mean annual temperature in the Palma District is 26°C; the minimum monthly average temperature reaches 17.6°C, between the months of July and August, and a maximum of 32°C in March. Relative air humidity is high all year long, varying on average between 75 % in September to 83% in April along the coast (CROPWAT 2008).

A summary of the climate for the Palma District is show in Tables 3.1 and 3.2 below.

Tables 3.1 & 3.2: Summary of the climate of the Palma District (CROPWAT 2008)

Country: Mozambique Station: PALMA
Altitude: 60 m. Latitude: 10.46 °S Longitude: 40.30 °E

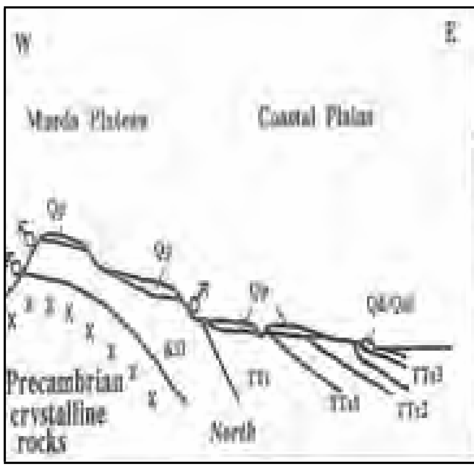
Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	20.8	31.4	80	86	5.8	19.1	4.10
February	20.8	31.9	82	78	5.9	19.2	4.09
March	21.4	32.0	81	86	6.3	19.2	4.12
April	20.8	31.1	83	112	6.9	18.7	3.91
May	19.6	30.0	79	130	8.0	18.4	3.76
June	18.3	29.0	80	121	7.5	16.8	3.30
July	17.5	28.4	80	121	7.5	17.2	3.30
August	17.7	28.8	76	121	8.8	20.5	3.95
September	17.9	29.4	75	121	9.2	23.0	4.49
October	18.9	30.4	75	121	9.5	24.6	4.93
November	20.0	31.0	76	121	9.2	24.3	5.01
December	20.5	31.6	76	86	6.9	20.7	4.41
Average	**19.5**	**30.4**	**79**	**109**	**7.6**	**20.1**	**4.11**

Station: PALMA Eff. rain method: FAO/AGLW formula

	Rain	Eff rain
	mm	mm
January	[illegible]	111.2
February	171.0	112.8
March	183.0	122.4
April	235.0	164.0
May	101.0	56.8
June	30.0	8.0
July	28.0	6.8
August	12.0	0.0
September	19.0	1.4
October	15.0	0.0
November	57.0	24.2
December	119.0	71.2
Total	1139.0	678.8

3.4 Geology

The Study Area lies in the Rovuma Sedimentary Basin. A generalised vertical profile of the main geological strata from west to east across this region is taken from Ferro and Bouman (1987) and shown in Figure 3.3 below.



FORMATION		HYDROGEOLOGICAL GROUP
Qal	Quaternary	A123,C1
Qal,Qd,Qp	Quaternary	A3,C1
TTs3	Littoral limestones	B3
TTs2	Mikindani Beds (Sandstones)	B3
TTs1	Sandstones and calcarenites	B3
TTi	Sandstones and marlstones	C2
Ks,Ki2	Marlstones	C2
Kil	Maconde Sandstones	B3

Figure 3.3: Generalised geological cross-section from West to East across the Study Area from Ferro and Bouman (1987)

The coastal margin of the Study Area is dominated by unconsolidated Quaternary coastal dune and sand sheets with local gravel beds (Qd and Qss) (Figure 3.4) that overly the littoral limestone (reefs) and sandstone beds of the Mikindani Formation. The interior region of the Study Area is generally covered by Quaternary deposits comprising alluvium, silt, gravel, debris, mud, pebble bearing debris, estuarine and tidal flats with back-barrier and interdunal wetlands. Underlying these recent sandy sediments and occasionally outcropping, is the extensive Mikindani Formation (TeK) that underlies a large portion of the Study Area. At varying depths, these Quaternary and tertiary sedimentary aquifers overlie the Cretaceous sandstone and marlstone deposits of the Maconde Formation that generally are not suitable aquifers because of their lower permeability and poor water quality.

Pliocene to recent calcarenites and reef limestones occur along the entire coast and also on the Quionga peninsular (Figure 3.4) while the gently East-West sloping sedimentary deposits are considered to be representative of the underlying geological stratigraphy along the entire coastal region of the Study Area.

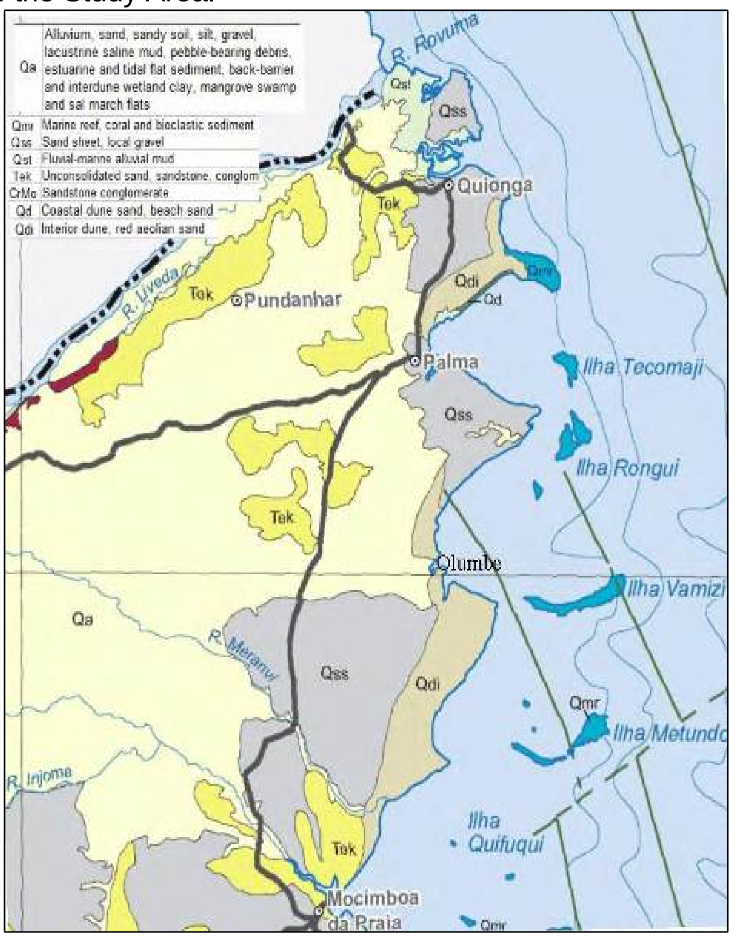


Figure 3.4: Geological units for the Study Area (from Carta Geológica; Ministério dos Recursos Minerais; Direcção Nacional de Geologia; República de Moçambique)

The salt domes are generally too deep to affect the shallow boreholes in the Study Area. It is these Quaternary-Pliocene/Miocene sediments into which most of the areas shallow boreholes are dug as the main rural water supply. The substrate of Palma District comprises predominantly of sedimentary rocks of the tertiary and Quaternary eras (Impacto 2007). Rock outcrops are few, and are only seen when exposed on steep drainage lines. However, a notable geological area north of Palma Town consists of uplifted calcareous coral formations of the Pleistocene era, and this outcrop lies under a very thin soil layer on the Cabo Delgado peninsula.

3.5 Soils

In the present report, the soils are classified under the "World Reference Base for Soil Resources 2006", a framework for international soil classification that was produced by the UN Food and Agricultural Organisation (FAO) (IUSS Working Group WRB, 2006) . The typical soils found in the Study Area can be classified into three distinct groups, Ferralsols, Arenosols and Planosols. Figure 3.5 illustrates the soils of the Cabo Delgado region with the Study Area situated in the north-east corner (red oval).

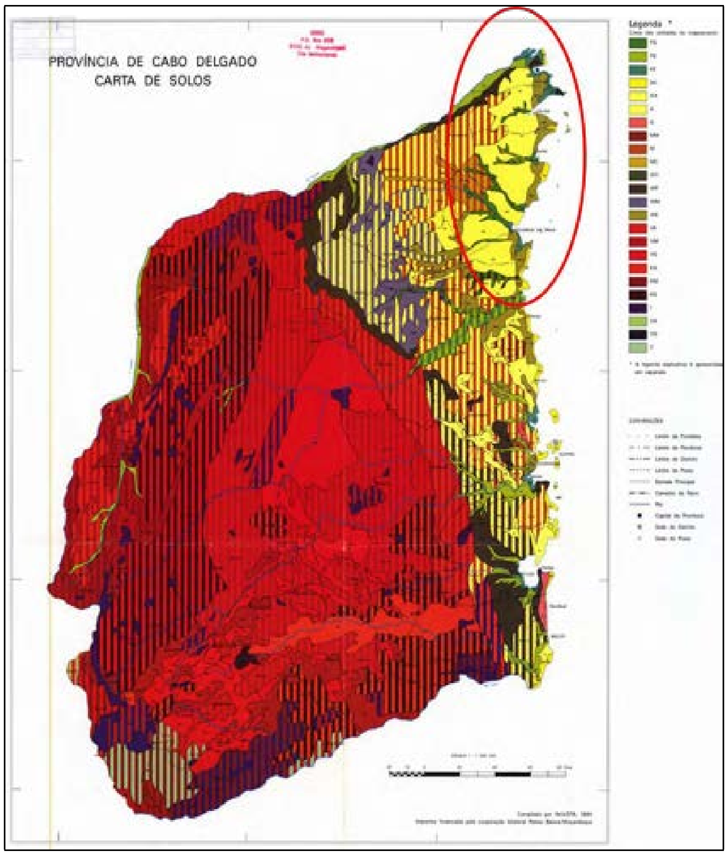


Figure 3.5: Soils of the Cabo Delgado area - Palma Study Area is in the north-east (red oval)

Ferralsols: these occur in tropical and subtropical regions of the world, mainly on old and stable land surfaces. They have a clay content varying from 5 – 8% in the topsoil to 22% in the subsoil and an iron- oxide content which gives ferralsols a distinctive red colour. These soils have a high potential for farming.

Arenosols: these soils occur over large areas in Africa, and are characterised by a topsoil light (bleached) in colour with very low organic carbon content, and a clay content of less than 15% in the rest of the horizon. These soils can be divided into two types; one type has a pale grey coloured structure throughout the profile, while the other has a greyish brown to brownish grey coloured structure (up to 80 – 100cm depth) on top of a pale grey horizon (Figure 3.6).

Figure 3.6: Arenosols from the Study Area showing the different coloured structures
(7.2/6 pale grey and 16.2/6 grey brown)

The latter will be the better soils for farming due to their higher nutrient state and organic carbon content and while they have a low water holding capacity due to the very low clay content (3 – 5%), as well as a low nutrient state, they can be improved by good farming practices (i.e. addition of fertilizers and irrigation).

Planosols: the wetland areas consist of a combination of Planosols and Plinthic Arenosols. The underlying gleyed material and plinthic horizon is poorly formed, not showing all the characteristics of these horizons properly. They are very sandy and also white to light grey in colour. There also less than
2% clay content. These areas are used mainly for rice production but are not good for crop production.

The criteria for assessing the agricultural suitability of the soils are discussed below and are based on the known properties of these soil types:

Total Available Moisture (TAM) / Available Water Capacity (AWC)

Total Available Moisture (TAM) or Available Water Capacity (AWC) is a measure of the water available to crop roots, expressed as mm per metre, and is dependent both on soil depth and soil texture. From information available in respect of the same soils elsewhere in the region (IUSS Working Group WRB, 2006), the estimated range of Total Available Moisture values for each of the soil types occurring in the Study Area are given below;

Soil	Mm/m
Ferralsols	80 - 100
Arenosols	50 - 90
Planosols	40 - 60

Steady Water Intake Rate (Infiltration Rate)

The estimated Steady Water Intake (infiltration) Rate is the rate at which the soil can absorb water and is measured as mm per hour. The Steady Water Intake Rate for the soils occurring in the Study Area is given in table below:

Soil	Steady Water Intake Rate (mm/hr) (moist soil)
Ferralsols	20 – 50
Arenosols	40 – 60
Planosols	50 – 100

Organic Matter (Organic Carbon)

An important component for assessing the agricultural potential of the soils in the Study Area is the organic matter content of the topsoil. This will be determined in the laboratory analysis as the % of carbon.

pH

The pH values of the topsoil in the Study Area will vary depending on the soil type present. In the case of the Ferralsol soils, they have a neutral to slightly acid subsoil, to slightly acid topsoil.

Cation Exchange Capacity and Exchangeable Cations

The cation exchange capacity (CEC) of the soils in the Study Area will give an indication of their inherent fertility, especially in respect of calcium and magnesium and the levels of nitrogen which are required to ensure optimum crop yields.

Salinity

Salinity can seriously affect crop yields especially in areas where the high evapo-transpiration, as a result of high temperature in arid and semi-arid zones, is the basic cause for salt accumulation on the soil surface (Khalid, 2007).

Soil salinity thresholds commonly applied in respect of soils for the cultivation of crops therefore are:

Salt Thresholds	Salinity
0 - 200 mS/m	Non saline
200 - 400 mS/m	Slightly saline
400 - 600 mS/m	Moderately saline
600 - 800 mS/m	Highly saline
> 800 mS/m	Very highly saline

3.6 Vegetation

Until the Timberlake expeditions in 2008 and 2009 (Timberlake 2010), there was very little published on the vegetation of the Study Area other than in general accounts of national vegetation distribution (e.g. White, 1983). However, since the Timberlake expedition coupled with the vegetative assessments conducted by Impacto/Enviro-Insight (2011) and ERM & Impacto (2012), there is now a better picture of the diversity of vegetative and habitat types that exist in the area. Vegetation types observed and described in the Study Area during the EIA (ERM & Impacto 2012) comprised dense forest, dense woodland with miombo, degraded woodland with miombo, riverine savannah mosaic, coral rag forest, coastal open savannah, sandy coastal open woodland, wetlands and pans, dense mangroves swamps, and river delta with mangroves.

The vegetation of the Palma area has adapted to the severe water stress; most herbs die back and most trees lose their leaves by the end of the dry season. This increases the vulnerability of the area to bush fires, which readily burn the dry leaf litter and desiccated plant matter at the end of the dry season (Clark 2000). Forest is still present on most soil types in the Study Area, except for the soft white sands in the coastal margins and this is particularly noticeable in the thinly wooded areas just north of Palma Town, possibly due to a long history of intensive cultivation and fire burning in this zone.

Clark (2000) observed that denser forests and woodlands existed to a greater extent further inland and that this may have been due to a low population density and fewer bush fires. However, human population statistics for NE Mozambique (quoted in Impacto, 2007) projected a 30% increase in local inhabitants in the region between 1997 and 2010, and this rise in population may have had an impact on the dense vegetation found in the Study Area by Clark (2000).

3.7 Hydrology

According to Clark (2000), permanent standing/flowing water is limited in the Palma District, due in part to the long dry season as well as to the gentle topography and well-drained sandy soils. However, there are numerous seasonal wetlands, pans and watercourses present. The pans are formed in areas with a heavy clay substrate which prevents the free drainage of water, and are characterised by standing water for many months of the year, and by the absence of trees, often exacerbated by human-induced fire (Clark 2000). The wetlands and pans generally have shallow water table profiles around their peripheral margins that have been targeted extensively by the local community for their water requirements using shallow, hand dug wells (ERM & Impacto 2012).

3.8 Land Use

The local communities resident in the area are generally reliant on subsistence agriculture and fishing. The main agricultural crops grown in the area consist of cassava and millet (using slash-and-burn practices), rice (cultivated in wetlands situated in lowlands and along waterways), cashew nut, mangoes and coconut. In addition there is also some livestock grazing but this was observed to be fairly limited with only a few cows noted with goats and chickens being the most frequent livestock found in villages.

There are numerous fishing villages situated along the coastline and most fishing is conducted with the use of fine-mesh netting in the shallow waters close to the coast, and by line-fishing from boats in the deeper waters (ERM & Impacto 2012).

The surrounding forests and woodlands provide a range of natural resources (mainly the utilisation of trees for firewood, building poles, charcoal production and commercial logging). The majority of households use firewood for fuel as their main source of energy, specifically for cooking purposes (ERM & Impacto 2012). Poles cut form the forests, along with coconut and palm tree leaves and grasses are used for the construction of housing structures. The leaves and grasses are also used for making mats and baskets (ERM & Impacto 2012).

Hunting is undertaken, mainly for subsistence purposes but some is sold locally. Hunting is undertaken using traditional traps, and the most commonly hunted animals in the forest areas are gazelle and the helmeted guinea fowl (ERM & Impacto 2012).

3.9 Infrastructure Villages and Towns

Prior to the field study there was no map sourced which identified and named all the villages and towns in the Study Area. The survey team made the point of establishing, where possible, the names of all villages and towns that were encountered during the survey.

A map was generated by CES showing all the village and town names ascertained during the survey (excluding those in the Afungi DUAT area) and these are shown in Figure 3.7 below.

Figure 3.7: Village and Towns identified during the site survey (excluding the DUAT Area)

Roads

While there are a number of dirt roads throughout the Study Area the survey team discovered that not all are currently usable by motorised vehicles while others are only passible using 4x4s or trucks. Some have become overgrown or reduced to foot/cycle paths joining neighbouring villages and towns. The survey team did explore all drivable routes in the Study Area and produced a map illustrating these roads (see Figure 3.8).

In order to identify particular roads/tracks with reference to areas surveyed and photographs taken, the survey team assigned specific codes / numbers to these roads and tracks (Figure 3.8). The exception is the road labelled as R9 by the survey team which represents the national N247 road which runs from Mocímboa de Praia, south of the Study Area, to Quionga in the north of Cabo Delgado.

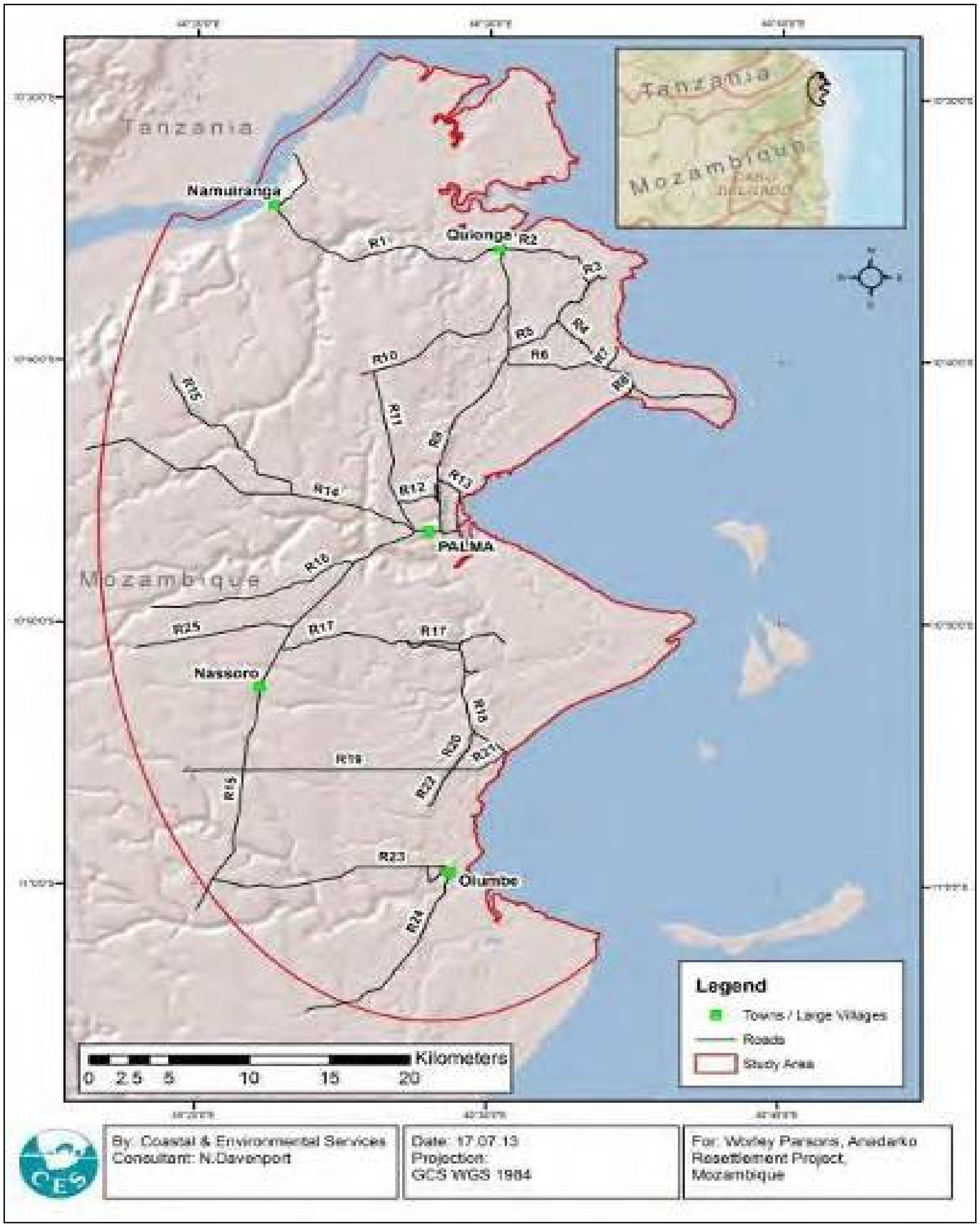


Figure 3.8: Map illustrating the drivable roads in the Study Area as identified by the survey team

4 RESULTS AND FINDINGS

The purpose of this chapter is to present the findings of the Rapid Assessment Field Survey and, based on first hand data combined with and other information derived from secondary sources, to comment, as far as possible, on the accuracy of the assumptions and findings presented originally by WorleyParsons.

4.1 Constraints and Land Use Assessment

CES were provided with maps developed by WorleyParsons as part of their constraints mapping exercise (Phase 2) which illustrated the previously identified potential biophysical constraints as a result of land use practices in the Study Area; the latter essentially showed the areas currently under use for agriculture (cultivation).

The results of the CES Rapid Assessment Field Survey and ground-truthing exercise were used to confirm and amended the information provided in the original WorleyParsons constraint maps. Most of the information contained in the WorleyParsons constrain maps was verified during the survey of the Study Area with the only noticeable change being observed in the amount of land currently under cultivation as a result of recent clearance of dense forest areas. Updated maps illustrating the most recent land use and additional constraints (cultivated land and the known logging concession) in the Study Area were produced by CES; for example, see Figure 4.29, the vegetation map for the Study Area.

As mentioned in section 1.2, gathering information in order to fully understand the current land use practices within the Study Area was extremely restricted due to the fact that, at the time of the field assessment, the resettlement process had not yet been announced. Due to confidentiality restrictions, the assessment team was not allowed to engage in detail with the local communities about potential land use constraints that they may have been aware of.

Therefore the most prevalent land use practices were determined by very limited consultations with local and district authorities, some of the local inhabitants, and by driving around the limited road network in the Study Area in order to observe the typical agricultural practises and natural resource uses. Despite the confidentiality surrounding the project it was possible to gain limited information regarding fishing practises during short visits to local fishing villages and information of agricultural practises through informal conversations with people in in-land agricultural villages.

The meetings held with the local authorities were designed to gain information regarding the existence of current or future Land Use Plans, whether at National, Provincial or Local (District) level, or a Regional Master Plan, and status of current or recently acquired DUAT's which might affect the availability of land available for resettlement purposes.

4.1.1 Concessions, DUATs and Land Use Rights in the Study Area

In order to meet the relevant authorities, it is normal practise in Mozambique to send a formal letter requesting an official meeting and providing details on the purpose of the meeting at least 15 days in advance. This allows the authorities to prepare, or to be better prepared to provide the information requested. With the sensitivity surrounding the resettlement project not allowing for full explanation of the reason for the meeting requests, the only institutions with whom meetings could be arranged were the Administration of the District, and the District Services of Economic Activities (SDAE).

Four official meeting were held during the sire visit; two with the Palma District Administration, one with District Services of Economic Activities (SDAE) and one with the District Service for Planning and Infrastructure (Serviço Distrital de Planeamento e Infra-estrutura).

The first meeting took place on 21st June with the June with the Permanent Secretary of the District of Palma Mr. Abdul Piconês. The meeting was attended by José Sá Pereira of WorleyParsons, Horácio Gervásio of Anadarko and Elisa Inguane Vicente of CES, Lda..

In addition to introducing the survey team the meeting was aimed at collecting information/documents relating to the urban plans of the district and the current land use patterns as well as the Strategic Development Plan of the District. The Permanent Secretary informed the team that there was a Land Development Plan for the district currently being revised by the Government and it is expected to be approved in September 2013. At the time he intimated that he could possibly search for and provide the draft of the document in the following week.

During the second meeting, held with the District Service for Planning and Infrastructure (Serviço Distrital de Planeamento e Infra-estrutura) on 27th June, a list of the number of boreholes and hand- pumps in the Study Area was acquired. This meeting was attended by Bruce Kelbe and José Sá Pereira.

In a follow-up meeting with the Permanent Secretary, held on 1st July and attended by Acácio Ntauma of Anadarko and Elisa Inguane Vicente of CES, Lda., the Permanent Secretary informed the team that the Land Development Plan covering the Study Area was not currently available as it was being reviewed in Pemba by MICOA. The Permanent Secretary did provide the team with the Strategic Development Plan of the District (2008-2012). However, this Strategic Plan is now outdated within the current context of the district, and therefore did not provide any additional relevant information on constraints regarding the Study Area.

Another meeting was held on 1st July at the District Services for Economic Activities (SDAE). The meeting was attended by Carlos Paulo, an SDAE Technician, Acácio Ntauma of Anadarko and Elisa Inguane Vicente of CES, Lda. The purpose of that meeting was to gather information regarding forest concessions and any historical or recently granted DUATs within the Study Area.

There was also evidence of commercial logging within the Study Area (Figure 4.1). Cut logs waiting to be transported out of the area were observed along Road 19 (see Figure 3.8 above) about three kilometres from the main road. (Coordinates – 10^{o}55’36.09”S 40^{o}19’55.29”E).

During the meeting with District Services for Economic Activities (SDAE), the SDAE technician informed the survey team that there are two forest concessions in the district, located respectively in the Administrative Post of Pundanhar (outside the Study Area) and in the Administrative Post of Olumbe. Unfortunately, the technician was unable to provide the exact location of the Forest Concession in the Administrative Post of Olumbe, but provided a sketch of the concession known as Jacinto Lopes (see Figure 4.2).

Figure 4.1: Commercial logging from the Jacinto Lopes forestry concession

Using the sketch provided it was possible to identify the location in the south-west of the Study Area and map this forest concession on the vegetation and ecological sensitivity maps (Figures 4.9 & 4.10).

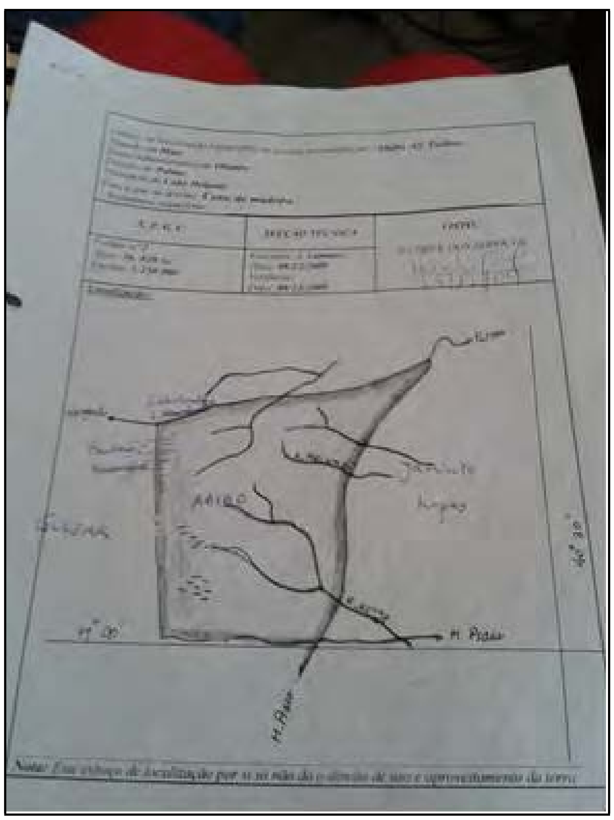


Figure 4.2: Government drawing showing the position of the Jacinto Lopes logging concession

From consultations with authorities there were no other logging concessions identified in the Study Area.
In follow-up visits to the Mineral Resources offices in Maputo, Ms Vicente (CES) identified three current DUATs designated in the Palma region. The coordinates of these DUATs are shown in the table below (Table 4.1) and the positions of DUATs 5836 & 5589 are shown on a map of the Study Area below (Figure 4.3).

Table 4.1: Coordinates of the know DUATs currently assigned in the Study Area

Number of the DUAT License	Owner	Lat. (S)	Long. (E)
5836	R&G Minerais Limitada (Located in Quionga)	10° 37' 30"	40° 13' 45"
		10° 37' 30"	40° 20' 30"
		10° 46' 00"	40° 20' 30"
		10° 46' 00"	40° 13' 45"
5589	Floriano Sozinho Muchabje		
		10° 54' 30"	40° 06' 30"
		10° 54' 30"	40° 12' 00"
		11° 02' 30"	40° 12' 00"
		11° 02' 30"	40° 06' 30"
3417	Africa Yuxiao Development Company Limitada (Not complete, the number of points was high)	Not able to confirm coordinates at this stage	

DUAT 5836, R&G Minerais Limitada, is situated in the north-west of the study are and is centred over one of the densely forested areas.

DUAT 5589, Floriano Sozinho Muchabje, is situated to the west and is outside the Study Area. According to information collected from the Mozambique Government official Bulletin of the Republic, Friday July 19 2013, Series III #58, Floriano Sozinho Muchabje "has the right to conduct prospecting for phosphates and associated minerals in the province of Cabo Delgado district of Palma".

DUAT 3417 is issued to Africa Yuxiao Development. The coordinates for this DUAT could not be confirmed at the time of Ms Vicente's visit. However, it is known that this is a mining organisation involved in heavy mineral sand mining and therefore it could be assumed that the DUAT could be situated in a coastal area. According to information collected from the internet (Macauhub Free News Service, www.macuhub.com.mo), "*The Yuxiao group also has a company set up in partnership with businessman Chuanyou Cong, with stakes of 80 % and 20 %, respectively. The Africa Yuxiao Mining Development Company, which was registered in Mozambique in 2008, is focused on surveying and exploration of mining resources and they have a licence to mine zircon and titanium near Quelimane*".

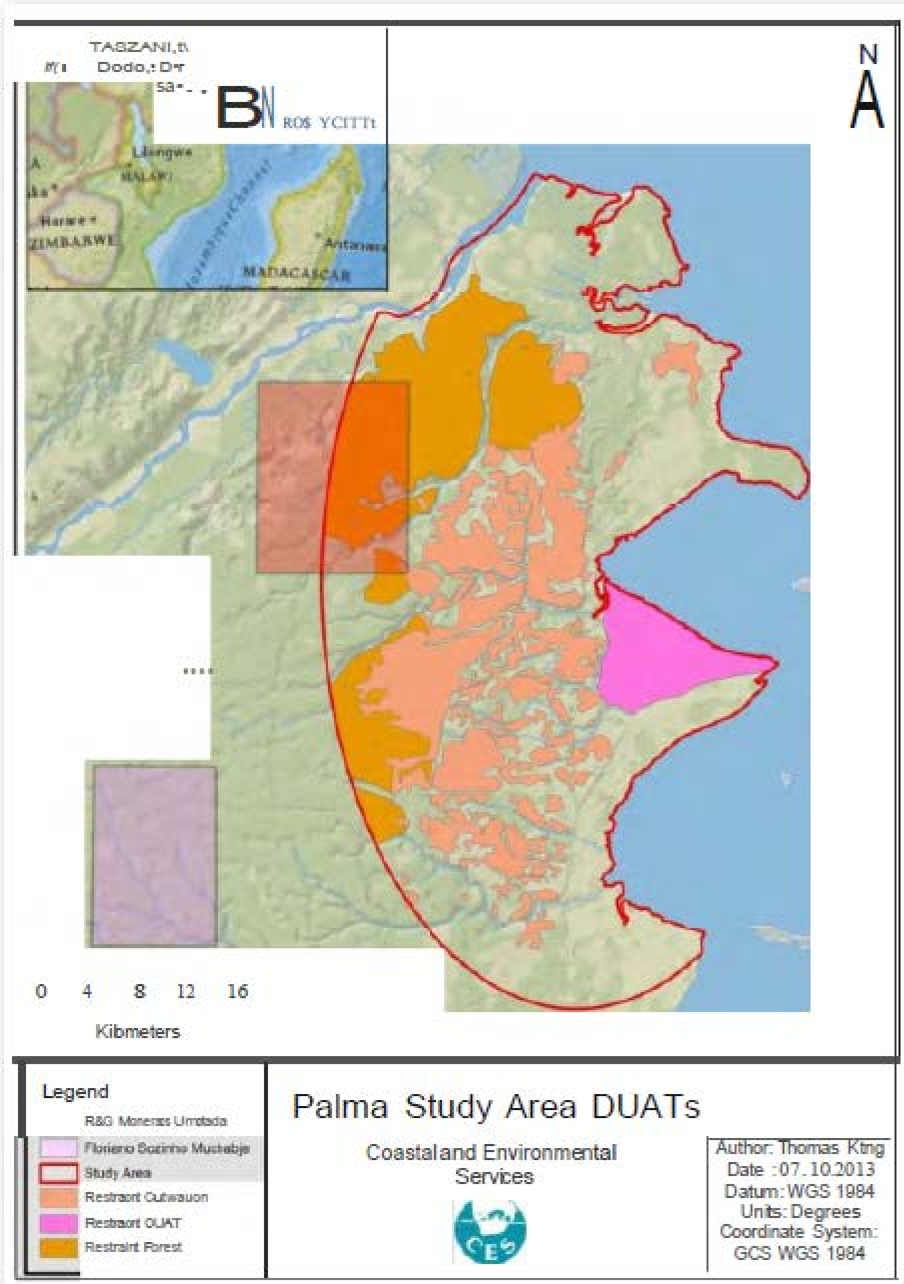


Figure 4.3: Map showing the positions of DUAT 5836, R&G Minerais Limitada, and DUAT 5589, Floriano Sozinho Muchabje in relation to the Study Area

Prior to the start of the Rapid Assessment Field Survey it was understood that there was a mining concession (DUAT) allocated to the mining company Rio Tinto, which was situated in the north-central area of the Study Area. This might effectively preclude a large proportion of this area from being considered as a potential resettlement site. However, following consultations with the National Directorate of Mines in Maputo, it was established that the Rio Tinto's DUAT had expired in 2003 and that there has been no application to extend this DUAT in Rio Tinto's name. As such, this was no longer considered a constraint.

In addition, the SDAE technician informed that there are still many requests for land use rights (DUATs) for agricultural projects, but these have not yet been approved. He also informed that there are no game reserves in the district. However, there are many plans for development of the tourism sector, but presently they are restricted only to the islands and associated coral reefs.

4.1.2 Agricultural Land Use

Historically agriculture and fishing have been the mainstay of the economy for this region (ERM & Impacto 2012). The cultivation of land has been practiced for a number of generations, as evidenced by the extensive land working and land scars (slow recovery of cultivated land) where the vegetation has been cleared by slash-and-burn agricultural practices for subsistence crop cultivation.

It was important for this survey to ground-truth the current extent of the agricultural land use activity within the Study Area with reference to the areas with settlements and cultivated land, as previously identified by WorleyParsons (2013).

It was apparent from observations made during the field assessment of the western side of the Study Area that there were numerous newly cleared areas within the dense forest. Many of these had not been previously identified from aerial/satellite imagery by CES or WorleyParsons. Many of these areas had been cleared to obtain building poles (see Natural Resource Use below) and some of these areas had been further cleared to create new agricultural plots.

On returning from the field survey additional observations of human activity in the Study Area were reassessed using the latest satellite imagery from Bing maps. It was observed from this imagery, which was more recent than that available via Google Earth, that the anthropomorphic activity in the Study Area was considerably more extensive than had been originally mapped on the "Dry Forest" constraints map provided by WorleyParsons (June 2013).

In the constraints map produced by WorleyParsons (May 2013) the area designated as Dry Forest covered and area of approximately 35540 ha, while in the map produced by CES (August 2013) following the reassessment of land clearing from satellite imagery, the equivalent "Dense Forest" area covered only 29360 ha, representing a reduction of 6180 ha.

Based on observations in general across the Study Area the most commonly grown crops observed growing were cassava, millet, and maize, most of which is grown during the rainy season (November to April). During the drier season, cultivation of rice can be found in many of the wetland areas and pans where water is available for a majority of the year (Figure 4.4). Further information on each of these key crop types is provided below.

Figure 4.4: Rice being cultivated in a wetland along the R6 road

Cassava

Cassava (*Manihot esculenta*), also called manioc, is the third-largest source of food carbohydrates in the tropics, after rice and maize. Cassava is a woody shrub of the Euphorbiaceae (spurge) family, and is extensively cultivated as an annual crop in tropical and subtropical Africa for its edible starchy tuberous root. It is also one of the most drought-tolerant crops with the capability of growing in the climatic conditions and soils found in the Palma area (Figure 4.5).

Figure 4.5: Cassava crop grown extensively in the Palma region

Millet

Millet is a member of a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for both human food and fodder. It is an important crop in the semi-arid tropics of Africa where the crop is favoured due to its high productivity and short growing season under dry and high temperature conditions. Millet is not only adapted to poor, droughty, and infertile soils, but they are also more reliable under these conditions than most other grain crops. This has, in part, made millet production suitable for the climatic and soil conditions found in the Palma area (Figure 4.6).

Millet does respond well to increased soil fertility and moisture. On a per hectare basis, millet grain produced per hectare can be two to four times higher with use of proper irrigation and sustainable soil supplements. This makes it a valuable crop in areas where there is access to fertilizers and irrigation.

Figure 4.6: Millet typical of the Palma region

Maize

Maize was introduced into Africa in the 1500s and has since become one of Africa's dominant food crops. Like many other regions, it is consumed as a vegetable although it is a grain crop. The grains are rich in vitamins A, C and E, carbohydrates, and essential minerals, and contain 9% protein. They are also rich in dietary fibre and calories which are a good source of energy. Maize accounts for
30−50% of low-income household expenditures in Eastern and Southern Africa, but heavy reliance on maize in the diet, however, can lead to malnutrition and vitamin deficiency diseases such as night blindness and kwashiorkor.

Maize is the most widely grown grain crop in Africa because of its ability to grow in climatic and soil condition found here. However, because of its shallow roots, maize is susceptible to droughts, intolerant of nutrient-deficient soils, and prone to be uprooted by severe winds. The importance of sufficient soil moisture is shown in many parts of Africa, where periodic drought regularly causes maize crop failure and consequent famine.

While maize is grown across the Palma region, the sandy free-draining soils typical of the area do not make it ideal for growing maize and since most maize production in the area is rain fed and any irregular rainfall can trigger famines during occasional droughts.

Rice

Mozambique's hot to warm moist climate is suitable for rice production as it fulfils all the requirements of the crop. However in the Palma region the majority of the soils are of a permeable sandy natural with poor water retention. Consequently the growing of rice in the area is limited to wetlands, pans and riverine areas which retain water for a majority of the year.

4.1.3 Other Agricultural Practices

Fruit trees, in particular mango (*Mangifera indica*), were dominant in the area and occasionally orange trees were seen growing in a number of villages. Cashew nut (*Anacardium occidentale*) was also a dominant tree throughout the area and these were evident in and around most villages (Figure 4.7). The spread of these trees around the area may have been due in the past to distribution by elephants (Azam-Ali & Judge, FAO 2004).

Figure 4.7: Cashew trees (Anacardium occidentale), very common throughout the Study Area

4.1.4 Natural Resource Use

As mentioned above and as observed during the survey, the local communities in and around the Study Area rely on the dense forest areas for the provision of building materials. With increasing demand for food much of the forested areas that have been recently cleared, initially for wood, are now being prepared as new agricultural plots.

The production of charcoal was commonly observed in most of the villages situated in the forested, western side of the Study Area and vehicles and bicycles loaded with charcoal bags were frequently seen moving towards the commercial markets in and around Palma. It could be seen on racks for sale on the side of the main road (247) running from Quionga to Mocímboa da Praia (Figure 4.8).

Firewood is still the main source of energy for cooking (ERM & Impacto 2012) but with greater access to the forested areas from the upgrade of roads it would appear that more charcoal is making its way towards the major towns such as Palma.

Figure 4.8: Charcoal for sale on side of the main N247 road

The cutting of trees for firewood and building poles was also evident. Figure 4.9 shows extensive pole cutting which was observed in the densely forested area along the recently improved and widened Road 15 heading north-west (Figure 3.8).

Figure 4.9: Evidence of extensive pole cutting in the dense forest along R15 road

Many of these poles were young msasa, *Brachystegia spiciformis*, which tends to grow tall and straight with an appropriate width for building poles. These poles were transported out of this area by tractor and trailer. As mentioned above, this appeared to be a very recent operation and seemed to be a consequence of the upgrading of Road 15, which provided the local communities with an easier access to the forested areas. All the appropriate trees for poles had been cleared from within approximately 200m either side of the road.

The extent of the pole cutting suggests that there is a demand and ready market for this resource. If new roads are established throughout the densely forested areas, then this resource may well be over- utilised. As such, the planning of new roads for access to potential resettlement villages should be carefully considered.

Fishing

In order to gather first-hand information on the fishing activities currently practised by the communities within the Study Area, a number of fishing villages were visited, namely Quiwiya, Mbuize, Quionga, Quirinde, Mbauala and Mangandja (see Figure 3.6 above).

Some informal interviews were conducted to gather general information on fishing practises and activities in the area. During conversations with the fishing communities no reference was made or questions asked concerning possible resettlement or the potential of other fishing villages being relocated close to current fishing villages.

In general, the fishermen catch fish, shrimp, octopus, lobster and calamari (Figure 4.10). The catches are mainly for consumption within the villages but some fishermen will sell their catches if someone comes to the village looking to buy fish. There is a small number of commercial fishing groups who will share the waters with the local fishermen.

All the fishing villages visited were densely populated and, as mentioned, the fishing areas often received fisherman coming from different areas. The preferred fishing grounds are the shallow near-shore waters, the surface of the deep offshore waters, sand banks, coral reef/rocky areas and sheltered areas including seagrass beds, bays, small creeks, as well as around the edges of mangroves and associated channels.

Fishing is practiced throughout the year. Most activity is during the day time with the exception of night fishing which is practiced according to the phases of the moon. There is also increased fishing activity at the time of the spring tide which sees greatly increased numbers of fish in the sea around the Study Area.

The majority of the fish caught were processed by salting and then sun-drying them.

In many of the villages, women and children are engaged in collecting invertebrates in the intertidal zone. Intertidal collection of marine invertebrates (molluscs and octopus) is widespread in the area and is practiced on all accessible beach fronts in the area, including the adjacent islands. The activity is mainly a subsistence activity, although some of the collected shells are sold to supplement incomes or on a low-key commercial basis if interested buyers come to the villages. Participants are mostly women and children, but do include some men. Processing of molluscs is done by cleaning, boiling and sun- drying (Figure 4.9).

Figure 4.10: Fish and mollusc sun-drying at Mangandja Village

Following the casual interviews with the fishing communities it was reasoned that the following conditions should be available to fishing communities that will be resettled from the Afungi DUAT.

- The availability of fish and the distance from the fishing grounds are of concern to all fishermen who preferred to be no more than 2km from the sea.

- Many of the fishing villages are located such that they are close to fishing grounds but also tend to be in areas that provide sufficient land for housing, have access to fresh water and suitable sewage disposal sites (i.e. ground in which to dig pit-latrines).

- The fishermen who sell commercially tend to walk to markets but would like to have better transport links and facilities between the fish landing places, collection points and market outlets in order to make their businesses more profitable.

Graves and Sacred Sites

Without being able to ask local communities about the locations of graves and sacred sites, combined with restricted movement off the roads, it was difficult to identify the locations of these features.

However, two sites of potential spiritual significance were encountered during the survey. There was a grave site located on the edge of a footpath between two villages consisting of three graves marked with small wooden signs. It could have been very easily overlooked.

There is a sacred forest situated on the coast near the village of Mbuize, north of Palma Town at $10^0$39'40S and $40^0$34'31E.

Conservation and Protected Areas

A desktop study was conducted to identify the presence of any nationally or regionally protected areas which may exist within the Study Area and therefore be a constraint on selecting an area for the establishment of a resettlement village. There were no protected areas shown on the constraint maps of the Study Area as produced by WorleyParsons.

Figure 4.11 shows all the protected areas in Mozambique and also shows a more detailed picture of the protected areas within Cabo Delgado.

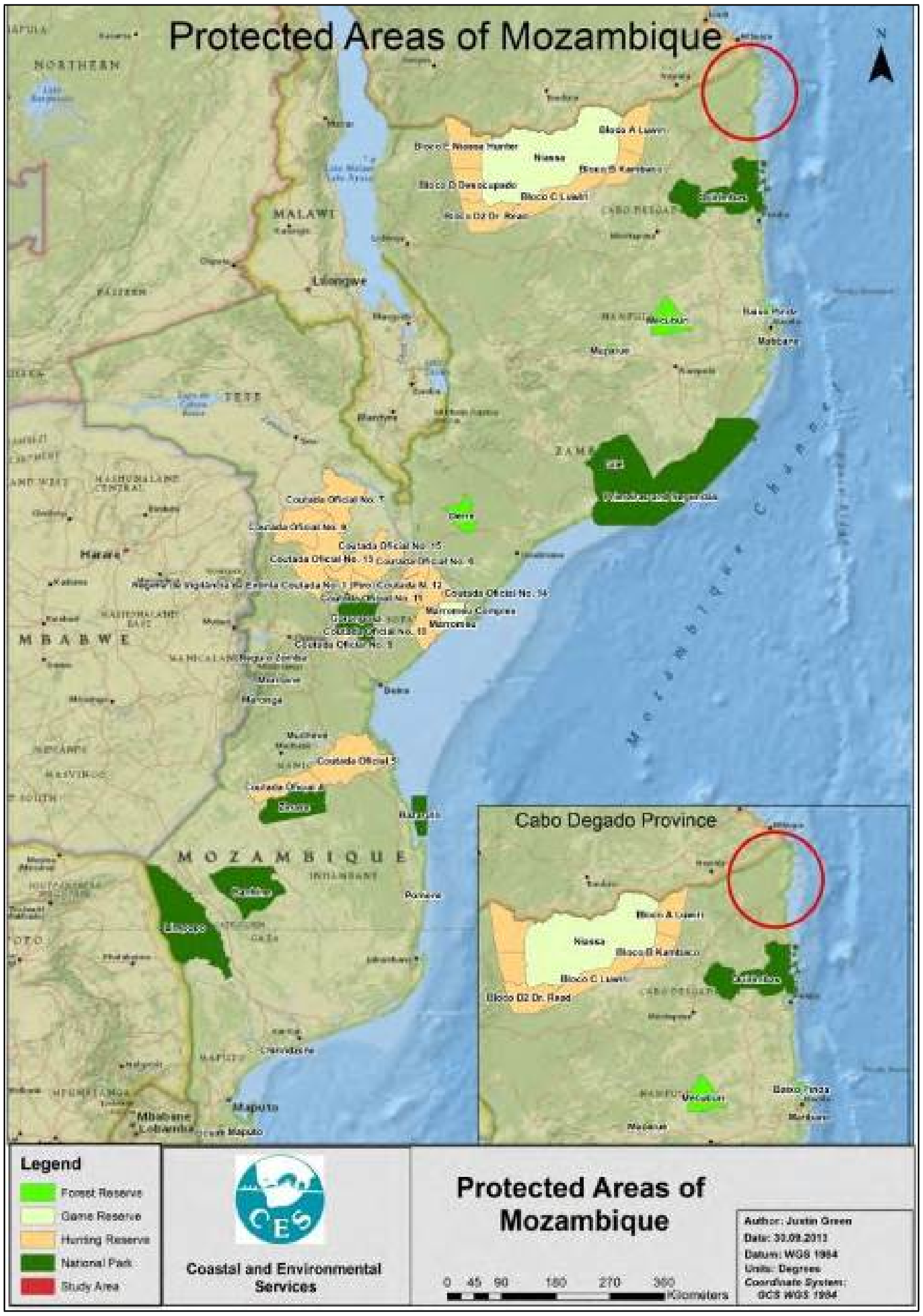


Figure 4.11: Protected Areas of Mozambique

From Figure 4.11 it can be seen that there are no protected wildlife areas within the Study Area which could be considered constraints on the project.

The nearest protected wildlife area to the Study Area is the Quirimbas National Park situated approximately 80kms to the south.

In 2007 MICOA were considering the establishment of the Rovuma Reserve which would have included some of the northern areas of the Study Area (ERM & Impacto 2012). However, the proposed reserve has not been given any further consideration to date.

Important Bird Areas

According to BirdLife International (http://www.birdlife.org/datazone/country/mozambique/ibas 2013) there are no Mozambique Important Bird Areas (IBAs) near the Study Area. The nearest IBA is Manzi Bay which is situated in Tanzania just north of the Rovuma River and the Study Area (Figure 4.12).

However the Study Area still provides important habitats for a number of bird species. For example Wattled Crane (*Bugeranus carunculatus*), listed as 'Vulnerable' by the IUCN, were seen in the Study Area. This is discussed further in Section 4.4 Vegetation and Ecology, below.

Figure 4.12: Important Bird Areas near the Study Area (red circle) (from Birdlife International)

RAMSAR Sites in Mozambique

There are two RAMSAR sites in Mozambique:

1) Lake Niassa and its Coastal Zone (Lago Niassa e Zona Costeira). 26/04/11; Niassa Province;
1,363,700 ha; 12º30'S 034º51'E. and;

2) Marromeu Complex. 03/08/04; Sofala, Zambezia; 688,000 ha; 18°35'S 035°56'E. Comprising the protected Marromeu Buffalo Reserve (Reserva Especial de Marromeu) and four surrounding hunting concessions shown in Figure 4.11.

The nearest of the two RAMSAR site to the Study Area is Lake Niassa which will not be affected by the project.

Site of Global Importance (WWF)

WWF have established global coastal and marine conservation objectives, which has included the creation of the Eastern African Marine Ecoregion (EAME), spanning from Somalia to South Africa, along 4,600 km of coastline [EAME, 2004]. This WWF site is situated in the oceans off the coast of the Study Area.

Within the EAME a total of eight sites of global importance were identified, including the Mtwara-Quirimbas Complex, located across the Tanzania/Mozambique boundary.

The Mtwara-Quirimbas Complex (which includes Mnazi Bay, Ruvuma Delta and Quirimbas reefs to
Pemba) is considered a site of global importance for the following
reasons:

- It possesses an extensive complex of reefs with high coral diversity (>48 genera), for example, according to the marine habitat survey of the ERM & Impacto EIA (Chapter 7), three locations along the Cabo Delgado coastline from Vamizi Island south to Medjumbe Island, Acropora aspera (a staghorn coral) was identified and this species is categorized as Vulnerable according to the IUCN (2010) red list;
- It is an important turtle feeding and nursery site and feeding area for Crab Plovers and migratory birds;
- The unique Ruvuma dunes system with likelihood of rare or endemic flora and;
- It is an important nursery area for Humpback whales.

UNESCO sites in the Study Area

From detailed internet searches and the literature reviewed for the Afungi Peninsular EIA and Fisheries study (ERM & Impacto 2012), there was insufficient information available to confirm whether the coral formations around the Study Area are expected to be classified by UNESCO as Natural World Heritage.

The presence of turtle nesting beaches could justify them being designated as UNESCO sites as all turtles are protected species. No sites of turtle nests have been recorded in the Study Area although five species of turtle are found in the Quirimbas Archipelago, just outside of the Study Area. According to the EIA (ERM & Impacto 2012), the mainland beaches in Palma Bay are steep and the high tide levels extend to the top of the beaches make them unsuitable for turtle nesting, as nests will have a high probability of flooding. However turtle nesting has been recorded on Rongui Island and is also reported to occur on Tecomaji Island.

4.2 Hydrology and Geohydrology

The Study Area is characterised by deeply incised river channels and multiple depressions that form the many wetlands and pans covering much of the Study Area (Figure 4.13).

The vertical profiles of ten valleys in the Study Area clearly visible in the digital terrain model for the area were surveyed (Figure 4.14). Each of the valleys was surveyed at approximately 10m intervals using a handheld GPS that was calibrated at the start and end of each track using the Palma base camp Trig Beacon (51m). The cross-sectional profiles are shown in Figure 4.15.

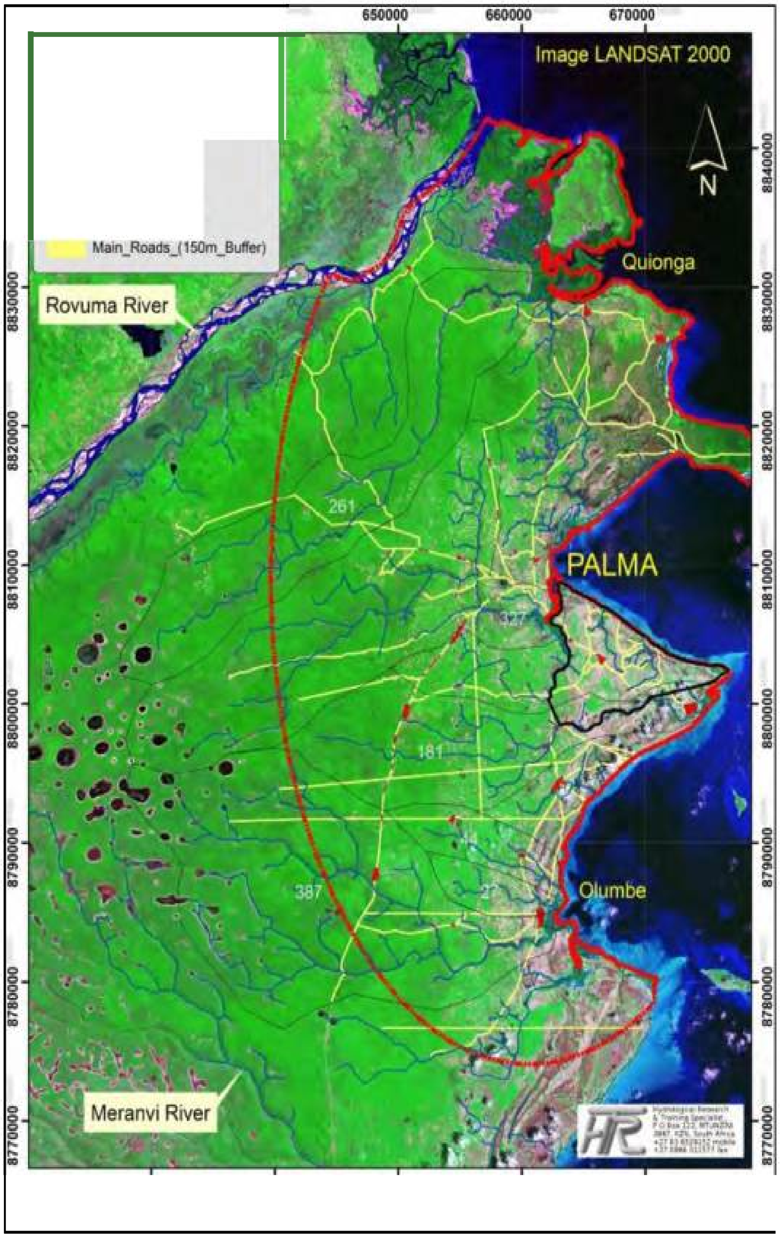


Figure 4.13: Landsat 2000 image of the Study Area shown with the main towns to the north and south of Palma together with other important hydrological features

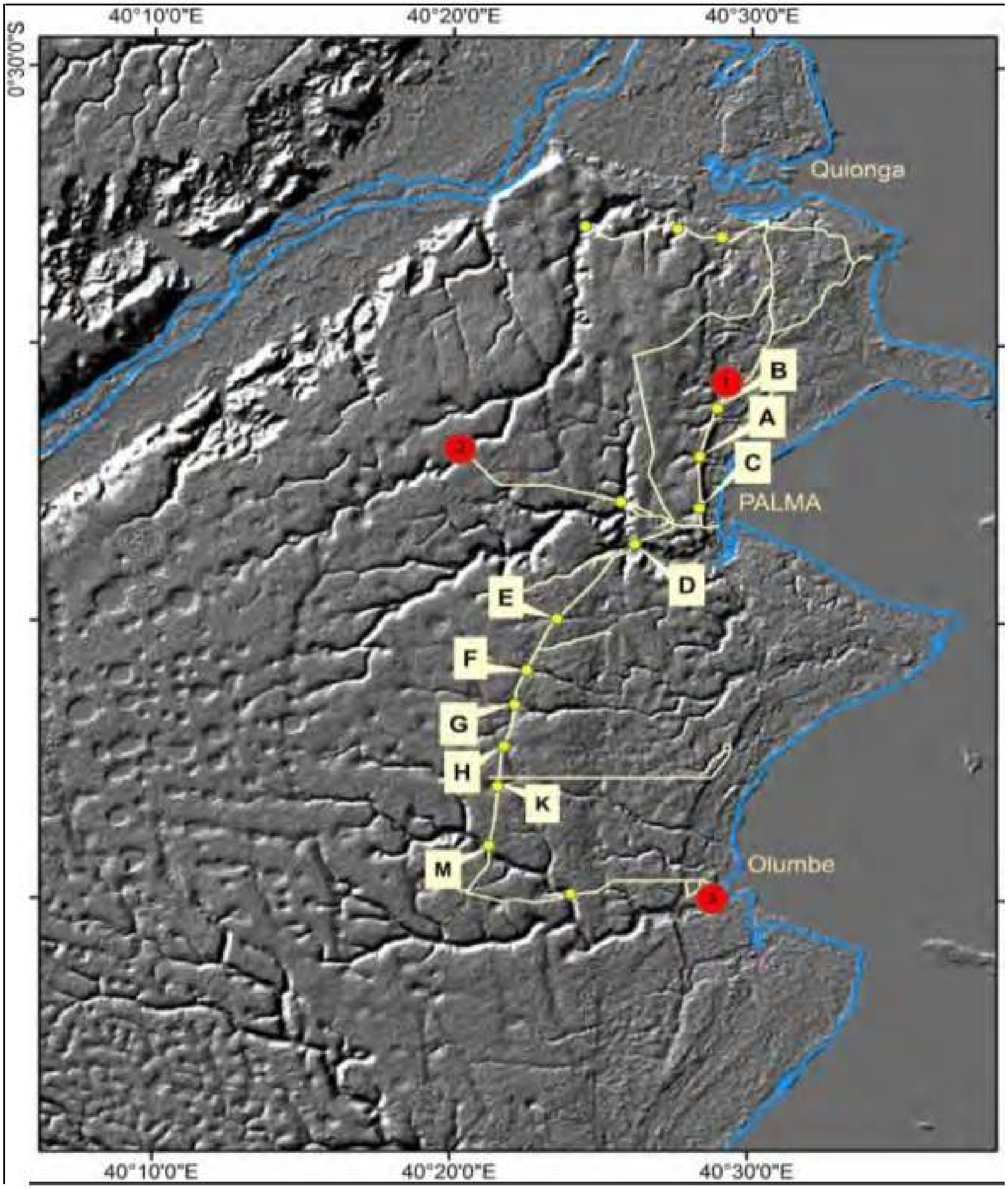


Figure 4.14: OEM and GPS tracks. Letters show the location of the river valley labelled in Figure 15. The large red dots show the location where river runoff/flow was detectable but could not be measured accurately. The smaller yellow dots show the road crossing (culverts) where water was present but no river flow was detectable

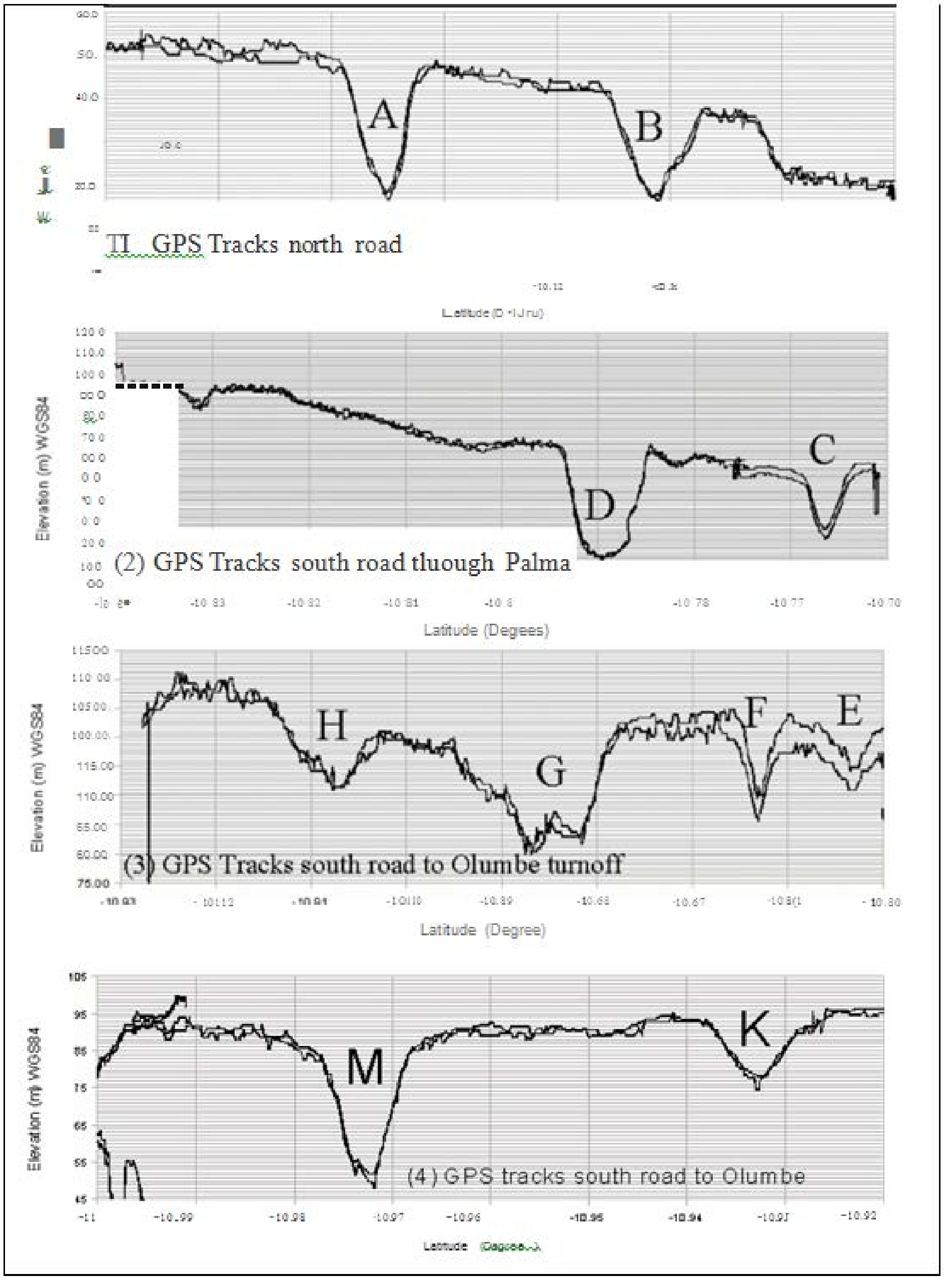


Figure 4.15: The GPS outward and return tracks to the north (1) and south (2&3) of the Palma Study Area showing the elevation profile of the terrain, including ten individual river valleys

Rivers

All road/river crossings (culverts) encountered within the Study Area were inspected and it was determined that there was no flowing water in most with the exception of three culverts the locations of which are indicated by red dots in Figure 4.14. The three sites with identifiable flow are described below.

Site 1: Observed along the northern road from Palma to Quionga. The culverts were approximately 1m wide and 1 m deep. The flow was estimated at 10m^3/day at the tributary crossing (Figure 4.16). The wetland adjacent to the second culvert on the same river (different tributaries) may have had some flow but it was not possible to measure the flow direction or rate.

Figure 4.16: Site 1: River crossing with ~10m3/day runoff on 25/06/2013

Site 2: Several small streams were crossed on the road to the west of Palma but only one had any detectable flow into a wetland (Figure 4.17). The flow was estimated to be about 20m^3/day.

Figure 4.17: Site 1: River crossing at Site 2 showing flow into the wetland

Site 3: The estuary draining into the Indian Ocean just south of Olumbe had flow at several points across the road crossing (Figure 4.18). Results from the laboratory analysis for selected ions shows very high concentrations for sodium and chloride indicating that the flow at this location is most likely to be the tidal return flow. The rate was estimated at 100 m^3/day at one section (11° 00' 27.20"S & 40°
28"24.72" E), but this was not considered a true reflection of the flow rate in the river. The reason for this was that no flow was observed at several road crossings upstream of the estuary so it must be assumed that the flow rate in this river was negligible during the reporting period.

Figure 4.18: Site 3 river crossing that was tidal with the possibility of some freshwater flow estimated at <100m3/day) from right to left

There has been significant damage to the road culverts at Point D (Figure 4.14 and 4.19 below), which appears to have been caused by erosion. This would suggest that there can be large flood events in this river during the summer rainfall period. The construction of large road culverts on the main road from Palma to Olumbe turn-off (Figure 4.19) also suggest that there can be large runoff events although there was no clear evidence of a river channel at these sites.

Figure 4.19: Dry road culverts on route from Palma to Olumbe turn-off. (Left) culvert at section D

Pans and Wetlands

There are numerous pans, lakes and wetlands observed across the Study Area, particularly in the higher regions to the west of Palma. These wetlands are used for both water supply and subsistence agriculture. The valley bottoms of many of the larger rivers in the west of the Study Area have wetlands and shallow groundwater both of which are used for water supply and agriculture where rice is grown in the standing water (see geohydrology section below).

From observations of activity around these pans and wetlands, it appears they are an important source of water for local communities, in particular for those who do not have access to boreholes and hand pumps. A water tanker was observed at the edge of pan to the west of Palma where it is assumed that it was collecting water for a local community. There were numerous hand dug wells around the outer edges of many pans in the area that were being used by the local community for water supply as well as washing amenities (Figure 4.20).

Figure 4.20: A typical example of the local community water supply and use in low-lying areas where the water table is within five meters of the surface

Geohydrology

The Study Area lies on the extensive coastal plain that runs along the east coast of Mozambique. The unconsolidated sediments forming this coastal plain create an extensive primary aquifer that is the main water supply of the local people. There is virtually no sign of surface (overland) runoff at the time of the field survey, although groundwater seepage was observed on the edge of a river channel near Olumbe (Figure 4.21).

Figure 4.21: Groundwater seepage into the estuary south of Olumbe

The aeolian cover sands along the coast are generally very permeable and lead to direct recharge from all rainfall events that are greater than about 10mm over 5 days. Nearly 30% of all historical 10 day periods had rainfall of >20mm (Figure 4.22) that are assumed to lead to significant recharge to the primary aquifer.

Nearly all the rivers were dry during the site visit so it must be assumed that the groundwater profile (gradient) along these drainage boundaries was just beneath the surface as shallow groundwater was observed in the wetland areas.

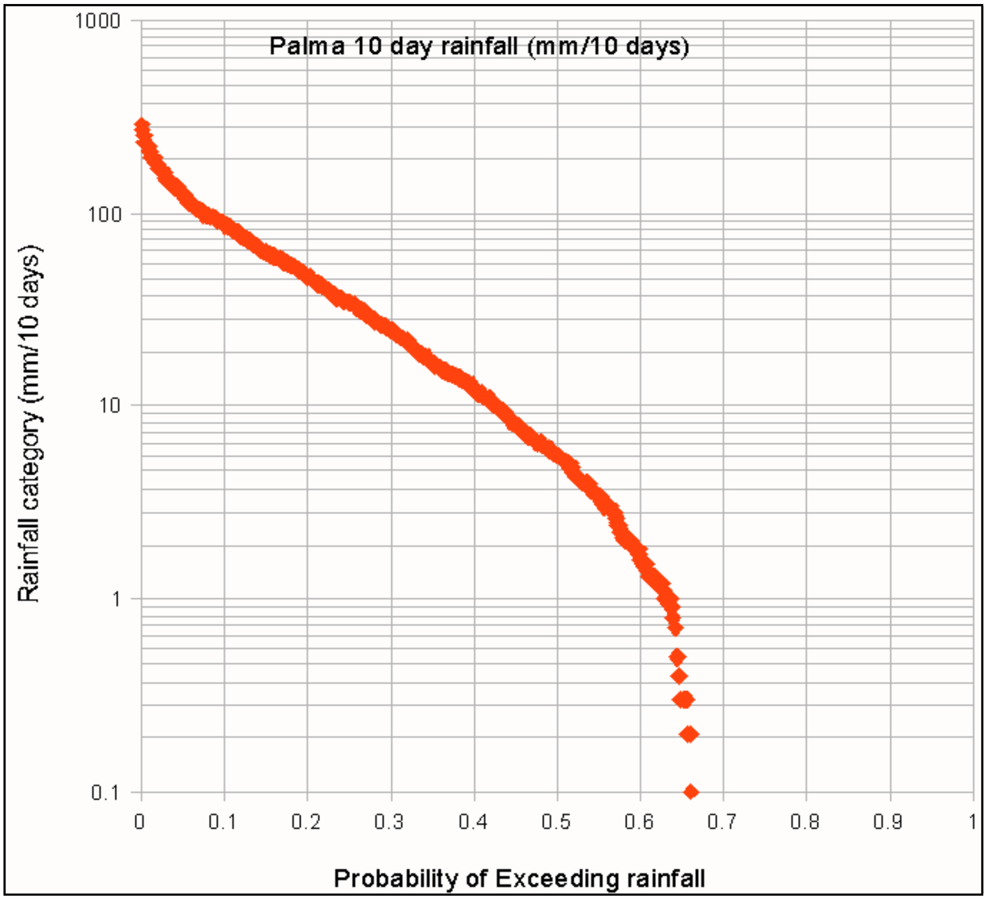


Figure 4.22: Rainfall probability for 10 day events

Groundwater Model

The groundwater model was created using the MODFLOW 2000 code (USGS). The Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) was used to create the surface topography (Figure 4.13). The external boundaries were set along the coastline, Rovuma River, Maranvi River and a no flow boundary to the in-land of the highlands in the west (Figure 4.23).

The SRTM elevation (Figure 4.14) for all the exposed lakes, pans, and open water wetlands were used as initial targets for calibration of the hydraulic properties. The recharge was based on the average seasonal 10-day rainfall (Figure 4.22) and calibrated against the river flow during winter. The flow in summer is unknown so it was not possible calibrate the recharge for the rainy season.

An inverse model (PEST) was used to determine the spatial distribution of the hydraulic conductivity during the parameter calibration. There is a ridge of high conductivities parallel to the Rovuma River and along a north-south transect which general conforms to the Mikindani Formation (TeK).

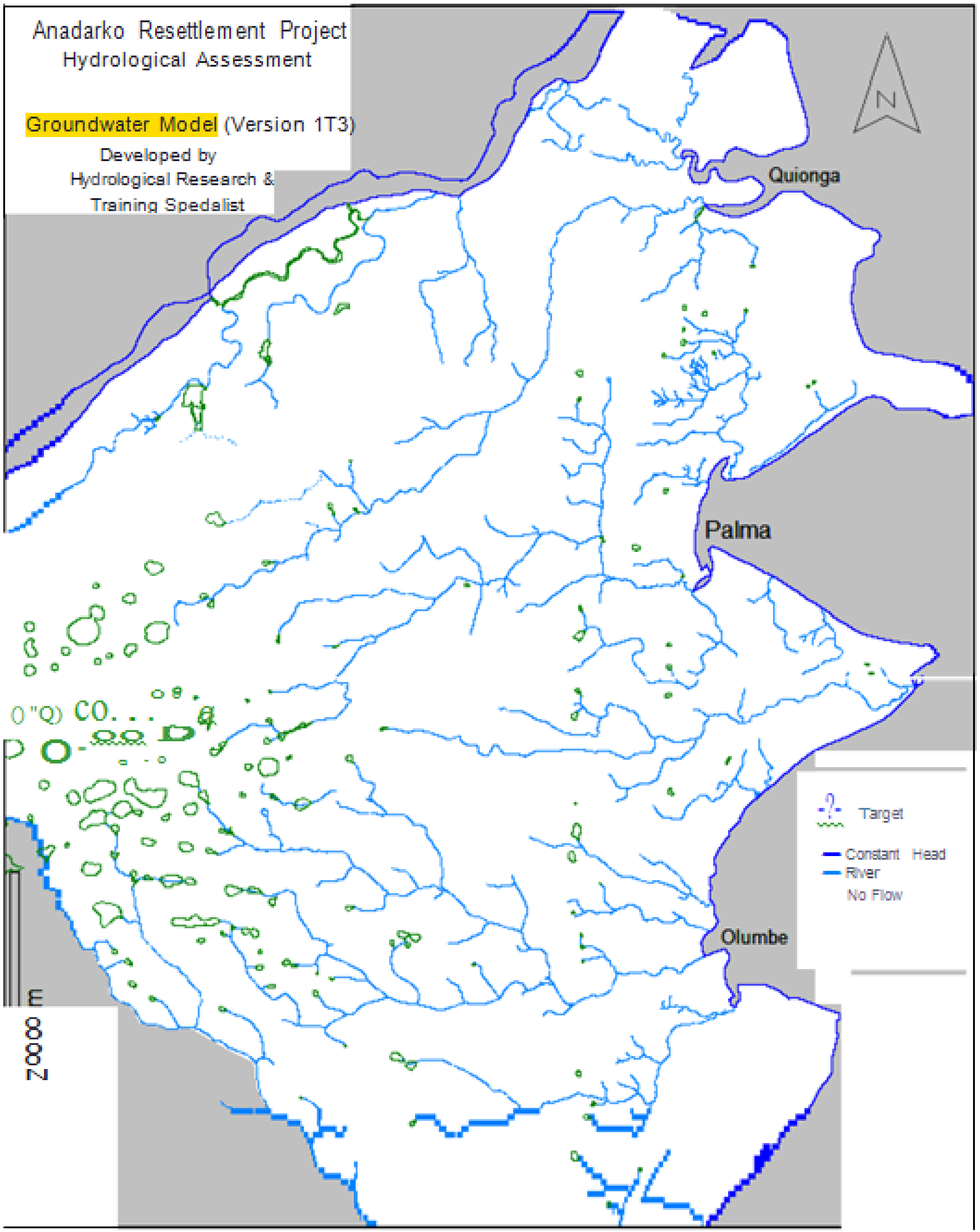


Figure 4.23: The model domain showing the external and internal boundaries of the groundwater model for the Palma area

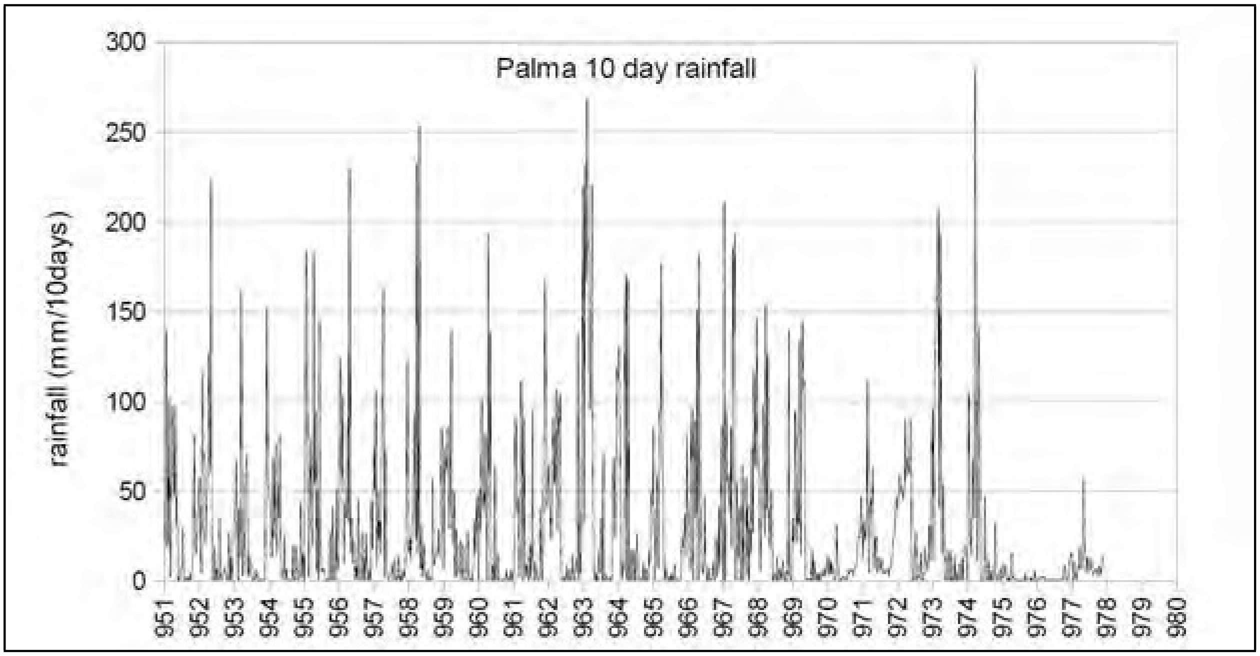


Figure 4.24: Palma 10 day rainfall totals from 1951 to 1977 from INAM (Instituto Naciona de Meteorologia), through the Famine Early Warning Systems Network (FEWS. NET), Africa Data Dissemination Service

The water levels predicted by the model were compared to the SRTM elevations of lakes, pans and wetlands together with other measurement from boreholes in Afungi and the resulting scatterplot is shown in (Figure 4.25). With due regard to the inherent errors in the SRTM data and other assumptions, the model predictions are generally within ±5m across the Study Area. This is considered adequate to assess the depth to the water table which is considered an important factor in community water supply and in identifying areas prone to flooding.

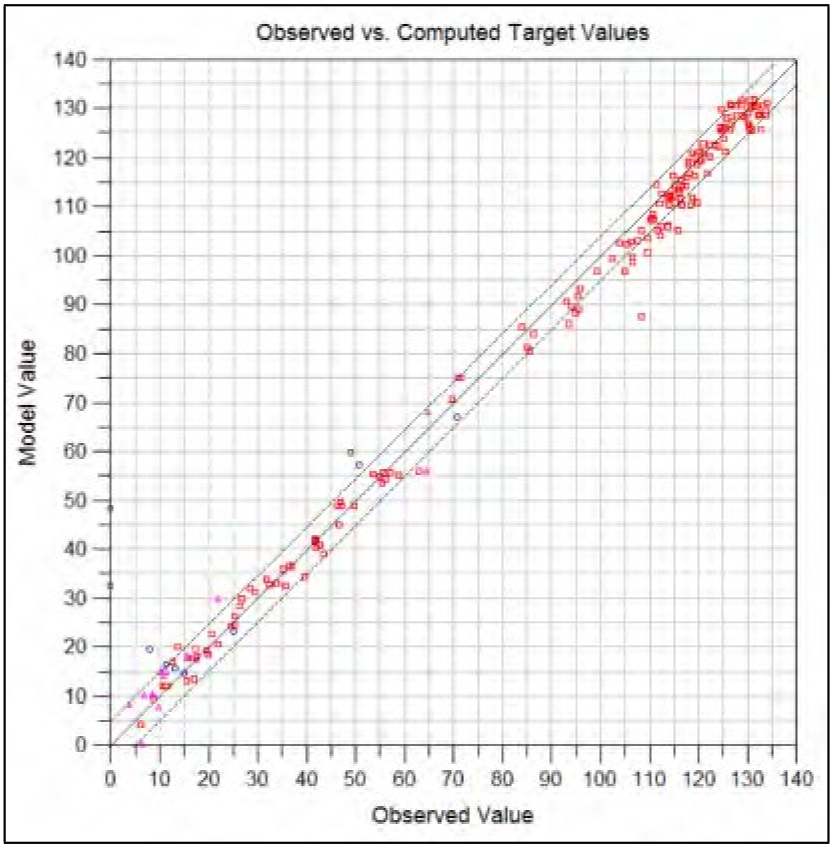


Figure 4.25: The scatter plot of the predicted and measured heads under steady state conditions

The water table contours predicted by the model for the average dry winter season conditions are plotted in Figure 4.25. The steep gradient in the water table profile indicates that the Palma River should have the highest flow rates but it was not possible to find a suitable location to conduct any measurement. The model also indicates that there may be some flow in the upper reaches of the river draining to the sea at Olumbe but that transmission losses of water through the river bed will reduce the flow to considerably reduced volumes at the coast.

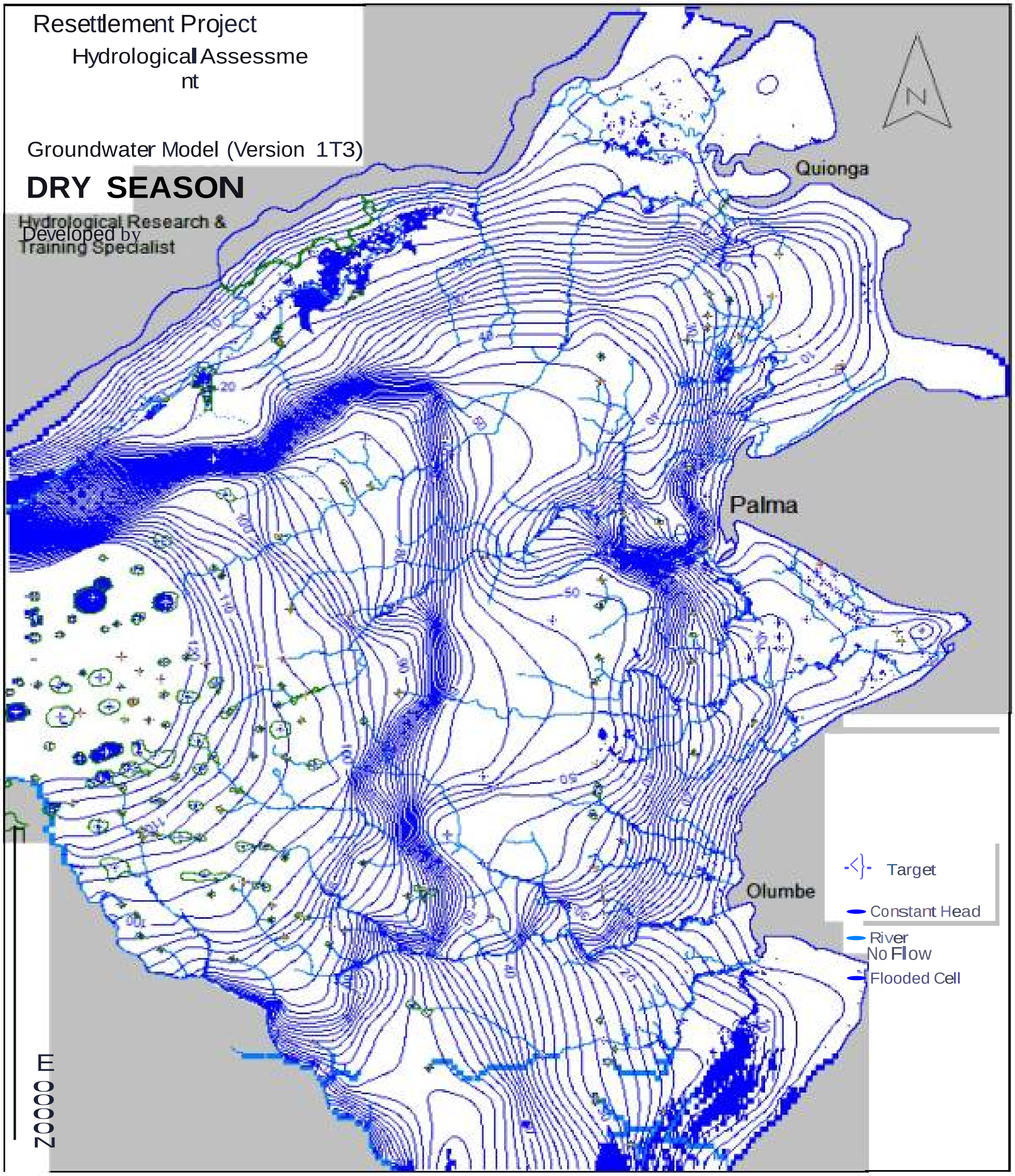


Figure 4.26: The simulated water table contours (mAMSL) for the middle of the dry period

The depth to the water table was calculated for both the average wet summer period and the dry winter period. The simulated flooded areas during these two periods are plotted in Figure 4.26 and Figure 4.27. The model suggests that large sections of the Study Area are prone to surface wetness and potential flooding. In winter the water table drops significantly leaving a much reduced area with surface wetness (wetlands).

It must be noted that as this site visit was restricted to the dry season and comparable seasonal flooding patterns for the summer can only be validated against the very limited available information (maps/reports from limited sites in the Afungi DUAT). However, from observations during the site survey it was apparent that flood level can be quite extensive. For example, the road leading past the wetland area visited on the R6 road (Figure 4.4) was lined with three foot-high sticks which, according to the local residents, were there to indicate the sides of the road during the summer months when the road is under flood water. Other flat areas in the east of the Study Site also showed evidence of previous flood waters (e.g. old Hippopotamus footprints) indicating that, as shown in Figure 4.27, the summer flooding can be extensive.

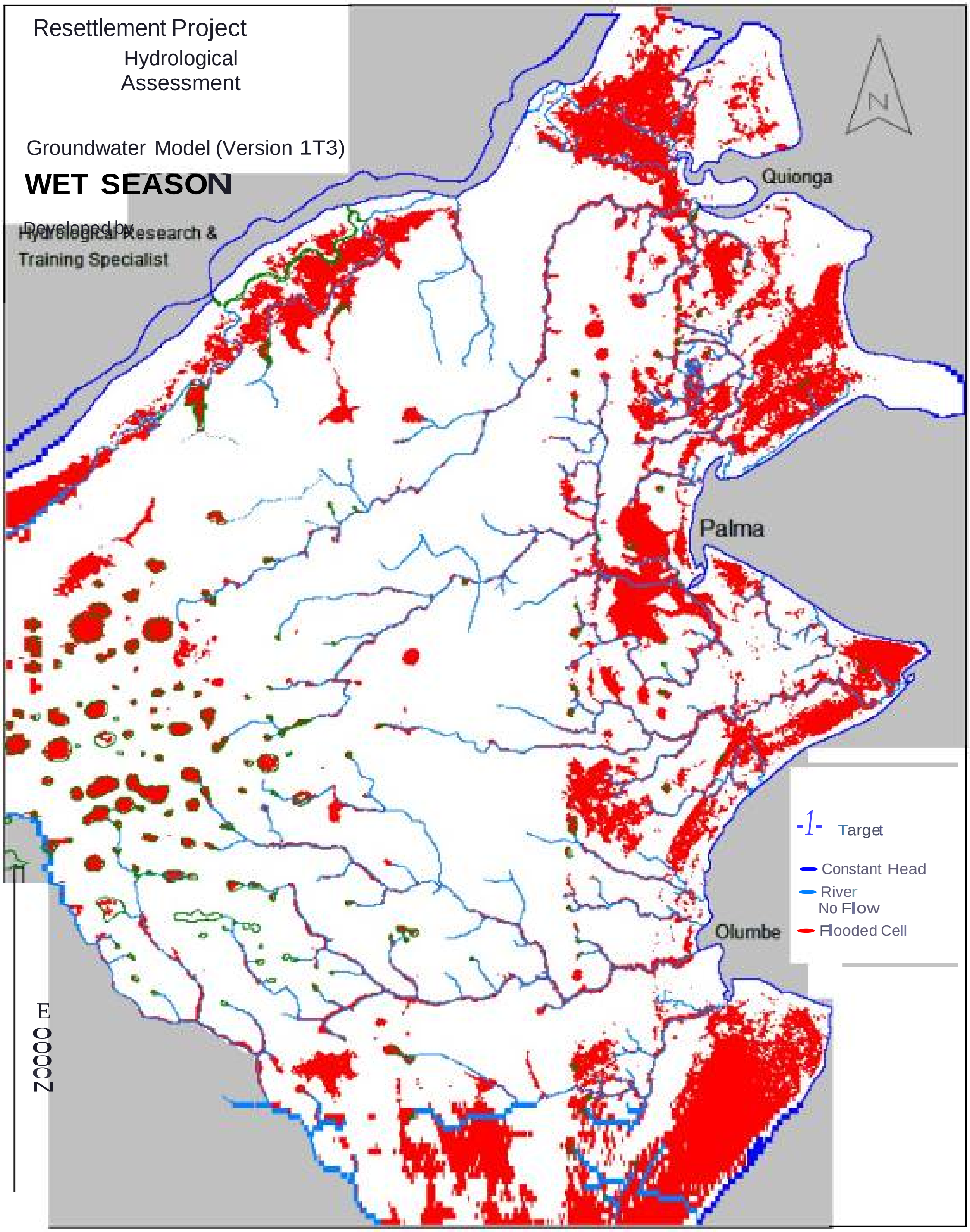


Figure 4.27: The simulated zones (red) where flooding could occur during the WET summer mont

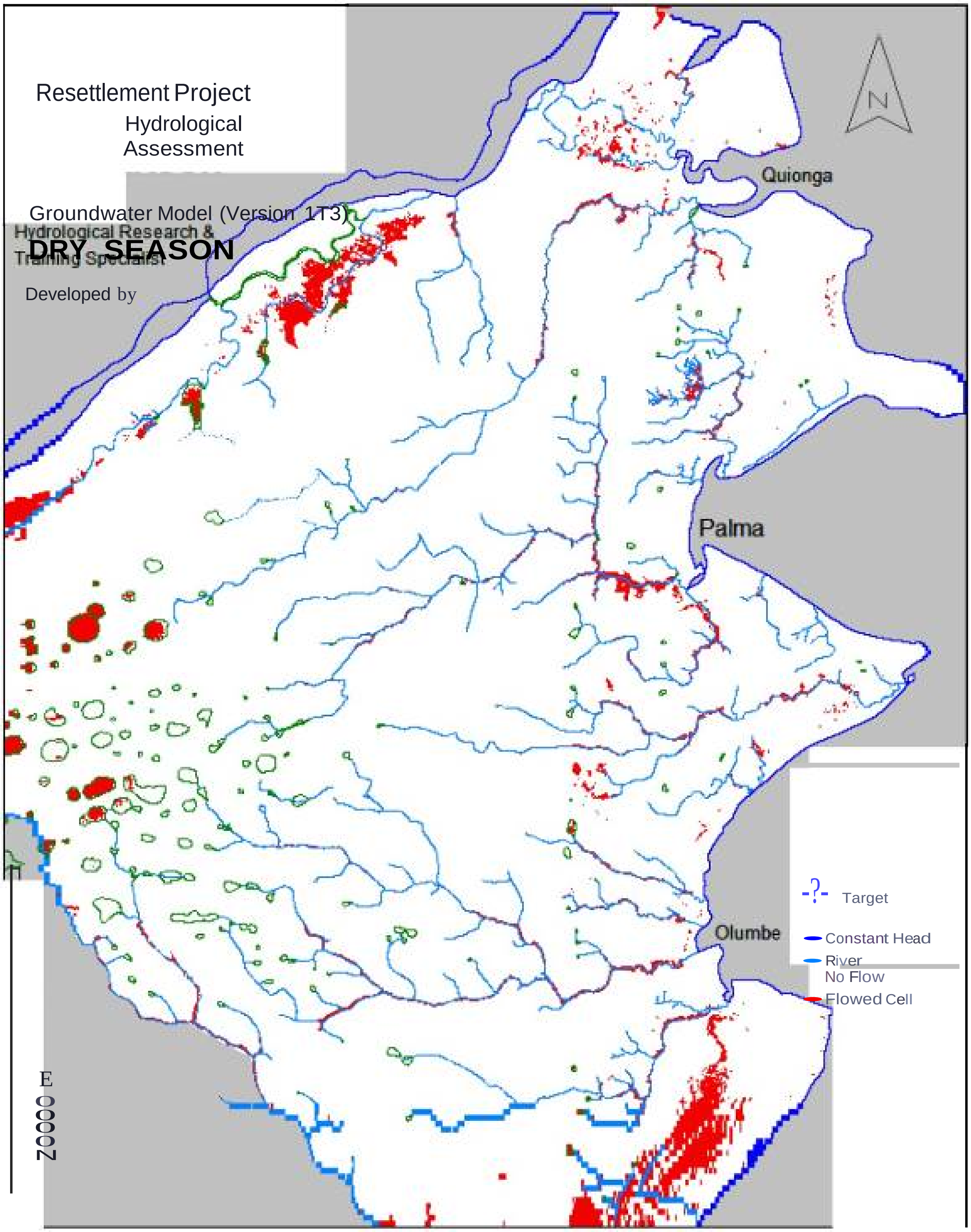


Figure 4.28: The simulated zones (red) where flooding could occur during the DRY winter months

The model was used to simulate the depth to the water table in an attempt to demarcate ease of access to groundwater for the local communities. The depth to the water table is plotted in Figure 4.28 and shows large sections along the coastal margin with the water table close (<5mBGL) to the surface and easily accessible through hand dug wells.

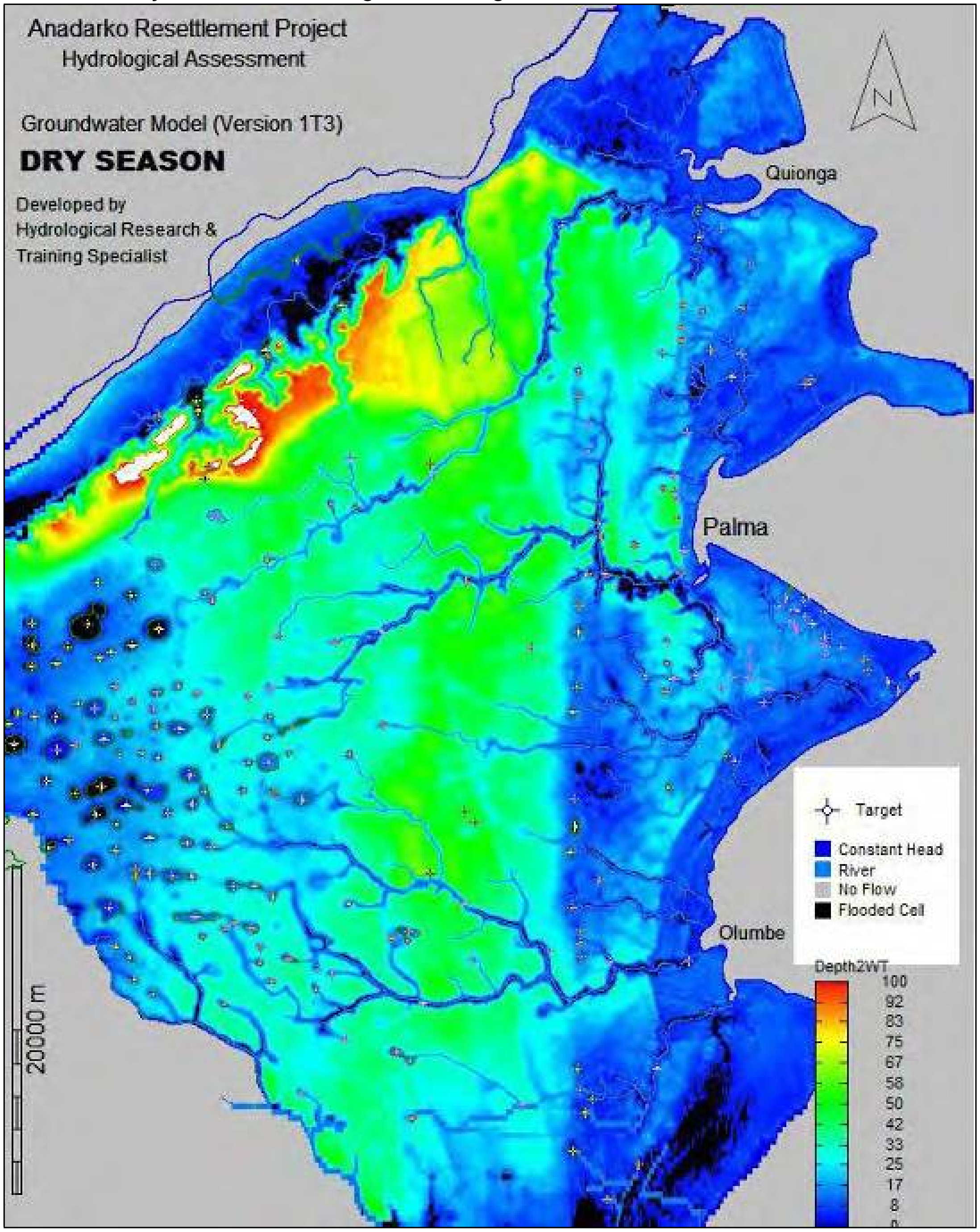


Figure 4.29: The simulated DEPTH (mBGL) to the water table during the middle of the DRY season

Access to the groundwater is only restricted in the Study Area by the depth the water table. Nearly all villages have been provided with boreholes that have hand pumps fitted. While not all of these are in working order for several reasons, they do indicate that groundwater is the main source of supply and is accessible over the entire Study Area. The major physical constraints are the ease of access (depth) and the abstraction rate (potential yield) of the underlying aquifer, and the deeper the water table, it seems the more difficult to extract by handpump.

Water Quality

Twenty one (21) water samples were collected during the field trip for an evaluation of the surface and groundwater quality at the sites shown in Figure 4.30.

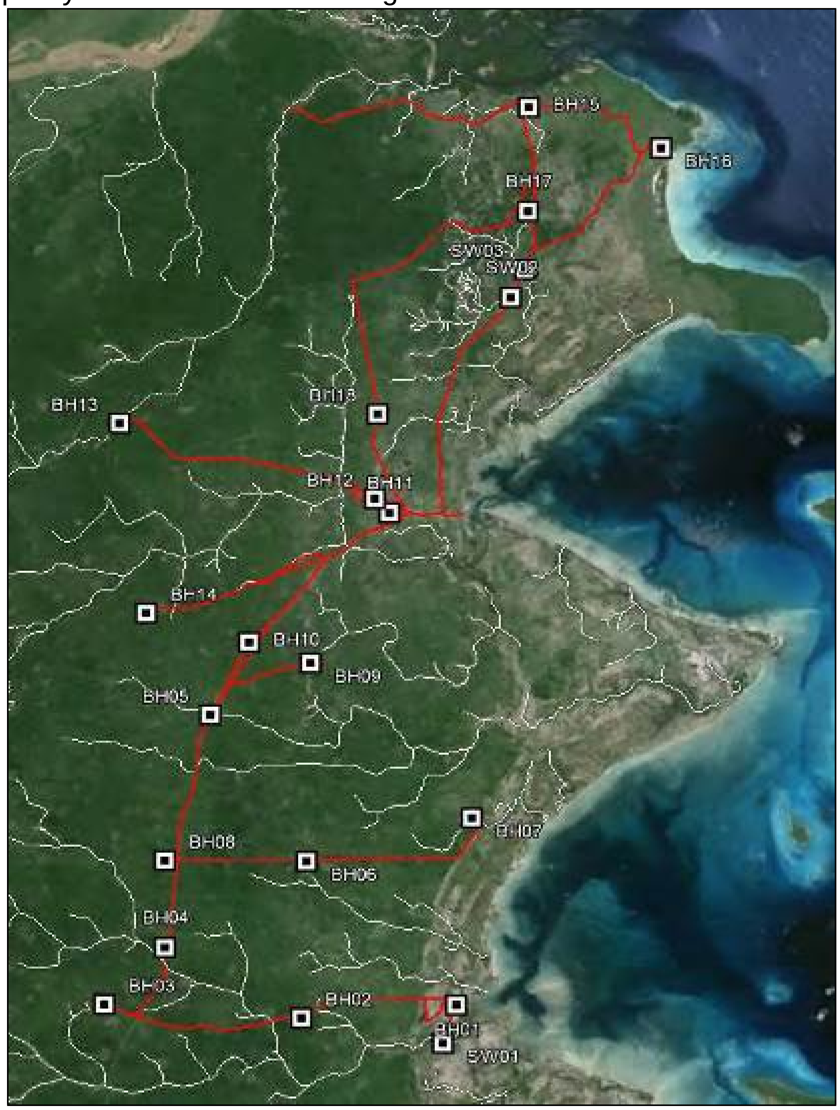


Figure 4.30: The location of all the water sampling points. SW refers to river runoff sites and BH refers to hand pumps, community wells and wetlands

The details of the sample sites are given in Table 4.2. The analytical results are given in Appendix A and summarised in Table 4.3.

Table 4.2: The details of the water quality sampling sites

Sample ID	X	Y	Z	Description
SW1	660966	8782765	5	River/estuary road crossing
SW2	664347	8819017	13	Road culvert
SW3	665013	8820378	16	Road culvert
BH1	661634	8784659	14	Village hand pump in Olumbe
BH2	654430	8784085	51	Village hand pump
BH3	645273	8784824	91	Hand dug well on edge of Pan
BH4	648106	8787559	92	Village hand pump
BH5	650204	8798842	80	Hand dug well on edge of wetland
BH6	654705	8791693	52	Hand dug well in wetland
BH7	662395	8793748	22	Village hand pump
BH8	648125	8791774	98	Mine camp water tank
BH9	654941	8801314	59	Hand dug well on edge of river wetland
BH10	652096	8802333	84	Hand dug well
BH11	658655	8808565	48	Edge of pan
BH12	657977	8809261	55	Excavation pit
BH13	646113	8812963	80	Hand dug well on edge of wetland
BH14	647318	8803760	89	Hand dug well
BH15	665222	8828243	28	Village hand pump in Quionga
BH16	671405	8826261	13	Village hand pump in fishing village
BH17	665156	8823203	20	Wetland
BH18	658126	8813358	60	Village hand pump

Table 4.3: The concentrations of selected ions for stream, wetland, wells and hand pump samples for the Study Area. Also included are the Mozambican and WHO standards for potable water quality

Name	Type	Bicarbonate	Chloride	Boron	Calcium	Iron	Lead	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Tot_Alkalinity	TDS
Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Moz_Std	-	-	250	0.3	50	0.3	0.01	50	50	-	200	400	-	1000
WHO(2011)		-	250	2.4		0.3	0.01		50		200	500		
SW01	Estuary	67	565	0.213	18.0	0.05	0.0000	41.00	0.04	16.00	365.00	62.40	67	1210
SW02	Stream	26	52	0.05	5.9	0.04	0.0000	3.00	0.01	2.40	34.00	3.19	26	139
SW03	Stream	26	41	0.048	3.5	0.17	0.0000	2.20	0.05	3.30	25.00	3.79	26	130
BH01	Hand-pump	21	11	0.022	6.6	0.02	0.0000	1.50	2.41	6.90	6.90	5.60	21	112
BH02	Hand-pump	51	103	0.097	6.2	0.02	0.0000	5.00	0.08	5.60	81.00	23.60	51	354
BH03	Well	53	63	0.056	2.1	0.44	0.0012	1.10	0.34	5.90	151.00	25.80	53	330
BH04	Hand-pump	21	6	0.057	0.0	0.02	0.0000	0.30	3.75	1.30	17.00	4.27	21	136
BH05	Well	30	32	0.048	1.1	0.18	0.0020	0.80	2.09	13.00	14.00	603.00	30	730
BH06	Well	18	20	0.029	1.0	0.03	0.0000	2.20	0.44	2.50	15.00	11.40	18	118
BH07	Hand-pump	18	75	0.034	4.6	0.07	0.0000	3.40	0.04	2.20	41.00	4.73	18	194
BH08	BH Tank	70	142	0.131	8.0	0.04	0.0000	7.50	0.33	6.50	98.00	27.00	70	462
BH09	Well	0	13	0.057	2.1	0.03	0.0000	2.80	0.08	2.10	9.80	16.90	0	142
BH10	Well	17	7	0.056	0.0	0.07	0.0000	0.40	0.10	0.70	9.20	3.28	17	98
BH11	Pan	102	117	0.142	13.0	0.04	0.0000	12.00	0.05	13.00	75.00	11.40	102	374
BH12	Pit	18	27	0.064	1.3	0.01	0.0000	1.00	0.04	2.20	20.00	5.49	18	116
BH13	Well	51	17	0.035	2.0	0.15	0.0000	3.50	0.04	0.90	22.00	2.55	51	116
BH14	Well	0	11	0.024	0.3	0.04	0.0000	1.10	0.12	2.60	7.40	5.02	0	64
BH15	Hand-pump	0	57	0.038	15.0	0.04	0.0000	9.80	20.20	15.00	32.00	9.98	0	296
BH16	Hand-pump	285	70	0.062	81.0	0.03	0.0000	13.00	7.07	5.30	41.00	23.70	285	490
BH17	Wetland	15	25	0.065	0.7	0.31	0.0000	1.20	0.04	5.30	16.00	6.66	15	144
BH18	Hand-pump	62	161	0.025	15.0	0.04	0.0000	13.00	0.40	6.80	78.00	4.03	62	450

The water sample from the road crossing at the estuary (SW1) shows high salinity levels indicating that there is an associated marine influence. The samples taken from the other two streams that were flowing just north of Palma (SW2 and SW3) were will within Mozambique and WHO potable water quality standards.

The hand dug wells generally had lower concentrations of all ions when compared to the hand pumps. The average of the TDS concentrations for all hand pumps was 290mg/l which was marginally higher than the TDS concentrations for the hand dug wells (230mg/l) where there was much greater risk of contamination from detergents where the well is used for washing clothes, for example. This difference could have been significantly larger but for the very high sulphate levels in the one hand dug well at BH5 just south of Palma. It is probable that the shallow groundwater (represented by the hand dug wells) reflects the influence of the direct recharge (with short residence time) when compared to the longer residence time in the deeper aquifer (represented by the hand pumps).

Based on chemical parameters alone, generally the groundwater in the hand dug wells and hand pumps is potable by WHO and Mozambican standards, and can provide the necessary water requirements for the basic (domestic) needs of the rural communities. However, the Site Selection Process will need to be informed by a more detailed water quality assessment that includes an assessment of potential bacterial contaminants. Consequently, the main hydrological constraint for relocating homesteads in the Palma region is the potential risk of flooding and hygiene.

The Results and Findings section of the hydrology and geohydrology survey can be reviewed in detail in the Surface and Ground Water Hydrology Report attached as Appendix A.

4.3 Soils and Agricultural Potential

The full laboratory analysis of the 74 soil samples collected from 37 sites in the Study Area (Figure 4.31) is detailed in the Palma Agricultural/Soil Study in Appendix B.

Figure 4.31: Location of the 37 soil sampling point in the Study Area

All the soil samples were analysed for the following parameters: pH, resistance, Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Lead (P), Bray II, titratable acidity, stone fraction, Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Boron (B), and Carbon (C). Also assessed were Total Available Moisture (TAM) / Available Water Capacity (AWC), Steady Water Intake Rate (Infiltration Rate), Cation Exchange Capacity and Exchangeable Cations.

The findings of the laboratory soil analysis are summarised below.

Table 4.4; Results of the laboratory analysis of the soil samples from the Study Area

Sample	Depth	Soil	pH	Resist.	H^+	Stone	Phosphorus Bray II	Potassium	Exchangeable cations (cmol(+)/kg)				Copper	Zinc	Manganese	Boron	Iron	Carbon
#	(cm)		(KCl)	(Ohm)	(cmol/kg)	(Vol %)	mg/kg		Sodium	Potassium	Calcium	Magnesium	mg/kg					%
N01	20	Sand	4.7	19450	0.25	1	1	23	0.01	0.06	0.39	0.16	0.71	3.9	9.4	0.03	17.38	0.15
	60	Sand	4.7	20000	0.25	1	1	30	0.03	0.08	0.36	0.14	0.68	2.9	2.6	0.03	8.34	0.15
N02	20	Sand	5.2	12300	0.25	1	8	30	0.01	0.08	1.39	0.35	1.29	1.5	126.7	0.03	44.71	0.27
	60	Sand	5.3	12350	0.25	1	3	31	0.01	0.08	0.95	0.29	1.44	13.1	124.1	0.03	30.42	0.23
N03	20	Sand	5.4	12960	0.3	1	2	17	0.02	0.04	1.17	0.27	1.05	1	161.7	0.07	62.47	0.23
	60	Sand	5.4	15360	0.25	1	1	29	0.01	0.07	0.62	0.23	1.08	1.3	128.3	0.05	44.95	0.15
N04	20	Sand	5.4	20000	0.25	1	1	6	0.01	0.02	0.2	0.1	0.75	0.7	4.3	0.03	**6.59**	0.17
	60	Sand	5.4	17560	0.25	1	1	14	0.01	0.04	0.13	0.11	0.75	1.4	1.3	0.03	**6.59**	0.17
N05	20	Sand	5.6	3460	0.25	1	1	77	0.03	0.2	1.64	0.51	1.24	2.3	178.3	0.15	218.4	0.39
	60	Sand	5.7	6610	0.25	1	1	49	0.01	0.12	0.96	0.36	0.8	8.2	84.3	0.21	22.92	0.19
N06	20	Sand	5.8	8350	0.2	2	1	24	0.02	0.06	0.95	0.24	0.98	12.6	116.5	0.07	42.46	0.18
	60	Sand	5.8	13680	0.25	2	1	41	0.01	0.1	0.6	0.49	0.82	7.2	78.8	0.09	16.1	0.17
N07	20	Sand	4.7	20000	0.45	1	1	14	0.01	0.04	0.13	0.07	0.67	1.6	1.8	**0.01**	**6.62**	0.19
	60	Sand	4.7	20000	0.35	1	2	7	0.01	0.02	0.1	0.05	0.74	3.7	0.6	**0.02**	**4.49**	0.14
N08	20	Sand	5.3	9180	0.25	1	2	31	0.01	0.08	1.02	0.27	0.84	0.5	20.7	0.04	14.95	0.3
	60	Sand	5.4	5000	0.25	1	1	15	0.04	0.04	0.32	0.15	0.81	0.7	5.4	0.06	18.54	0.12
N09	20	Sand	4.9	1810	0.35	1	1	27	0.19	0.07	0.45	0.27	0.74	0.9	54.6	0.09	20.26	0.25
	60	Sand	4.9	10340	0.3	1	1	24	0.02	0.06	0.34	0.33	0.71	0.6	20.5	0.13	12.3	0.12
N10	20	Sand	5.1	7180	0.25	1	2	26	0.02	0.07	1.1	0.36	0.88	0.6	91.1	0.17	21.44	0.34
	60	Sand	5.2	9880	0.3	1	1	23	0.01	0.06	0.72	0.28	0.74	2.2	51.2	0.1	14.51	0.18
N11	20	Sand	5.4	13320	0.25	2	5	19	0.02	0.05	1.33	0.35	0.78	2.8	23.9	0.03	11.41	0.27
	60	Sand	5.2	19710	0.25	2	2	43	0.03	0.11	0.46	0.18	0.68	4	2.4	0.04	15.78	0.19
N12	20	Sand	5.5	4960	0.25	1	1	86	0.05	0.22	1.4	0.31	0.86	8.3	65.4	0.36	44.81	0.26
	60	Sand	5.6	8210	0.25	1	1	41	0.04	0.11	0.82	0.37	0.71	5.7	24.7	0.26	17.21	0.12
N13	20	Sand	5.1	10940	0.3	1	2	41	0.02	0.11	0.38	0.29	0.9	0.5	61.6	0.16	21.53	0.18
	60	Sand	5.1	12170	0.3	1	1	40	0.01	0.1	0.36	0.36	0.91	0.8	36.9	0.11	11.23	0.17
N14	20	Sand	5.1	16050	0.3	1	1	21	0.03	0.05	0.74	0.34	0.91	0.7	78.4	0.06	28.15	0.23
	60	Sand	5	17840	0.25	1	1	22	0.03	0.06	0.61	0.39	0.96	2.2	85.7	0.05	19.88	0.17
N15	20	Sand	5.1	7210	0.3	1	0	30	0.02	0.08	0.69	0.27	0.74	0.6	80.9	0.04	17.09	0.35
	60	Sand	5	15960	0.3	1	1	35	0.02	0.09	0.4	0.35	0.71	3.1	46	0.02	11.7	0.12
N16	20	Sand	5.2	15970	0.25	1	2	31	0.05	0.08	0.65	0.26	0.74	1.4	65.4	0.02	17.46	0.15
	60	Sand	5.2	14910	0.25	1	1	45	0.05	0.11	0.7	0.14	0.73	10.1	50.1	0.02	21.38	0.19
N17	20	Sand	5.2	5720	0.45	1	1	79	0.06	0.2	2.1	0.59	1.06	2.5	258.9	0.06	97.55	0.58
	60	Sand	5.3	7850	0.35	1	1	54	0.01	0.14	0.96	0.57	0.84	27.7	178.1	0.06	40.48	0.17
N18	20	Sand	5	20000	0.3	1	3	21	0.01	0.05	0.59	0.18	1.29	2	123	0.02	43.78	0.25
	60	Sand	5	15400	0.3	1	2	28	0.01	0.07	0.49	0.15	1.09	5.5	121.8	0.02	43.47	0.12
N19	20	Sand	4.6	9800	0.4	1	1	31	0.02	0.08	0.49	0.15	0.74	1.1	63.8	0.04	28.17	0.34
	60	Sand	4.7	13100	0.4	1	1	36	0.05	0.09	0.58	0.13	0.7	14.7	28	0.04	16.26	0.28
N20	20	Sand	4.7	5910	0.45	1	1	95	0.04	0.24	0.39	0.6	0.88	2.9	240.9	0.09	77.48	0.23
	60	Sand	4.7	8840	0.45	1	1	98	0.04	0.25	0.34	0.51	0.81	26.9	225.8	0.06	73.12	0.24
N23	20	Sand	4.4	10810	0.5	1	1	45	0.02	0.11	0.21	0.21	0.75	3.8	82.9	0.05	45.54	0.19
	60	Sand	4.4	12580	0.55	1	1	36	0.02	0.09	0.19	0.31	0.71	9.4	78.1	0.06	24.26	0.27
N29	20	Sand	5	7170	0.35	1	1	50	0.03	0.13	0.86	0.4	0.98	1.3	258.9	0.08	93.72	0.26
	60	Sand	4.9	6510	0.4	1	1	71	0.03	0.18	0.43	0.64	0.79	10.9	178.6	0.15	48.76	0.12
N32	20	Sand	4.6	9600	0.55	1	1	42	0.02	0.11	0.83	0.2	0.89	1	167.6	0.12	66.78	0.37
	60	Sand	4.7	12350	0.35	1	**0**	53	0.02	0.14	0.78	0.27	0.75	9.1	108.6	0.09	46.48	0.22
N33	20	Sand	5	5730	0.3	1	1	72	0.02	0.19	0.9	0.4	0.95	5.1	191.5	0.09	96.63	0.19
	60	Sand	5	9060	0.35	1	1	64	0.02	0.16	0.44	0.82	0.78	32.4	138.8	0.18	29.5	0.11
N34	20	Sand	5.1	5710	0.3	2	1	44	0.01	0.11	0.66	0.3	0.77	1.7	94	0.11	39.01	0.25
	60	Sand	5.1	9730	0.25	2	1	82	0.02	0.21	0.57	0.35	0.72	54.7	44.4	0.04	15.26	0.23
N35	20	Sand	5.2	8960	0.3	3	1	46	0.11	0.12	1.53	0.51	1.03	3.2	173	0.04	59.85	0.43
	60	Sand	5.2	12490	0.3	3	2	31	0.16	0.08	0.99	0.7	0.84	10.2	102.8	0.03	41.46	0.12
N36	20	Sand	4.8	14230	0.35	2	2	8	0.01	0.02	0.28	0.12	0.75	1.5	9.4	**0.01**	8.24	0.17
	60	Sand	4.7	20000	0.35	1	2	4	0.01	0.01	0.16	0.07	0.75	0.3	2	**0.01**	8.06	0.23
N37	20	Sand	5	8150	0.3	1	1	34	0.01	0.09	0.61	0.45	0.83	1.1	105.7	0.05	37.33	0.3
	60	Sand	4.6	15960	0.45	1	1	37	0.02	0.09	0.21	0.66	0.85	12	103	0.04	20.03	0.17
N38	20	Sand	5	12430	0.25	1	2	16	0.02	0.04	0.69	0.25	0.72	1.2	33.4	0.03	19.53	0.23
	60	Sand	5	11740	0.25	2	1	33	0.02	0.08	0.72	0.28	0.7	13.9	7.4	0.07	14.76	0.16
N39	20	Sand	5.2	8410	0.3	1	1	55	0.02	0.14	0.47	0.51	0.81	17.3	101.6	0.07	33.55	0.13
	60	Sand	5.2	6070	0.25	1	1	55	0.01	0.14	0.79	0.38	0.89	1.9	142.4	0.07	74.34	0.18
N40	20	Sand	5.3	17570	0.25	1	3	13	0.01	0.03	1.37	0.29	1.09	2.1	55.8	0.03	20.83	0.31
	60	Sand	5.3	14900	0.2	1	2	13	0.01	0.03	0.53	0.16	0.9	1.2	22.6	0.03	9.89	0.19
N41	20	Sand	4.7	16760	0.35	2	1	31	0.07	0.08	0.33	0.19	0.74	0.7	4.5	0.05	7.9	0.2
	60	Sand	4.5	20000	0.35	2	1	31	0.02	0.08	0.2	0.18	0.69	4.5	1.5	0.05	8.96	0.14
N42	20	Sand	4.9	6420	0.35	1	1	56	0.03	0.14	0.6	0.77	1.24	1.2	316.8	0.1	56.03	0.18
	60	Sand	5.1	8630	0.35	1	1	47	0.01	0.12	0.6	0.7	1.24	12.4	248.2	0.1	54.74	0.19
N43	20	Sand	5.2	7460	0.25	1	1	43	0.01	0.11	0.82	0.35	0.8	0.7	107.3	0.08	49.98	0.17

	60	Sand	5.2	5440	0.3	1	1	122	0.03	0.31	0.31	0.41	0.81	18.3	109.8	0.12	86.61	0.23
N45	20	Sand	4.7	8710	0.45	1	1	37	0.05	0.09	0.77	0.29	0.87	20.6	109.7	0.1	53.4	0.14
	60	Sand	4.8	10620	0.35	1	1	40	0.07	0.1	0.66	0.26	0.97	78.3	120.3	0.05	40.16	0.24
N47	20	Sand	4.9	17480	0.25	1	1	15	0.01	0.04	0.38	0.16	0.7	2.7	14.5	0.05	**5.68**	0.18
	60	Sand	4.5	20000	0.3	1	**0**	29	0.01	0.07	0.19	0.17	0.73	3.1	5.3	0.02	**3.8**	0.12
N49	20	Sand	4.9	8020	0.35	2	3	20	0.03	0.05	1.22	0.2	1.06	2	48.1	0.04	30.89	0.23
	60	Sand	5	20000	0.2	2	2	11	0.01	0.03	0.39	0.29	0.72	3.7	7.7	0.05	10.32	0.1

4.3.1 Soils Map for the Study Area

The results from the soil analysis (Table 4.4) confirm the observations of the soil assessment specialist in the field that the soils of the Study Area are all sandy soils with very little variation in soil chemical characteristics. The differentiation of the soils into three soil types, Ferralsols, Arenosols and Planosols, is based mainly of their varying colours and textures.

The distribution of these soils across the Study Area is illustrated in the soils classification map for the Study Area below (Figure 4.32).

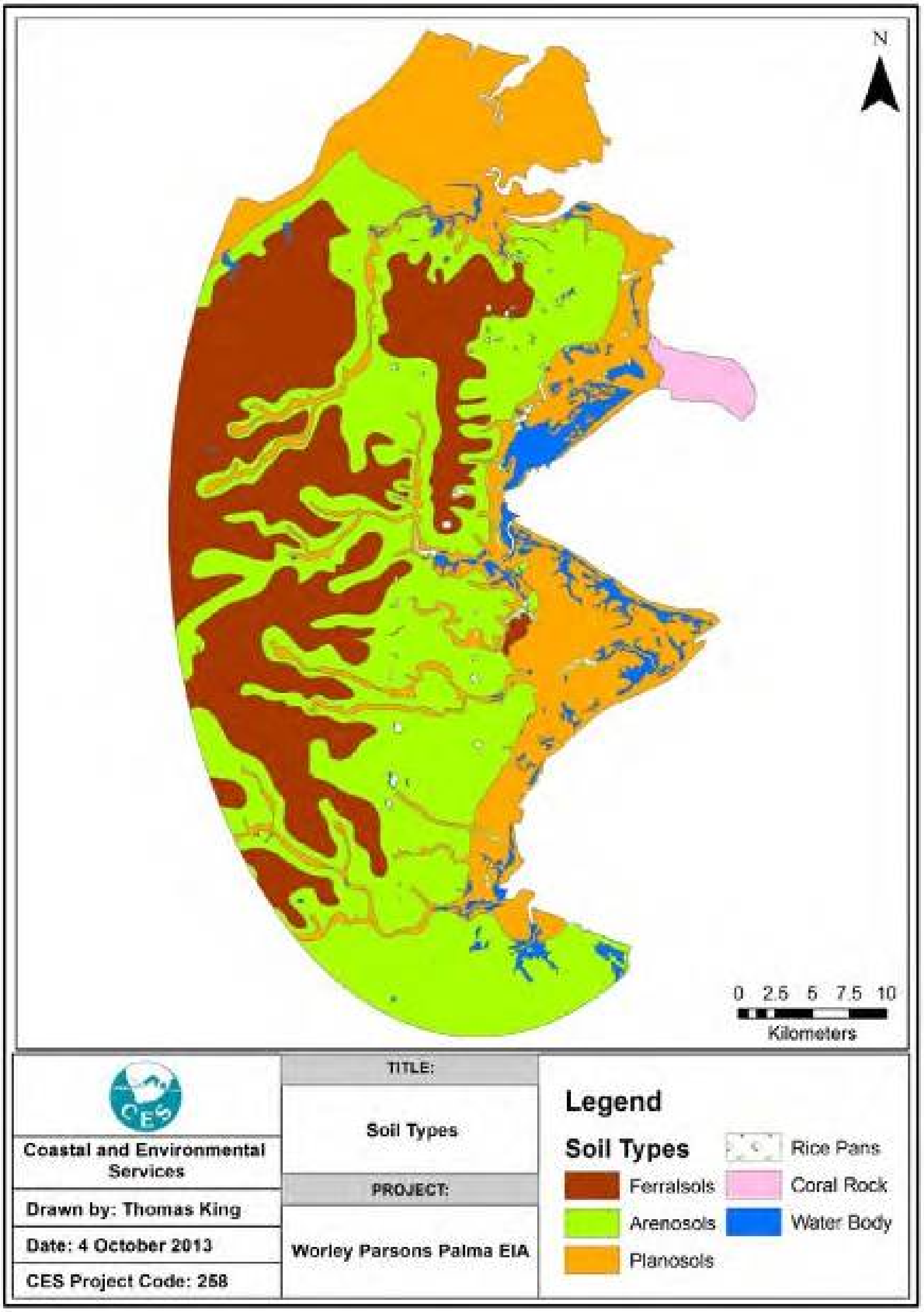


Figure 4.32: Distribution of the three soil types found in the Study Area along with the Coral Rock area and water bodies

4.3.2 Summary of soil suitability for agricultural purposes

Based on the known properties of these soil types, as described by the "World Reference Base for Soil Resources 2006" (IUSS Working Group WRB, 2006), and from the results of the soil analysis (Table 4.4) each of these soils was assigned a suitability rating when considered for the production of the typical crops grown and agricultural practices used in the Study Area (Table 4.5).

Table 4.5: Agricultural Suitability of the three soil types described in the Palma Region

Soil	Suitability
Ferralsols	Very high
Arenosols	High
Planosols	Moderate

The Ferralsols were considered to be the most suitable of the three soils present because of their higher Total Available Moisture (TAM) and Steady Water Intake Rate (Infiltration Rate). They were therefore assigned an agricultural/soil suitability rating of very high. The arenosols are considered to have better Total Available Moisture (TAM) and Steady Water Intake Rate (Infiltration Rate) properties than the Planosols and therefore they were assigned suitability ratings of high and moderate respectively.

Ideally it was required that the agricultural potential of soil types found in the Study Area be classified into five different classes. However, the soil analysis results coupled with observations from the field study revealed that there was very little variation or differentiation in the soils across the Study Area and therefore only three suitability classes could be assigned (see Table 4.5 above).

However, for the purposes of this study and the requirement to provide five classes for agricultural potential, the soils identified have been assigned a "Very High", "High", and "Moderate" as summarised in Table 4.5. The Coral Rock area found on the Cabo Delgado peninsular was considered to be of unsuitable agricultural potential because of the very thin soils that exist there. Most of the water bodies in the Study Area were also considered as unsuitable agricultural areas. The exceptions are those areas where the water level during the year was such that it allowed for the growing of rice and therefore they were considered to have limited or low agricultural potential.

Based on the agricultural potential of the three soil types found across the Study Area and also taking into consideration the wetland areas and the Coral Rock area on the Cabo Delgado peninsula, a map of agricultural suitability was developed (Figure 4.33).

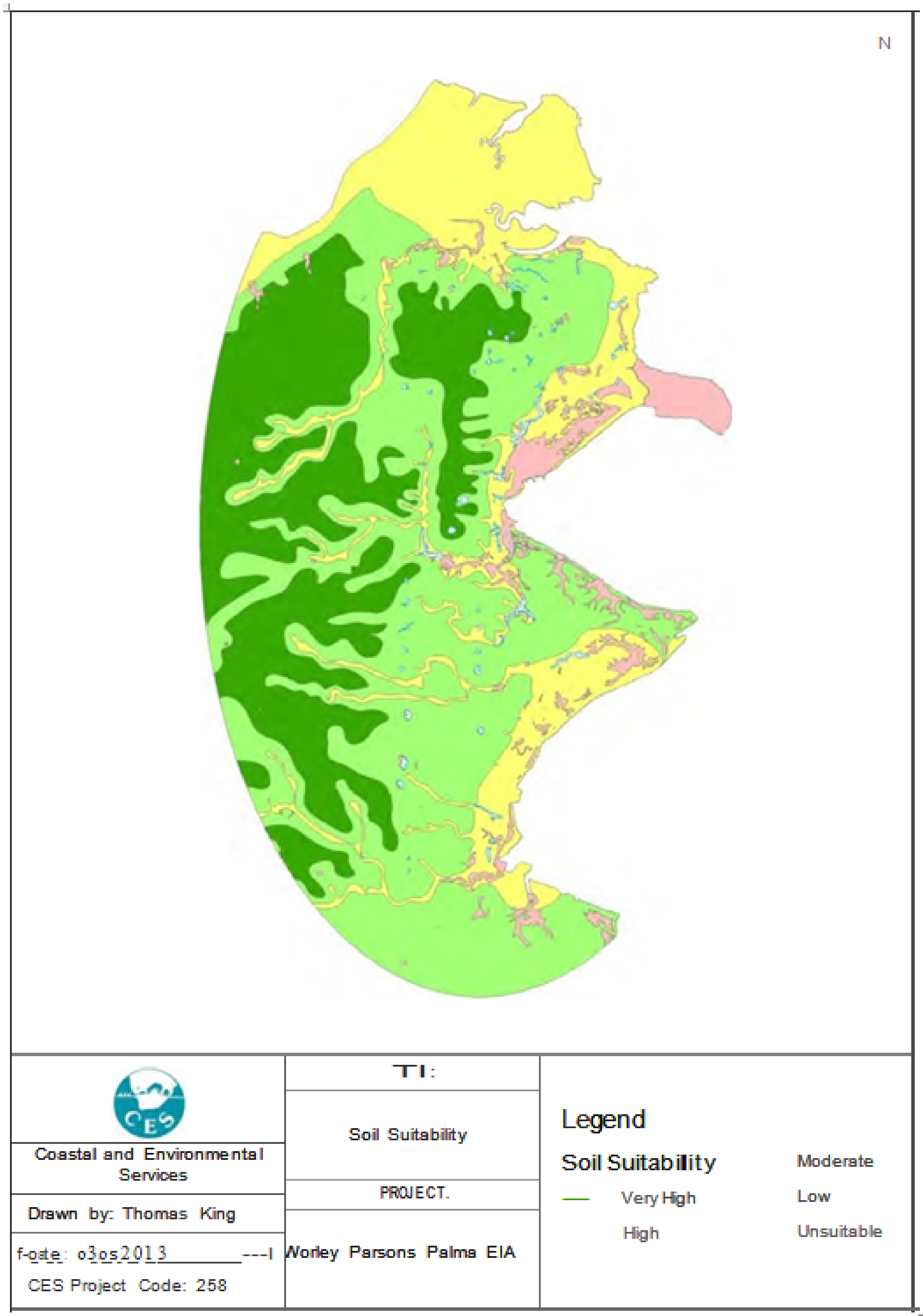


Figure 4.33: Agricultural Potential of the Soils, Coral Rock Area and Water Bodies of the Study Area

As the land drops down towards the sea the soils become more sandy and permeable so lessening their suitability for growing crops. However, as mentioned, they still retain the potential to produce good annual crops if properly managed and maintained.

4.4 Vegetation and Ecology

In order to maintain the consistency between this survey and previous surveys conducted in the area (for example, Enviro-Insight & Impacto, October 2011 and ERM & Impacto 2012), the vegetation classification used in this report was the same as the 'regional structural vegetation units derived from remote sensing imagery and ground-truthing' used in the ERM & Impacto ESIA (2012).

The vegetation composition of the Study Area was comprised of ten different vegetation types and the distribution of each of these habitats is illustrated in the vegetation map below (Figure 4.34). In addition to the vegetation types the land currently under cultivation and all water bodies and rivers are included in the map.

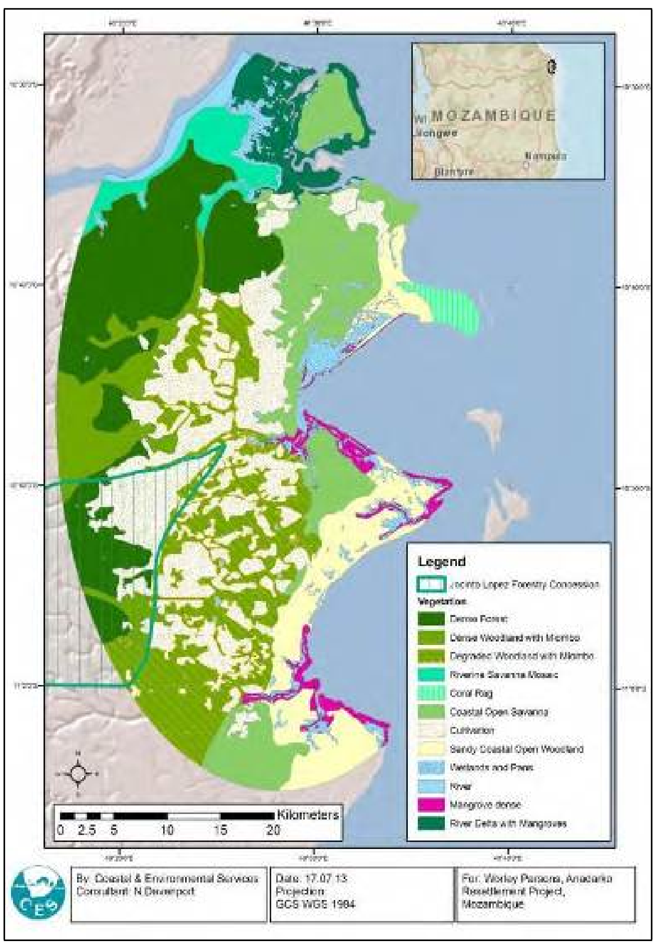


Figure 4.34: Vegetation map of the Palma Study Area

A brief description of each of the vegetation types is also provided.

Dense Forest

Of particular ecological and environmental concern within the Study Area is the presence of Coastal Dry Forest and the requirement of this study was to determine its current extent and utilisation.

The CES team was provided with constraints map depicting the extent of the Coastal Dry Forest as determined by the WorleyParsons constraints mapping exercise (Phase 2). The RAFS Team conducted a ground-truthing exercise to confirm and amend the most recent extent of these forested areas and updated the constraints map accordingly.

The Coastal Dry Forests of Eastern Africa, which stretch along the Indian Ocean coastline from Somalia to Mozambique, are considered by Conservation International to be a global biodiversity hotspot – an area of high diversity and endemism under increasing threat (Timberlake 2011).

In an intensive vegetation survey conducted by Timberlake *et al.* (2010) it was observed that these coastal forests were found to have high levels of endemism and hence their consideration as an important and distinct ecoregion. However, according to Timberlake *et al.* (2010), since the 1990s there have been several attempts to accurately define Coastal Dry Forests and Timberlake's recent definition and description is dependent on detailed observations and assessments of the vegetation species composition of the "dense forests" in the area in order to identify the diagnostic species and species combinations which are representative of the Coastal Dry Forests.

Part of this Rapid Assessment Field Study aimed at identifying the areas of Coastal Dry Forest as well as any other areas of dense forest within the Study Area. Unfortunately, with the time constraints associated with the field study, it was not possible to conduct the detailed botanical species composition analyses required to identify Coastal Dry Forests as described by Timberlake *et al.* (2010). Instead, for the purposes of this assessment it was recognised that all the dense forest areas that currently exist in the Study Area were considered together, as they play an important role in providing essential ecosystem services to the area. Consequently they were classified as 'very high' sensitive areas (see Figure 4.35).

These forests fall comfortably within the criteria set out by AETFAT – the association of taxonomists studying the flora of Africa – which defines a forest as being a vegetation type where fire is rare to absent, with a canopy more than 10 m high, interlocking tree crowns, and a distinct leaf-litter layer (White 1983). The canopy height of the forests of the Study Area varied from 8 to 20 m, with taller canopies found at the base of inclines and lower canopies on the tops of hills and plateaux.

Many of the tree species observed were usually widespread across the site and included deciduous species such as *Afzelia quanzensis*, (Figure 4.36), *Brachystegia spiciformis, Hymenaea verrucosa, Pteleopsis myrtifolia, Milicia excelsa* but also included endemics such as *Dialium holtzii* and *Berlinia orientalis*. Many of these trees were found to be without leaves as often these large trees are able to cope with the severe dry season by dropping their leaves.

The study revealed that there are still intact areas of dense forest found in the west and north of the Study Area but the extent of the forests has been reduced. The reduction in the forest cover can be observed from examining satellite imagery over the last five years and the most recent clearing of dense forest areas can be observed directly while driving around the Study Area. Observations from the satellite imagery clear show how the dense forest areas have been cleared to make way for additional agricultural areas and evidence on the ground reveals how the forests are being exploited for building poles and wood for charcoal.

Consequently the areas of Very High sensitivity shown in Figure 4.35 are much less extensive than those illustrated in the original WorleyParsons constraints map of coastal forests.

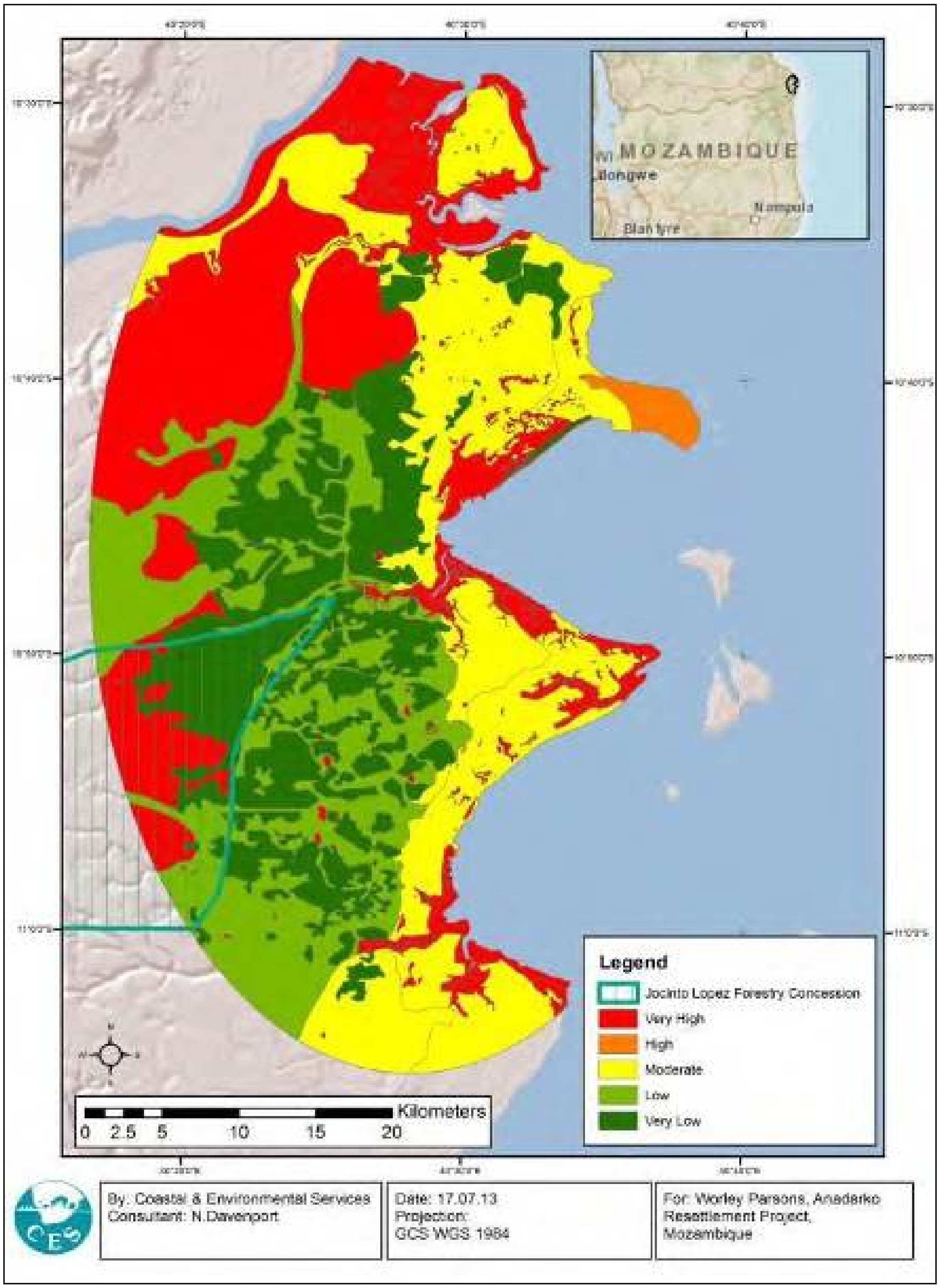


Figure 4.35: Vegetation Sensitivity map of the Palma Study Area

Figure 4.36: Afzelia quanzensis without leaves, typical of the dense forests in the Study Area

Dense woodland with Miombo

Woodland is ecologically distinguished from forest as these areas are subjected to frequent bush fires. Bushfires occur during the dry season, and almost all fires are started by people. Sometimes this happens accidentally during the clearing of fields when fires stray out of control, or originate from discarded cigarettes. Bushfires are also deliberately set by local people as a tool to manage the environment. They sweep through the woodland understory, consuming dried out grasses, fallen leaves and any dead wood. This opens up the habitat, giving a greater sense of security to the local population (Ferro 2007), who face a real risk of lethal encounters with wildlife (some 30 people were killed by lions in Palma District during late 2007/early 2008), while also killing snakes and other potential pests (Clark 2010).

Common species within this vegetation type included typical miombo species of *Brachystegia spiciformis* and *Jubinardia globiflora* with other dominants being *Berlinia orientalis, Parinari curatellifolia* and *Afzelia quanzensis* (Figure 4.36).

These areas were also found primarily in the west and north of the Study Area but they did extend towards the east to within a couple of kilometres of the coast in some places.

There are extensive examples of this vegetation type throughout southern Africa and as such these areas can be regarded as having a low sensitivity in relation to the other vegetation types found in the Study Area.

Degraded Woodland with Miombo

This vegetation type is very similar to that described above except that there is evidence of much more anthropomorphic activity where trees have been cut either for firewood or to clear new sites for agricultural purposes (most often by slash-and-burn practices). Fires are set a lot more frequently in these areas. *Berlinia orientalis* are frequent as they tend to be the most fire resistant species in these woodlands. However many of them are felled by first ring barking the stem and then setting fires at the base.

Other trees include occasional *Combretum collinum, Ximenia caffra, Strychnos madagascariensis, Kigelia africana, Pterocarpus angolensis, Hugonia orientalis, Sclerocarya caffra* (Marula).

Similar to the previous vegetation type, these areas can be considered as having a low sensitivity in relation to the other vegetation types found in the Study Area, especially when many of these areas are surrounded by intensive agricultural lands and have been impacted by these adjacent agricultural activities.

Riverine Savannah Mosaic

This vegetation type is found in the north of the Study Area where there is lower lying land along the Ruvuma River valley. Typical of the vegetation in this region are the stands of tall Borassus palm (*Borassus aethiopium)* on the Rovuma floodplain while on the slightly higher ground *Sterculia appendiculata* and *Ficus sycomorus* & *F. burkei* are common trees.

This vegetation type is restricted to the very north of the Study Area and is relatively densely populated by local communities who are dependent on the river for their livelihoods either as fishermen or those who act as ferrymen moving cargo across the river to Tanzania.

There is a restricted amount of this vegetation type within the Study Area and it is known to be utilised by wildlife (especially elephants) during the dry season when they need to be close to the last remaining available water, the Ruvuma River (Clark 2011). This area is also surrounded by ecological sensitive mangrove forest and for this reason it is considered as having a very high ecological sensitivity.

Coral Rag

Within the Study Area this vegetation type is only found in the very east on the Cabo Delgado peninsula where there is a dense closed canopy of maritime scrub forest on the uplifted coral rag shelf. The very thin layer of soil over the coral rag makes it unsuitable for cultivation, and this may have protected the scrub forest from anthropogenic destruction and fires in the past.

There are unique species found in this area such as the shrub, *Xylopia sp* which along with its contribution to the biodiversity of the area makes the ecological sensitivity of this coral rag high.

Coastal Open Savannah

This vegetation type extends across large areas in the east of the Study Area. They tend to be fairly flat, low-lying, open grasslands with exposed sandy areas and sparse tree cover. The most common trees include *Strychnos spinosa, Garcinia livingstonei, Parinari curatellifolia, Commiphora africana and Strychnos madagascariensi.* The dominant grasses are comprised of *Ctenium concinnum, Andropogon chinensis, Panicum coloratum* and *Trachypogon spicatu.*

Figure 4.37: Coastal Open Savannah on the R6 road

The characteristics of this are attributed to historic land use practices and there is still frequent seasonal burning which prevents the growth of tree seedling. Despite the close proximity to Palma Town this area is relatively under populated and there was evidence of wildlife in this area whose grasslands can attract grazing antelope and the possibility of predators. The open grassland will also provide valuable feeding grounds for a wide number of bird species. For these reasons this area was considered to have a moderate ecological sensitivity.

Sandy Coastal Open Woodland

This is dominant throughout the Study Area and extends south along the coast to the southern end of the Study Area. It is typically very disturbed vegetation type due to extensive local agricultural practices and its close proximity to the coast where most of the local towns and villages are found. Much of the vegetation here has been modified by slash-and-burn agriculture, with only remnants of the original vegetation structure and species composition existing as isolated thickets.
Common tree species found here include *Strychnos madagascariensis and Xylotheca tettensis* and there are *abundant* cashew nut *(Anacardium occidentale), mango (Mangifera indica), Grewia pachycalyx, Kigelia Africana* and the occasional Baobab (*Adansonia digitata (Figure 4.38).*

Figure 4.38: Baobab found east of Quionga Town

Where tree growth has been limited by frequent bush fires there are extensive stands of tall grasses including *Digitaria eirantha*, yellow thatching grass (*Hyperthelia dissoluta*), red grass (*Themeda triandra*) and couch grass.

As mentioned, much of this area has been disturbed and while it is not an extensive vegetation type in the area it is still a valuable habitat for feeding and breeding birds and insects. It has been classified as having a moderate ecological sensitivity.

Wetlands and Pans

Especially in the low-lying areas close to the coast there are numerous seasonal wetlands. These areas are important for wildlife both for large mammals, (Hippopotamus tracks were frequently seen in the deeper wetland areas along with Bush Pig and Hyaena footprints which were observed in the muddy edges of these wetlands) and also for wetland birds who will utilise these as breeding areas during the rainy season. These areas are also important for local communities as they are collecting points for water via holes dug in the ground, and as important agricultural areas as there is water on or close to the surface for most of the year.

The landscape around Palma contains numerous near-circular pans (known locally as *pantanos*) and drainage lines. These pans fill with water during the rains, while the drainage lines only briefly contain flowing water. Almost all pans dry out by the end of the dry season. However both features are utilised by wildlife for water and the local communities for growing crops.

The trees growing towards the centre of the line are predominantly *Parinari curatellifolia*, while *Brachystegia spiciformis* and *Berlinia orientalis* take over along the woodland edge. Fire probably opens up this habitat more than would otherwise be the case for areas that are just temporarily flooded.

Dense Mangroves Swamps

In many places along the coastline of the Study Area mangroves swamps are clearly evident. The dominant feature for these mangroves is the presence of the white mangrove (*Avicenna marina*) and the mangrove apple (*Sonneratia alba*) growing in the oceanic tidal zone (Figure 4.39), but they are also found as scattered individuals on the narrow stretches of white sand.

Among other things, the mangrove swamps play an important role in protecting coastlines from erosion and flooding, events that may become more frequent due to climate change. These areas therefore should be considered as essential part of the ecology of this area and are recognised as having a Very High ecological sensitivity. Their presence should be taken into consideration when deciding on potential resettlement fishing villages.

A common feature along certain stretches of these coastlines are the stands of tall coconut palms (*Cocos nucifera*), and the invasive horsetail tree (*Casuarina cunninghamiana*) (Figure 4.40). These are indications of the changes to the coastline ecology caused by human activity and the effect of moving more people to sensitive areas along the coast could exacerbate these changes.

Figure 4.39: Mangroves along the beach near Namanengo village

Figure 4.40: Casuarina tree along the beach; this tree is an alien invasive

The river system just south of Olumbe town has dense tidal mangrove swamps which typically stand less than 5m in height (Figure 4.41). The Black mangrove (*Bruguieria gymnorrhiza*) generally dominates on the seaward side while the larger white mangroves are found in the littoral zone. Also found on the landward side are the red mangrove (*Rhizophora mucronata*) and the Indian mangrove (*Ceriops tagal*).

Figure 4.41: Mangrove swamp in the river delta south of Olumbe Town

River Delta with Mangroves

There is one area of this vegetation type in the Study Area. An extensive area of river delta with mangroves is found just north of Quionga Town where the Rovuma River flows into the sea (Figure 4.42). This area extends north of the border into Tanzania where it is a protected area – Mnazi Bay – Ruvuma Estuary Marine Park. Within this protected area the mangroves are afforded additional protection and are designated as Mangrove #37 Forest Reserve.

Figure 4.42: River delta mangrove swamp just north of Quionga Town (young Baobab in the foreground)

These mangroves also play an important role in stabilising the river bank and preventing severe flooding episodes and are also recognised as having a Very High ecological sensitivity.

Agricultural Land

As mentioned in the Agricultural Land Use section above, the extent of the agricultural areas has increased in recent years such that there are very limited areas within the Study Area where there is little or no agricultural activity. All agricultural land has severely altered the natural vegetation with the result that all these areas are considered to have very low ecological sensitivity.

The current agricultural areas are considered to be an important parameter to consider in the Site Selection Process. When determining and mapping these agricultural areas it was assumed that if a small parcel of natural vegetation existed between two cleared agricultural areas then it was included in the mapped agricultural land, i.e. the Agricultural Land areas shown on the vegetation map (Figure 4.34) include these small parcels of natural vegetation and therefore appear more extensive than they actually are.

Fauna

Knowledge of the fauna of northern Mozambique remains one of the most poorly-known in Africa with the result that the fauna of this region has not been extensively surveyed. Historically, large mammal numbers have been recorded in the area but in recent years many species have been extirpated from the area due to the long history of local subsistence hunting and habitat destruction.

Mammal species that were observed during the survey included Striped Bush Squirrel (*Paraxerus flavovittis*), Samango Monkey (*Cercopithecus mitis samango*), Four-toed elephant shrew (*Petrodromus tetradactylus*), Baboons (*Papio ursinus*) and Mutable Sun Squirrel (*Heliosciurus mutabilis)*. However there were also signs (droppings and spoor) of Hippopotamus (*Hippopotamus amphibious)* and Bush Pig (*Potamochoerus larvatus*) observed in the wetlands along the R15 road, various small antelope and Hyaena (*Crocuta crocuta*) footprints were observed along the R22 north of Olumbe. On the R01 road leading north towards the Ruvuma River there where several locations where elephant droppings on the road indicated that there are a number of small herds moving within the densely forested areas of the Study Area. Local villagers in the Quionga area also reported recent sightings of a number of elephant herds in the area and were always vigilant to their presence (Figure 4.43).

Figure 4.43: Elephant warning near Quionga Town

The avifauna populations observed in the area tends to be very seasonal with increased numbers of species visiting the area during the rainy season. During this survey 42 bird species were observed. Only one species of conservation note was observed; eight Wattled Crane (*Bugeranus carunculatus*), listed as Venerable by the IUCN, were observed from the main N247 south of the Afungi turn-off on one of the saline plains (Figure 4.44). The Study Area represents the fringe of their distribution in southern Africa. In order to avoid impacting on these birds it may be necessary to conduct further bird surveys to identify if the Wattled Cranes are vagrants to the area or whether they are frequent visitors and if they possibly breed here.

Figure 4.44: Wattled Crane on Saline Plain south of Afungi

5 CONCLUSIONS AND RECOMMENDATIONS

The Study Area for this Rapid Assessment Field Study (i.e. area in which potential Replacement Village site(s) are to be identified) is defined as the area located in the north-eastern part of Mozambique, in Cabo Delgado Province and which surrounds the town of Palma and is limited to the north by the Rovuma River (Tanzanian border) and extends southwards to approximately 10kms south of Olumbe.

The results of the CES Rapid Assessment Field Survey and ground-truthing exercise confirmed and amended the information provided in the WorleyParsons constraints maps and provided information which could be used in the WorleyParsons GIS–based model to aid in the identification of the most suitable areas for the resettlement village(s).

5.1 Constraints and Land Use Assessment

WorleyParsons had identified the following as potential constraints or 'no-go' areas when considering areas prior to the CES Rapid Assessment Field Study:

- Wetlands;
- Mangroves;
- Coastal Dry Forest;
- Main towns, villages, settlements and infrastructure (e.g. social, transport and roads);
- Existing cultivated areas (existing agriculture);
- Conservation Areas (existing and potential Protected Areas);
- Game Reserves;
- Forest Concessions;
- Mining concessions;
- Coral reefs;
- Turtle beaches;
- Elephant corridors.

Based on the information gathered during the rapid site assessment and additional desk top research, the CES team was able to confirm the validity of the abovementioned constraints. In addition, the new information enabled revision of existing maps of important biophysical and social features that were relevant to identification of constraints.

It was apparent from both desktop studies including examination of satellite imagery and from what was observed during the field survey, that there is extensive agricultural activity across the Study Area. These observations demonstrated that there was less available land for new cultivation than was originally observed from the WorleyParsons agricultural constraints map (May 2013). When the additionally observed cultivated land was mapped along with the current cultivated areas and the wetlands, mangroves, dense forest, a known forestry concession and recently issued DUATS, then the available area for establishing resettlement village was much reduced.

It was particularly noticeable that where new or upgraded roads had been made into previously fairly inaccessible area, especially the dense forests in the west of the site, that the local communities made use of these routes to access the forests and utilise its natural resources. A lot of this activity involved the cutting of young trees and the resulting cleared areas were then transformed into agricultural land using slash-and-burn practises.

However there was still under-utilised land with good agricultural potential observed to the north of Palma Town and west of the Cabo Delgado peninsular. This area consisted of Coastal Open Savannah and Sandy Open Coastal Woodland. This area has probably been subjected to frequent bush fires in the past resulting in a more open vegetation structure which would require less preparation if required to convert to agricultural land.

There is also easy access to the sea and the main road to N 247 Palma Town which would provide easy access to markets.

It was observed that there was a disused camp, ($10^0$38'18.0S & $40^0$30'40.7E), previously used by a road construction team, which had a borehole and hand pump close to the road. This could potentially be an initial relocation option.

5.2 Hydrology and Geohydrology

An essential requirement for any resettlement is access to good quality and sufficient quantity of the water for drinking, domestic use and possible irrigation of agricultural crops.

Results from the hydrology and geohydrology surveys appear to show that there is accessible water across the Study Area at all times of the year. During the dry season when the ground water level drops it is necessary to use boreholes, dug to a depth of 5m and fitted with hand pumps, to provide access to water.

Results of the laboratory analysis have shown that the water quality found in most of the boreholes and open wells provides water which meets the Mozambique potable/drinking water standards.

5.3 Vegetation and Ecology

The objective of this survey was to confirm and amend the ecological constraints from ecologically sensitive vegetation types and faunal populations found within the Study Area as presented and mapped by WorleyParsons.

Of most concern were the areas of Coastal Dry Forest which are known to exist within this area and to define the boundaries of these forests. Due to the time and access limitations it was impossible to accurately define the boundaries of the Coastal Dry Forests but instead all dense forest areas were delineated as a constraint to resettlement village selection.

During the field study it was observed that many areas of dense forest (some of which may well have been Coastal Dry Forest patches) were being cleared and large amounts of timber was being removed. This forest clearance was being exacerbated by the construction and upgrade of roads into these areas allowing cut trees to be removed in large numbers.

In order not to further accelerate the clearing of dense forested areas within the Study Area it is recommended that any resettlement site village is not sited close to the remaining densely forested areas in the west. Instead it is suggested that areas closer to coast are considered as these present vegetation habitats with lower ecological sensitivity.

There are still herds of elephants and other game which were noted to be in the Study Area. However they tend to be shy and stay away from the more densely populated towns and villages by restricting themselves to the densely forested areas. Any resettlement of large numbers of people near these areas would result in increased disturbance of the animal populations who may either move out of the area or remain and cause human/animal conflicts from destruction of crops, for example.

There was evidence of animal poaching in the more western areas of the Study Area and this would also increase with an influx of people into the area.

5.4 Soils and Agricultural Potential

By comparing the overlapping the soils suitability map as well as the constraint maps, it would appear that there are potential areas that would be suitable for resettlement from an agricultural perspective. owever, it was not within the scope of work for this assessment to identify the most suitable areas that could be considered for Resettlement of Agricultural Farmers.

While the quality of the soils is an important consideration in selecting a potential resettlement area it is worth noting that with the addition of fertilizers, some irrigation during the dry season and some agriculture/farm training provided to the local farmers, many of these areas can potentially produce large quantities of crops and vegetables for self-support of for sale in local markets.

Details on the fertilizer types and guidelines suitable for this area are presented in the Agriculture and soils report in Appendix B.

In conclusion there appears to be sufficient access to water and potentially productive soils in many parts of the Study Area. There also appears to be large enough area of unoccupied land available north of Palma Town and west of the Cabo Delgado peninsular which would most suit the requirements of the people to be resettled.

During a detailed Environmental and Social Impact Assessment of a selected area it would be critical to closely determine the access to water, the soil quality for agriculture and the potential for improving those soils, along with being fully aware social constraints and the opinions and desires of the people being resettled.

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Appendix A – Surface & Ground Water Hydrology Survey

STUDY AREA FOR THE PROJECT, NORTHERN MOZAMBIQUE AFUNGI RESETTLEMENT PROJECT

FINAL ENVIRONMENTAL PRE-FEASIBILITY SCOPING STUDY RAPID ASSESSMENT FIELD STUDY

SURFACE & GROUND WATER HYDROLOGY

By HYDROLOGICAL RESEARCH & TRAINING SPECIALISTS cc

06 July 2013

TABLE OF CONTENTS

APPENDIXES

FIGURES

Tables

1 INTRODUCTION

The potential resettlement sites for the displaced inhabitants from the DUAT (Afungi peninsular) development sites were limited by WorleyParsons to the area shown in Figure 1. All potential sites should be located within The Study Area which is defined as the area which surrounds the town of Palma and is limited to the north by the Rovuma River (Tanzanian border) and extends southwards to approximately 10kms south of Olumbi and have similar or better water and food security conditions compared to those they currently have in DUAT (Afungi). This study examined the water supply potential for the Study Area during a site visit from 17/06/2013 to 27/06/2013 integrated with knowledge of similar hydrogeological settings in northern Mozambique and supported with numerical modelling techniques.

The hydrological and geohydrological features forming the water resources of the potential resettlement area will be determined by the topographical, geological, geomorphological and meteorological conditions that extend well beyond the immediate study area as demarcated in Figure 1. Consequently, it was necessary to extend the hydrological investigation to include hydrological boundary conditions beyond the limit of the Study Area. The head water of all the major rivers draining through the potential resettlements areas emanated from the high plateau to the west (see DEM in Figure 11). Similarly, the regional groundwater profile would be regulated by the larger external drainage boundaries formed by the Rovuma River in the northwest and the much smaller Meranvi River draining across the southwest (Figure 1). Consequently, the hydrological Study Area was considerably greater than the potential resettlement area.

The hydrology and geohydrology of the Study Area are controlled by the physical environment and climate. This report covers a brief review of the environmental setting and available data for the assessment of the hydrological conditions.

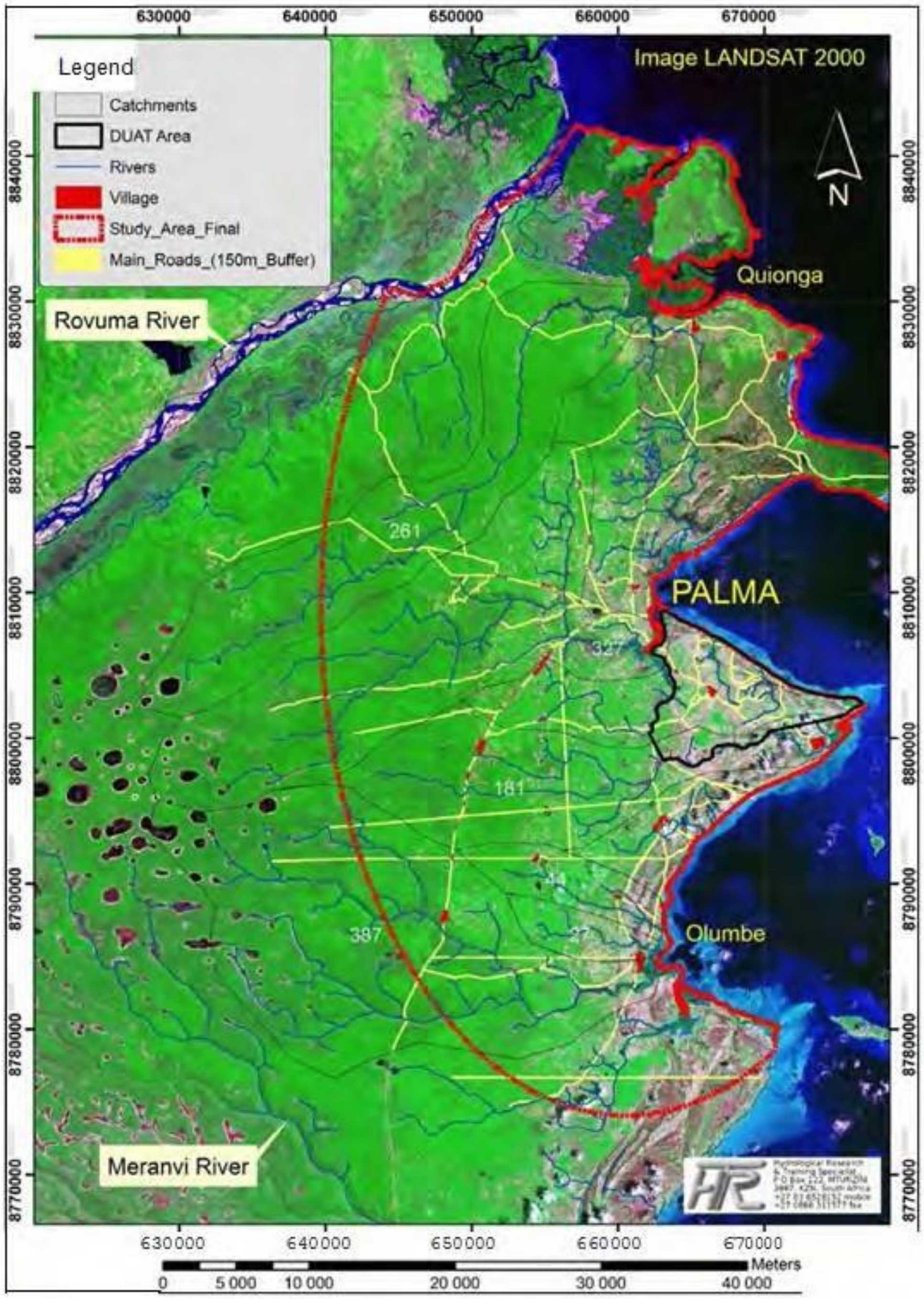


Figure 1: Landsat 2000 image of the Project study area shown with the main towns to the north and south of Palma together with other important features

2 GEOLOGY

The Study Area lies in the Rovuma Sedimentary Basin. The development of the Ruvuma sedimentary basin has been described by Salman and Abdula (1995). A national map of the main geological units has been presented by the Ministerio dos Recursos Minerais; Direccao Nacional de Geologia; Republic de Mozambique and the relevant section for this study is shown in Figure 2. A generalized vertical profile of the main geological strata from west to east across the region is taken from Ferro and Bouman (1987) and shown in Figure 3.

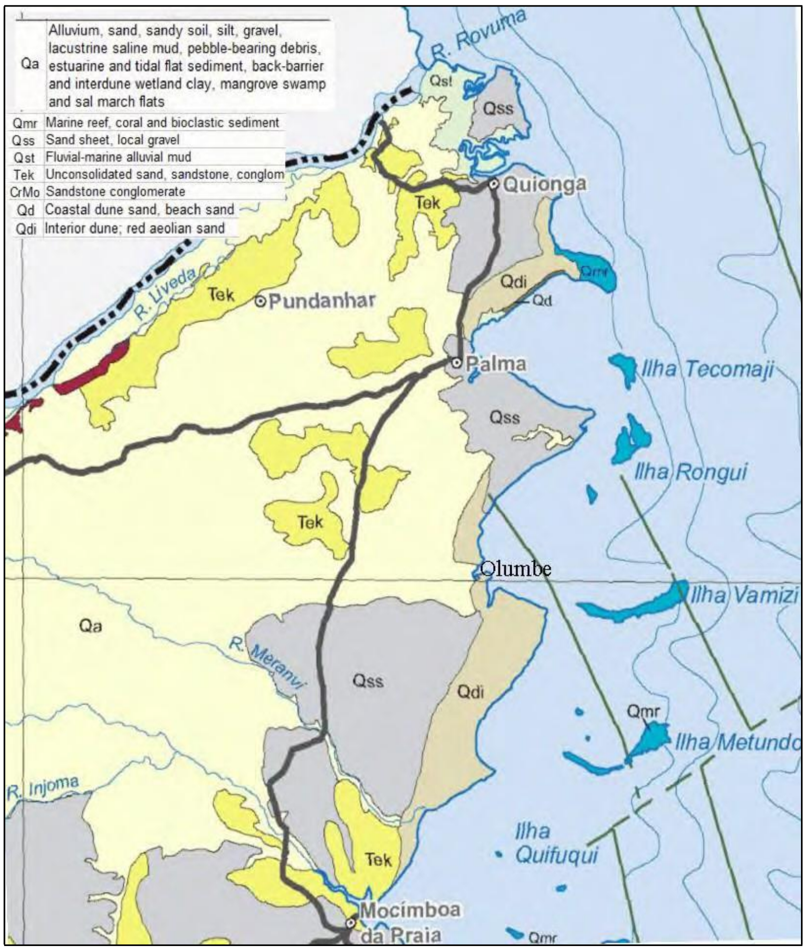
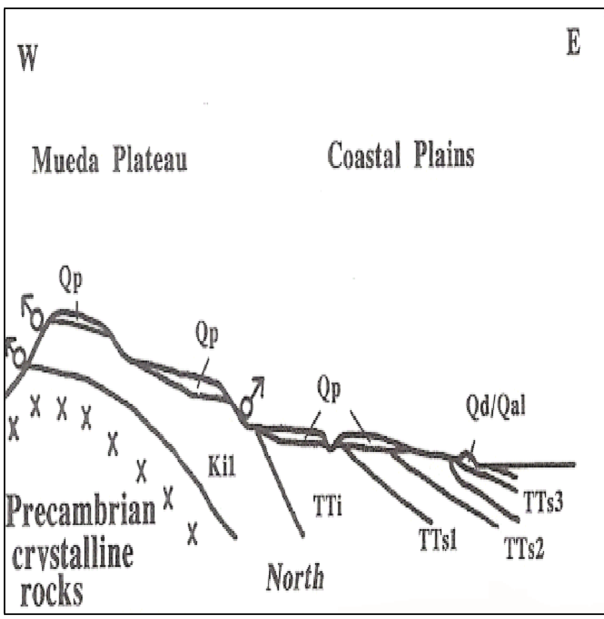


Figure 2: Geological units for the study area (from Carta Geologica; Ministerio dos Recursos Minerais; Direccao Nacional de Geologia; Republic de Mozambique)

The coastal margin of the Study Area is dominated by unconsolidated Quaternary coastal dune and sand sheets with local gravel beds (Qd and Qs) that overly the littoral limestone (reefs) and sandstone beds of the Mikindani Formation. The interior region of the Study Area is generally covered by Quaternary deposits comprising alluvium, silt, gravel, debris, mud, pebble bearing debris, estuarine and tidal flats with back-barrier and interdunal wetlands. Underlying these recent sandy sediments, and occasionally outcropping, is the extensive Makindani Formation (TeK) that underlies a large portion of the Study Area. At varying depths, these quaternary and tertiary sedimentary aquifers overly the Cretaceous sandstone and marlstone deposits of the Maconde Formation that generally are not suitable aquifers because of their lower permeability and poor water quality.

According to Ferro and Bouman (1987), along the entire coast one finds Pliocene to recent calcarenites and limestone reefs which occur on the Quionga peninsular (Figure 2) but may exist under the more recent aeolian or marine sands that generally cover the coastal margin.



FORMATION		HYDROGEOLOGICAL GROUP
Qal	Quaternary	A123,C1
Qal,Qd,Qp	Quaternary	A3,C1
TTs3	Littoral limestones	B3
TTs2	Mikindani Beds (Sandstones)	B3
TTs1	Sandstones and calcarenites	B3
TTi	Sandstones and marlstones	C2
Ks,Ki2	Marlstones	C2
Kil	Maconde Sandstones	B3

Figure 3: Generalized geological cross-section from West to East across the study area from Ferro and Bouman (1987)

The paper by Salman & Abdula (1995) reviewed the geological cross-section passing directly through Palma (Figure 4). The gently East-West sloping sedimentary deposits shown in Figure 4 are considered to be representative of the underlying geological stratigraphy along the entire coastal region of the Study Area. The salt domes are generally too deep to affect the shallow boreholes in the Quaternary-Pliocene/Miocene sediments that are the main target for rural water supply.

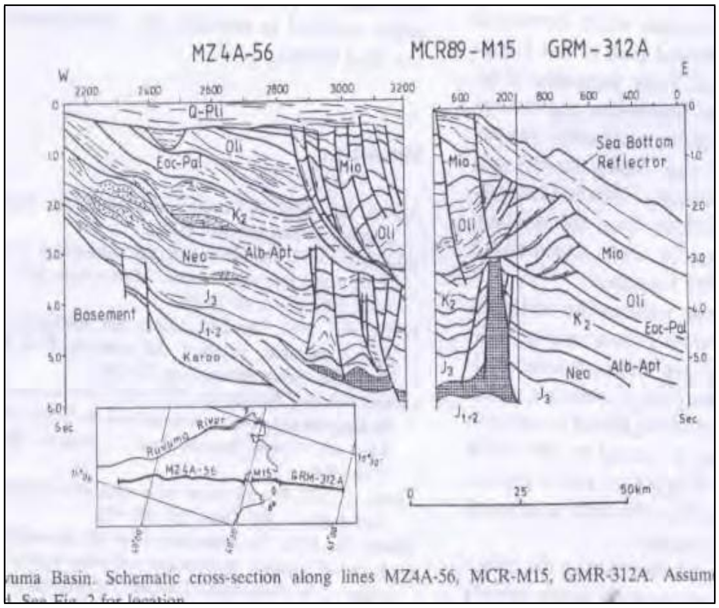


Figure 4: Rovuma Basin: Schematic cross-section along the indicated lines passing through Palma (from Salman and Abdula, 1995)

The upper formations are evident in the road cuttings and excavation along the main roads. A profile through the upper layers showing the recent aeolian sands overlying pebble beds and the red clayey sands of the Mikindani Formation are shown in Figure 5. The pebble beds are being mined in the river valley to the south of Palma (Figure 6) and are one of the few sources of building material in the region.

Figure 5: Geological profile in road cutting on Rovuma.

Figure 6: Sand/**pebble** mining near

2.1 DUAT/Afungi Geology and Hydrology

Several studies have reported on the geology and hydrology of the Afungi site. Moore Spence and Jones (2012) indicate that the geology is dominated by alluvial, littoral and aeolian sediments comprising sands, silty sands with subordinate lenses and layers of clayey sand, clayey silt and sandy clay. They also mention that the western section of Afungi comprised predominantly sandy sediments that are underlain by the Mikindani Formation comprising siltstone and mudstone at depth ranging from

23m to over 90m below ground level. The Mikindani Formation of Miocene Age has been eroded and infilled with alluvial/littoral sediments during periods of marine regression and transgression. It is probable that similar conditions occur along the coast from Olumbi to Quionga. As part of their investigation Moore Spence and Jones (2012) drilled 20 shallow boreholes to depths of approximately 2m below the water table reaching depths ranging from 2.7mBGL to 9.0mBGL. Water samples were collected for these shallow boreholes and analyzed for major anions and cations as well as some minor constituents. The results indicate that all the samples had TDS values ranging between 70 to 480mg/l with one exception (2500 mg/l). In one sample (GW1) the alkalinity accounted for ~75% of the TDS with Na, Ca and CL contributing the rest of the dissolved substances. In another sample (GW12) these dominant constituents only contributed 20% of the dissolved solids with small contributions from Aluminium and SO4 (2%). The greater proportions of the TDS are unknown. In GW16 the TDS comprised almost entirely (>90%) of the same constituents. However, in the GW5 sample, these constituents with small contributions from K, Fe, NH3 and Al only contributed <10% of the total dissolved solids, so the greater proportion of dissolved substances are unknown. This sample had a very high turbidity (>400 NTU) which could have affected the

TDS analysis; there was no clear evidence for this observation other than a contamination of the sample.

The analysis of all the heavy metals and other ions were generally below the detection limits and those that were determined are all within the South African Standard for Drinking Water with the notable exception of Aluminium and Lead. Moore Spence and Jones (202) also indicated high turbidity values in all the samples taken from the shallow augured holes. This may indicates some contamination of the groundwater sample that could have affected the results.

On the basis of these and other studies, the groundwater samples in this study are expected to show a similar trend, so only the major ions have been analyzed for their contribution to the total dissolved substances (TDS) described in a latter section. It is also anticipated that the hand dug wells will have high levels of contamination and will differ substantially from the drilled and sealed boreholes with hand-pumps. Consequently a sample of both wells and boreholes were sampled in this study.

2.2 DUAT/Afungi Aquifer

Table 1: Aquifer properties from ERM (2012) study

Aquifer	Lower range (m^3/hr/m)	Upper range (m^3/hr/m)	Source
Mikindani Formation	0.13	1.1	MacDonald and Davies (2000)
Littoral carbonates	0.53	3.3	Ferro and Bouman (1987) Steyl and Dennis (2009)
Quaternary alluvium	Not specified		Smedly (2002)
Sand & gravel aquifers	Not specified		MacDonald and Davies (2000)

An EIA study of Afungi Project Site by ERM (2012) for the Project derived groundwater yields given in Table 1. ERM (2012) also claim that the primary aquifer has transmissivities of between 2 and 200 m^2/day, which is comparable to the values derived from the groundwater modelling study described later. Knowledge of the coastal plain formations and the limited available data for the study site do indicate that the primary aquifer occupies the entire study area and lies in the various formations depending on the depth of the river valleys that are in the stratigraphic profile.

ERM claim the water table varies seasonally by a “few meters”. ERM (2012) also drilled 14 boreholes in the Afungi site to depths of between 35 and 90m, considerably below the water table. These boreholes were monitored and sampled by ERM (Table 2), who found all the boreholes with one exception exceeded the water quality guidelines for Mozambique for a range of cations and anions. Based on their results the following constituents will be analyzed in this study Na, Ca, Mg, Mn, Fe, Pb, Cl, SO4, HCO3 and B).

Table 2: Borehole results from ERM study in September 2012

BHID	Depth (mBGL)	Blow yield (l/s)	Constituents exceeding Mozambique water quality guidelines
LNG-W001	90	4	Na, Cl, Fe, Pb
LNG-W002	39	4	Pb
LNG-W003	60	3	pH
LNG-W004	60	3	pH, Pb
LNG-W005	60	3	Fe
LNG-W006	60	10	Fe
LNG-W007	84	1	PH, Pb
LNG-W008	60	2	Not sampled (broken pump)
LNG-W009	85	0.3	Not sampled – insufficient water
LNG-W0010	50	3	EC, Ca,Mg, Na, SO4, Cl, B, Fe, Mn
LNG-W0011	45	3	pH,Cl, Fe
LNG-W0012	37	3	Fe
LNG-W0013	35	6	pH
LNG-W0014	40	6	None

3 RAINFALL

According to Ferro and Bouman (1987), the rainfall varies between 800mm/yr at the Pemba coast to over 1200 mm/yr on the high Mueda Plateau approximately 100km to the west of the Study Area. Their studies also indicate that the recharge capacity is medium to high in the north, and the rivers are seasonal to ephemeral.

The rainfall data described in Ferro (1987) was similar to more recent rainfall data (e.g. CROPWAT rainfall data 1978 – 2008 used in the Agricultural section of the survey) which described the same the same rainfall patterns used by Ferro (1987).

The complete 10-day rainfall series have been obtained from FEWS.NET Africa Data Dissemination Service for the INAM stations in northern Mozambique. The data for Palma is available from 1951 to 1977 with some missing periods. The complete duration 10-day series is plotted in Figure 7. All the missing values have been replaced with the seasonal average value (Figure 8). No data is available for the period from 2001 to the present although the EIA report by ERM for Afungi does show the average monthly rainfall for Palma from 1978 to 2010. However, this data from 1978 to 2010 is currently not available for this report. The rainfall analysis presented below is based on these acquired 10-day rainfall record, which shows the same seasonal trends as those presented by ERM.

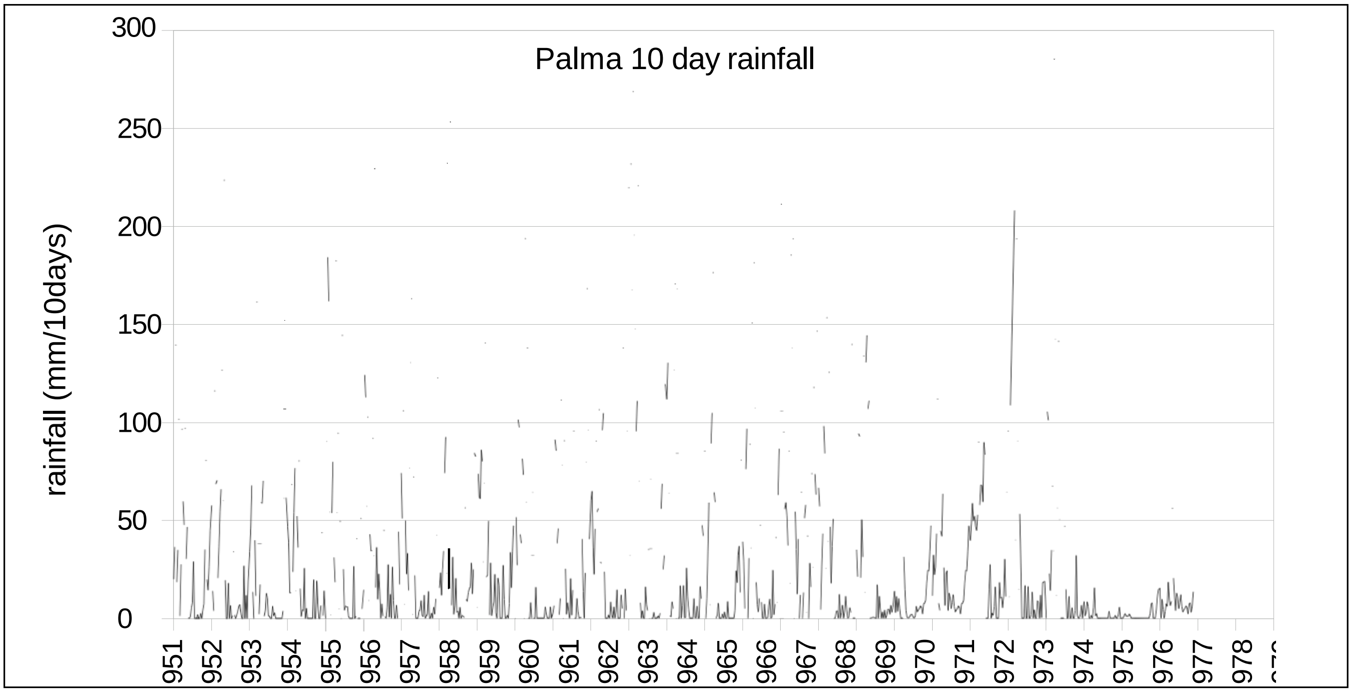


Figure 7: Palma 10 day rainfall totals from 1951 to 1977 from INAM through the FEWS.NET Africa Data Dissemination Service

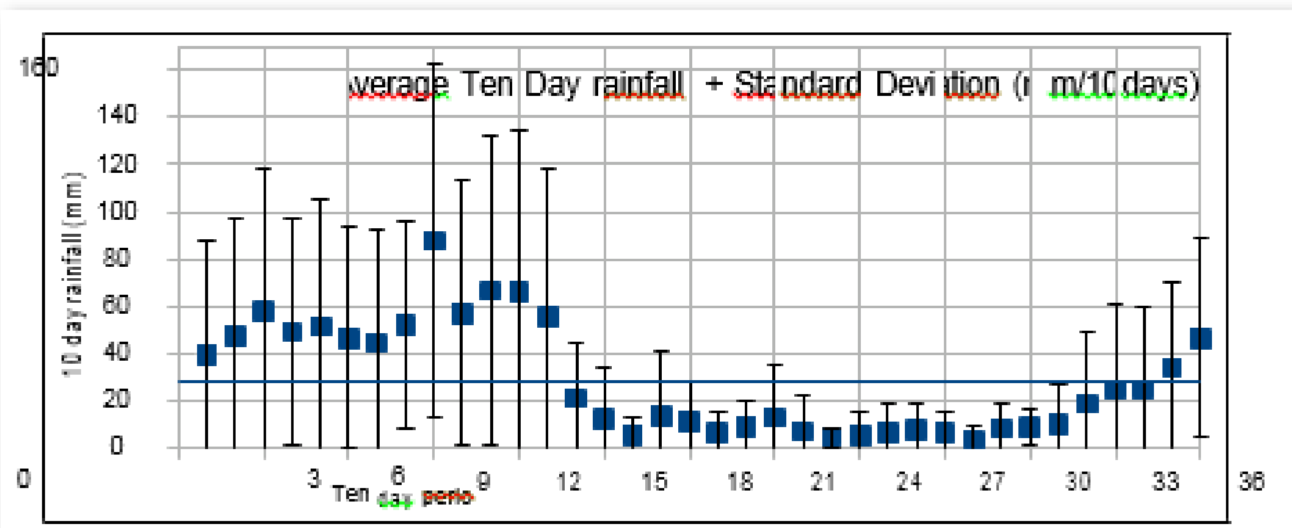


Figure 8: The 27 year average 10 day rainfall for Palma (INAM Station CD000028) from 1951 to 1977

The probability of exceedance for 10-day rainfall events is shown in Figure 9. There is a 7% probability that the rainfall could exceed 100mm in 10 days and a 35% probability that the period had no rainfall.

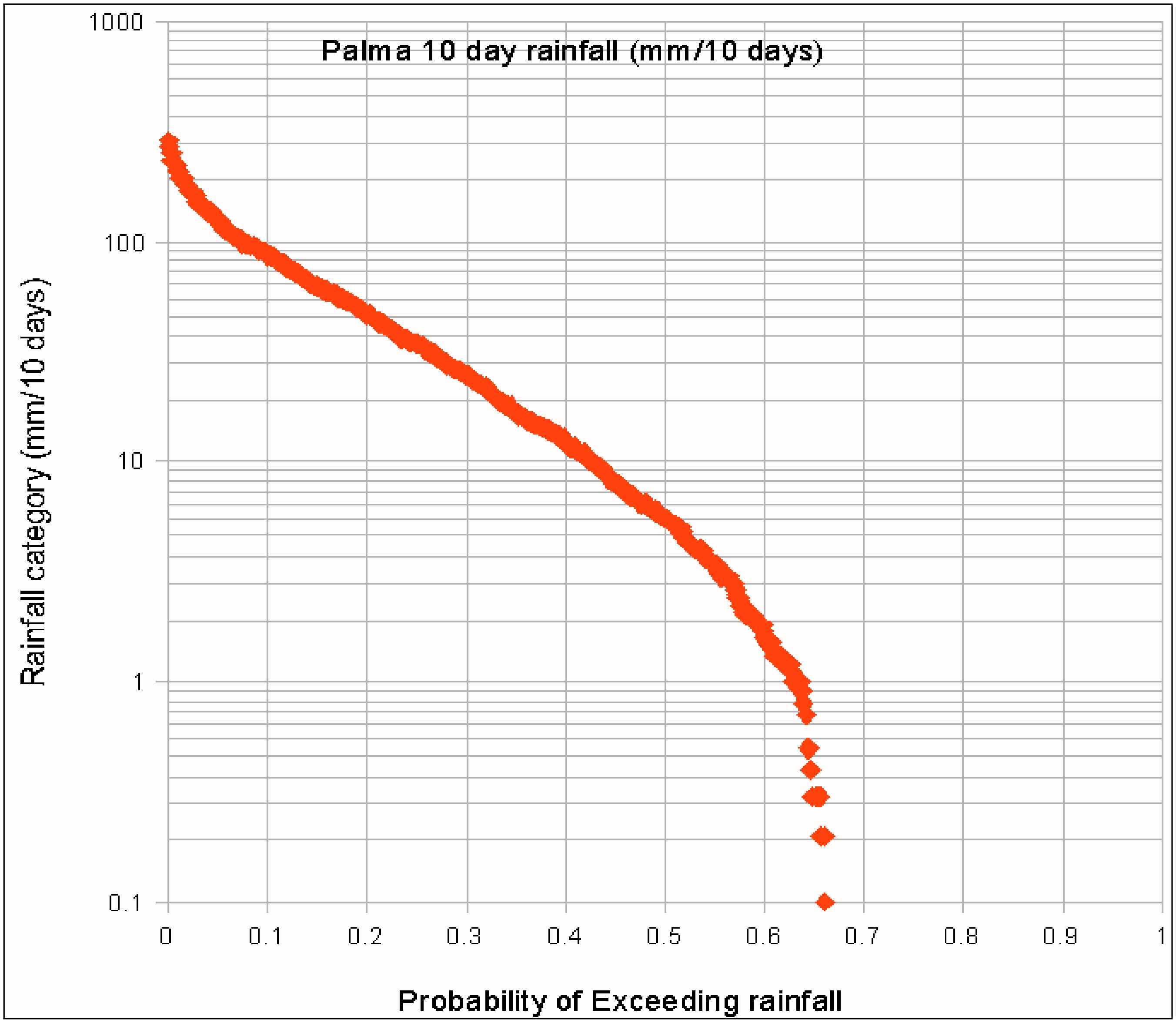


Figure 9: Rainfall probability for 10 day events

4 GEOMORPHOLOGY

The Study Area is characterised by deeply incised river channels and multiple depressions that form the many wetlands and lake features covering much of the Study Area (Figure 11). The vertical profile perpendicular to the many river valleys in the Study Area were surveyed at approximately 10m intervals using a handheld GPS that was calibrated at the start and end of each track using the Palma base camp Trig Beacon (51mMSL) shown in Figure 10. Three cross-sectional profiles are shown in Figures 12. The locations of the river valleys labelled in Figure 12 are shown in Figure 11.

Figure 10: Trig Beacon in Palma Camp. Elevation 51.2m

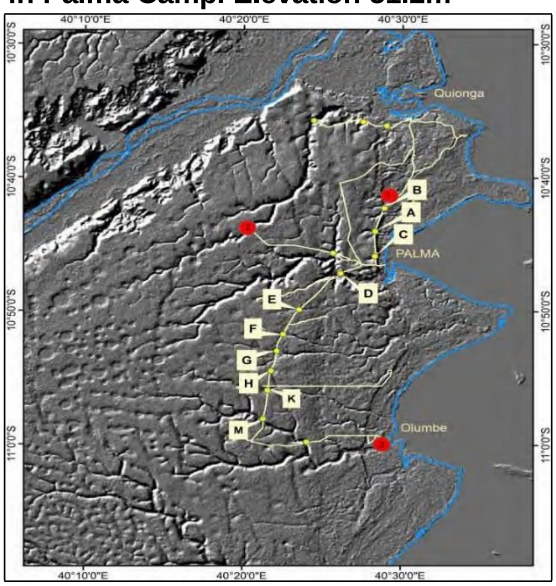


Figure 11: DEM and GPS tracks. Symbols show the location of the river valley labelled in Figure 12. The large red dots show the location where river flow was detectable but could not be measured accurately. The smaller yellow dots show the road crossing (culverts) where no river flow was detectable.

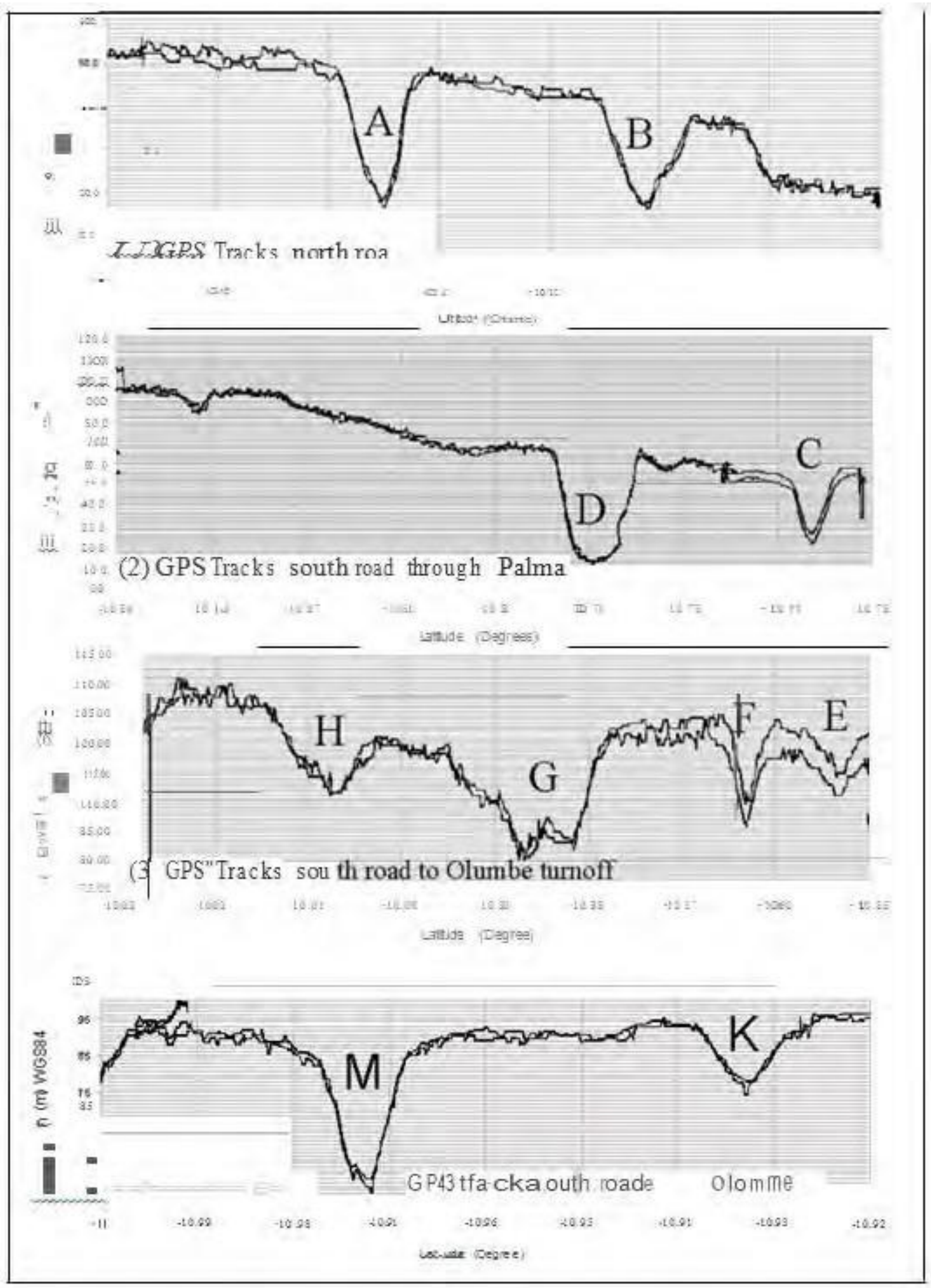


Figure 12: The GPS outward and return tracks to the north (1) and south (2&3) of the Palma Study Area showing the elevation profile of the terrain, including ten individual river valleys.

5 HYDROLOGY

A visual survey of all river crossings on the accessible road and those wetlands that could be reached by road were checked for flow and water level.

5.1 RIVERS

At all the road crossings (culverts), it was determined that there was no flow, with the exception of three culverts whose location is shown in Figure 11. In nearly all cases there were no clear river channels except for the construction of a road culvert. The three sites with apparent identified flow are described below;

- **SITE 1**: Generally, along the northern road from Palma to Quionga, the culverts were 1m wide and 1 m deep. Flow was estimated at 10m^3/day from tributary crossing (Figure 13) while the wetland occupying the second culvert on the same river (different tributaries) may have had some flow but it was not possible to measure the flow direction or rate.

Figure 13: Site 1: River crossing with ~10m3/day flow on 25/06/2013

- **SITE 2:** Several small streams were crossed on the road to the west of Palma but only one had any detectable flow into a wetland (Figure 14). The flow was estimated to be about 20m^3/day.

Figure 14: River crossing at Site 2: 4 pipes (18cmID) with flow of approximately 20m3/day into the wetland

- **SITE 3**: The estuary draining into the Indian Ocean just south of Olumbe had flow at several points across the road crossing (Figure 15). Results from the laboratory analysis for selected ions, shows very high concentrations for sodium and chloride indicating that the flow at this location is most likely to be the tidal return flow. The rate was measured at 100 m^3/day at one section but this is not a true reflection of the flow rate in the river. The reason for this was that no flow was observed at several road crossings upstream of the estuary so it must be assumed that the flow rate in this river was negligible during the reporting period.

Figure15: Site 3 river crossing that was tidal with the possibility of some freshwater flow (<100m3/day) from right to left.

There has been significant damage to the road culvert (Figure 16) on section D (location shown in Figures 10 & 12) which appears to have been caused by erosion which would suggest that there can be large flood events in this river during the summer rainfall period. The construction of large road culverts on the main road from Palma to Olumbi turn-off (Figure 16) also suggest that there can be large flow events although there was no clear evidence of a river channel at these sites.

Figure 16: Dry road culverts on the route from Palma to Olumbi turnoff. (Left) culvert at section D and (Right) culvert at section G in Figures 10 and 12.

5.2 PANS AND WETLANDS

There are numerous pans, lakes and wetlands across the Study Area, particularly in the higher regions to the west of Palma (see Figure 1). These wetlands are used for both water supply and subsistence agriculture (see rice field in Figure 16). The valley bottoms of many of the larger rivers have wetlands and shallow groundwater that is also used for water supply and agriculture (see groundwater section). The numerous wetlands in many river valleys would have a large moderating effect on flood waters and they are probably the reason there are generally no clear eroded river channels with steep banks.

A water tanker was observed at the edge of pan to the west of Palma (Figure 17) where it is assumed they were collecting water for the local community. There were numerous hand dug wells around the outer edges of this pan that were being used by the local community for water supply.

Figure 17: Water abstraction point on the pan to the west of Palma

It is highly likely that all the pans, lakes and wetlands are extensions of the regional groundwater. Based on this assumption, most of the identifiable open water bodies were captured in Google Earth and their elevation captured from SRTM data to form the initial calibration targets for the construction of a regional groundwater model to simulate the water table profile discussed in the next section.

6 GEO-HYDROLOGY

The Study Area lies on the extensive coastal plain that runs along the east coast of Mozambique. Most of the stratigraphic units in this area are assumed to be unconsolidated sediments (see Figure 5) which form this coastal plain to create an extensive primary aquifer that is the main water supply of the local people. There is virtually no sign of surface (overland) flow with the exception of roads, although groundwater seepage was observed on the edge of a river channel near Olumbi (Figure 18). The aeolian cover sands along the coast are generally very permeable and lead to direct recharge from all rainfall events that are greater than about 10mm over 5 days. Nearly 30% of all historical 10-

day periods had rainfall of >20mm (Figure 9) that are assumed to lead to significant recharge to the primary aquifer.

Figure 18: Groundwater seepage into the estuary south of Olumbi

The groundwater in the primary aquifer is controlled by the recharge rate (rainfall), the hydraulic properties of the soils (hydraulic conductivity and storage coefficient), and the elevation of the drainage boundaries (rivers and ocean). Nearly all the rivers were dry during the site visit, so it must be assumed that the groundwater profile (gradient) along these drainage boundaries was very low. In an attempt to define the groundwater profile across the Study Area a groundwater model was created using the MOFLOW2000 code developed by the US Geological Survey (Harbaugh *et al*, 2000).

7 DETERMINE THE WATER DEMAND REQUIRED FOR THE RESETTLEMENT

The current water consumption by the local community is generally very low. There is no piped water to individual community dwelling and all the rural villages use hand-pumps or hand-dug wells for their water supply. These communities collect their water requirements, sometimes travelling large distances of several kilometers, in 5-20 liter buckets that they carry on their heads or bicycles. A general estimate is that the average person uses less that 20l/day for domestic needs. Many people do their ablutions and washing at the wells and wetlands. The borehole data that is available for Afungi indicates that boreholes have yields of between 0.1 and 3m3/hr/m (2-70 m3/day/m). The many hand-pumps that were observed in the outlying villages generally had no queue of people waiting for more than a few minutes, which suggests that a hand-pump can supply a fairly large village of several hundred people.

ERM (Chapter 8) state that Palma district has a small water supply system located in Palma town. This is supplemented by a number of other sources such as open wells, rivers, creeks, boreholes with hand-pumps and other surface water sources such as rivers, streams, lakes, lagoons and pans. The 2007 Census showed that the vast majority of households in the District rely on unprotected water sources such as open wells (60%); rivers, lakes and lagoons (7%); and other unspecified sources. The proportion of households relying on protected water sources is 31%, out of which 27% utilize covered wells, 3% utilize boreholes with a hand-pumps and the remainder depend on water from the main water system in the town. Table 3 shows the sources of water available in the Palma District in 2011 and outlines the availability of these sources. Further boreholes with hand-pumps have recently been installed by GM Todd Drillers and the location and details have been requested but not yet received.

Table 3 Sources of Water in the District by Administrative Post, 2011(From ERM report)

Location	**Wells**		**Boreholes with pumps**		**Total Hand-**		
	Op	**Not Op**	**Op**	**Not Op**	**Op**	**Not Op**	**Total**
Palma District	26	9	53	17	79	26	105
AP Palma Centre	9	5	30	10	39	15	54
AP Olumbi	6	3	17	5	23	8	31
AP Quionga	9	1	2	0	11	1	12

Key: *Op: Operational.*
Not Op: Non-operational. AP: Administrative Post.
Source: Palma District Services for Planning and Infrastructures, 2011. (From ERM, 2012)

8 SITE VISIT & DATA COLLECTION

The site visit was arranged to collect baseline data on the groundwater and its use by the local inhabitants in the area outside the DUTA (Afungi Peninsular). An EIA has been conducted on the Afungi peninsular and is summarized below. Consequently, this area was not incorporated into this study.

Tension between the local administration and community elders, the concern over contamination of water supplies by the local communities, and the need to be discrete about the overall purpose of the study hampered the initial survey.

The Palma administration provided all the information they had on the boreholes but it was not up-to- date and it lacked all the necessary information required for a hydrocensus. No information is available on the borehole construction, borehole logs or yields from the local administration. WorleyParsons arranged for a survey of the GPS coordinates of the hand-pumps and their status, but this data is not available for this report and may not be able to provide the geological logs or water level profile needed to locate variations in the hydraulic properties (lithology) across the

Study Area. It is important that these geological logs are acquired to assist in the planning of drill sites for future water supply. Attempts are continuing to acquire this information from the drilling companies where they can be identified (G M Todd).

Prior to the installation of the centralized reticulation system and hand-pumps for the local villages and in areas without hand-pumps, the local communities collected their water requirements from hand-dug wells and wetlands. Where the hand-pumps are broken or require maintenance and no longer functional the local communities have continued to use the wetlands and hand-dug wells.

In Palma there is a centralized water supply system with taps at strategic locations (Figure 19), but the local community still use the local wetlands (Figure 20) and possibly tanker supply from the local pan (Figure 17). In the village just to the south of Palma a centralized water supply system has been installed using a borehole (Figure 21).

The use of groundwater is generally dependent on the depth to the water table. Most hand-dug wells are less than 2m in depth (Figure 22), but one was measured at >5m (Figure 23). This increased depth to the groundwater can be explained by the fact that the distance down to the water will vary with the topographic profile and the water table profile. Near the low lying depressions, river valleys and pans, the water table depth will be very shallow and often exposed. The depth to the water table increases rapidly away from these areas as the topography changes more rapidly than the water table profile. Most of the hand-dug wells are in low lying depressions or on the verge of wetlands (Figure 24) within walking distance (several kilometers) of the local community.

Figure 19: Palma centralized water supply

Figure 20: Community use of the Palma wetland in the background. Foreground is the dry

road culvert

Figure 21: Centralized groundwater supply

Figure 22: Example of a shallow hand-dug well

Figure 23: Deep hand-dug well with the water table at ~5.6m near the village with centralized water

supply (Figure 21)

Figure 24: A typical example of the local community water supply and use in low lying areas where the water table is within several meters of the surface.

The location and photographic record of the road culverts, hand-pumps, wells and wetlands have been recorded in Google Earth and are supplied with the report in *.kml format.

9 GROUNDWATER MODEL

The groundwater model was created to map the water table profile using the MODFLOW 2000 code (Harbaugh *et al*, 2000) based on the conceptual geological model described above. The SRTM digital elevation model (DEM) was used to create the surface topography (Figure 11). The external boundaries were set along the coastline, Rovuma River, Maranvi River and a no flow boundary to the inland of the highlands in the west (Figure 25).

The SRTM elevation (Figure 11) for all the exposed lakes, pans, and open water wetlands were used as initial targets for calibration of the hydraulic properties, (there are no available data to define the flow lines, groundwater divides so it was assumed the defined drainage boundaries were sufficient to define the water table profile where they were active).

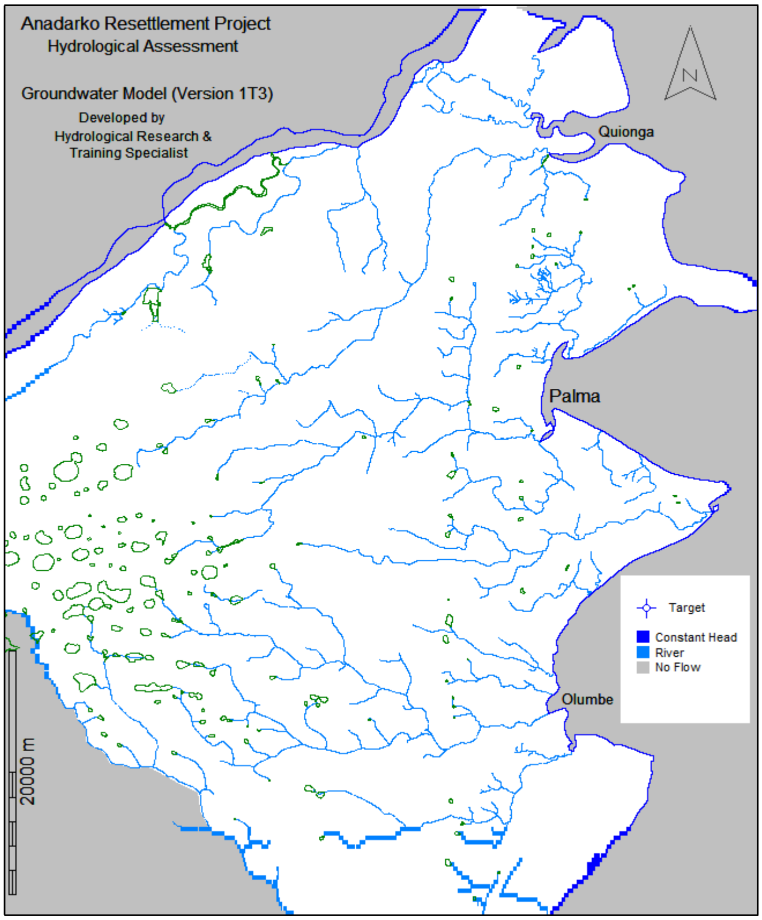


Figure 25: The model domain showing the external and internal boundaries of the groundwater model

The recharge was based on the average seasonal 10-day rainfall (Figure 8) and calibrated against the river flow during winter. The flow in summer is unknown, so it was not possible calibrate the recharge for the rainy season. An inverse model (PEST) was used to determine the spatial distribution of the hydraulic conductivity distribution during the parameter calibration. The generated hydraulic profile (Figure 26) was compared to the geological map and does indicate some similarity to the soil types shown in Figure 2. There is a ridge of high conductivities parallel to the Rovuma River and along a north-south transect which general conforms to the Makindani Formation (TeK).

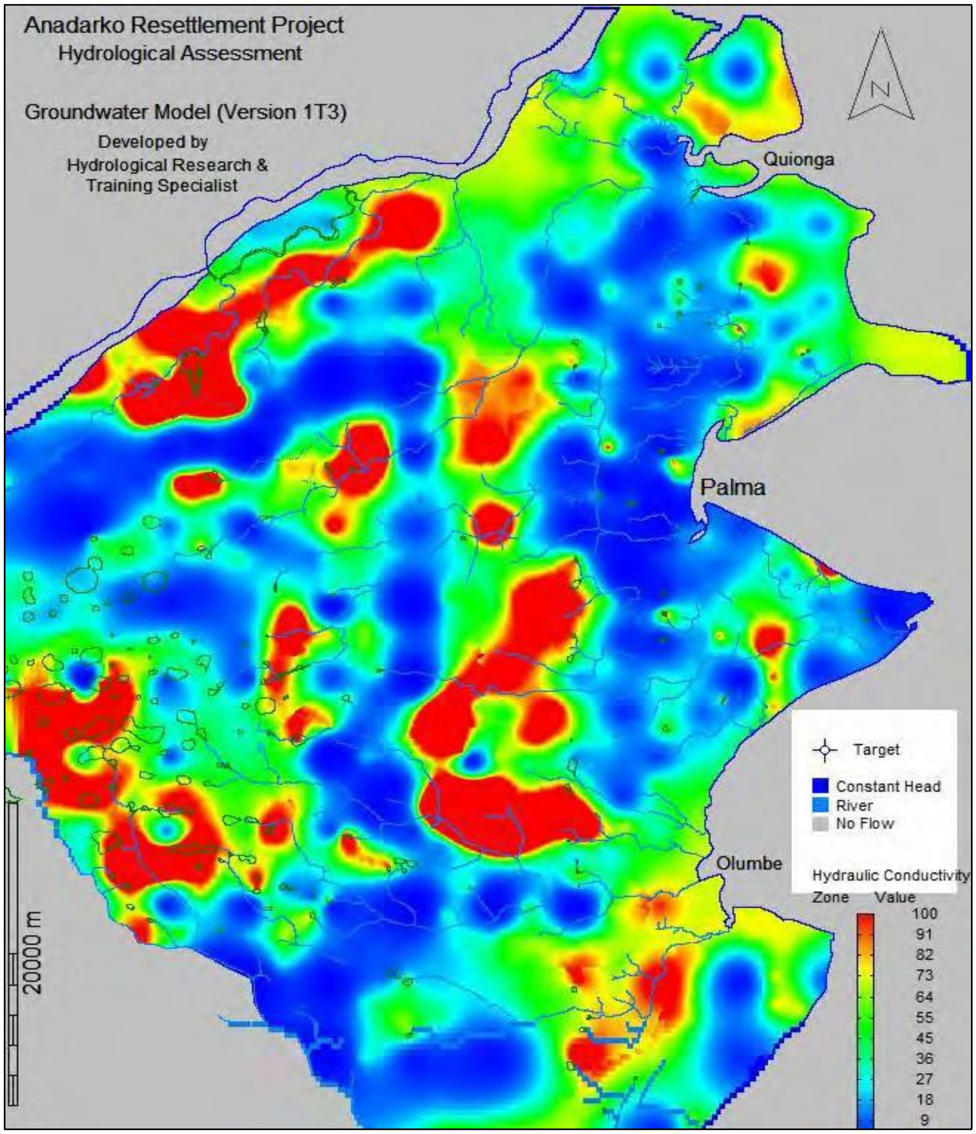


Figure 26: Derived hydraulic conductivities (m/d)

The model-predicted water levels are compared to the SRTM elevations of lakes, pans and wetlands together with other measurement from boreholes in Afungi and the resulting scatterplot is shown in Figure 27. With due regard to the inherent errors in the SRTM data and other assumptions, the model predictions are generally within ±5m across the Study Area. This is considered adequate to assess the depth to the water table, which is considered an important factor in community water supply.

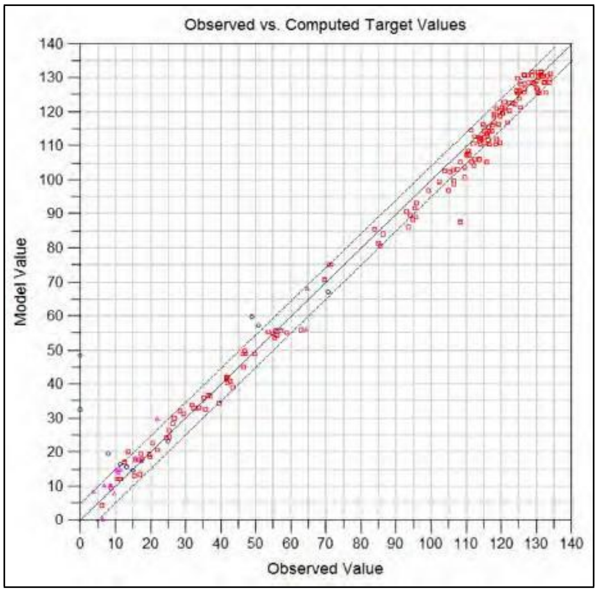


Figure 27: The scatter plot of the predicted and measured heads under steady state conditions

The model predicted water table contours for the average dry winter season conditions are plotted in Figure 28. The steep gradient in the water table profile indicates that the Palma River should have the highest flow rates but it was not possible to find a suitable location to conduct any measurement. The model also indicates that there may be some flow in the upper reaches of the river draining to the sea at Olumbi, but that transmission losses (loss of water through the river bed) will reduce the flow to negligible volumes at the coast.

The depth to the water table was calculated for both the average wet summer period and the dry winter period. The simulated flooded areas during these two periods are plotted in Figure 29 and Figure 30. The model suggests that large sections of the Study Area are prone to surface wetness and potential flooding. In winter the water table drops significantly leaving a much reduced area with surface wetness (wetlands).

The model was used to simulate the depth to the water table in an attempt to demarcate the ease of access to groundwater for the local communities. The depth to the water table is plotted in Figure 31 and shows large sections along the coastal margin with the water table close to the surface (<5mBGL) and easily accessible through hand dug wells. It is important to remember the inherent errors in the SRTM data that would increase the error margin for these predictions.

Access to the groundwater is only restricted in the Study Area by the depth to the water table. Nearly all villages have been provided with boreholes that have hand-pumps fitted. While not all of these are in working order, for unknown reasons, they do indicate that groundwater is the main source of supply and is accessible over the entire Study Area. The major physical constraints are the ease of access (depth) and the abstraction rate (potential yield) of the underlying aquifer.

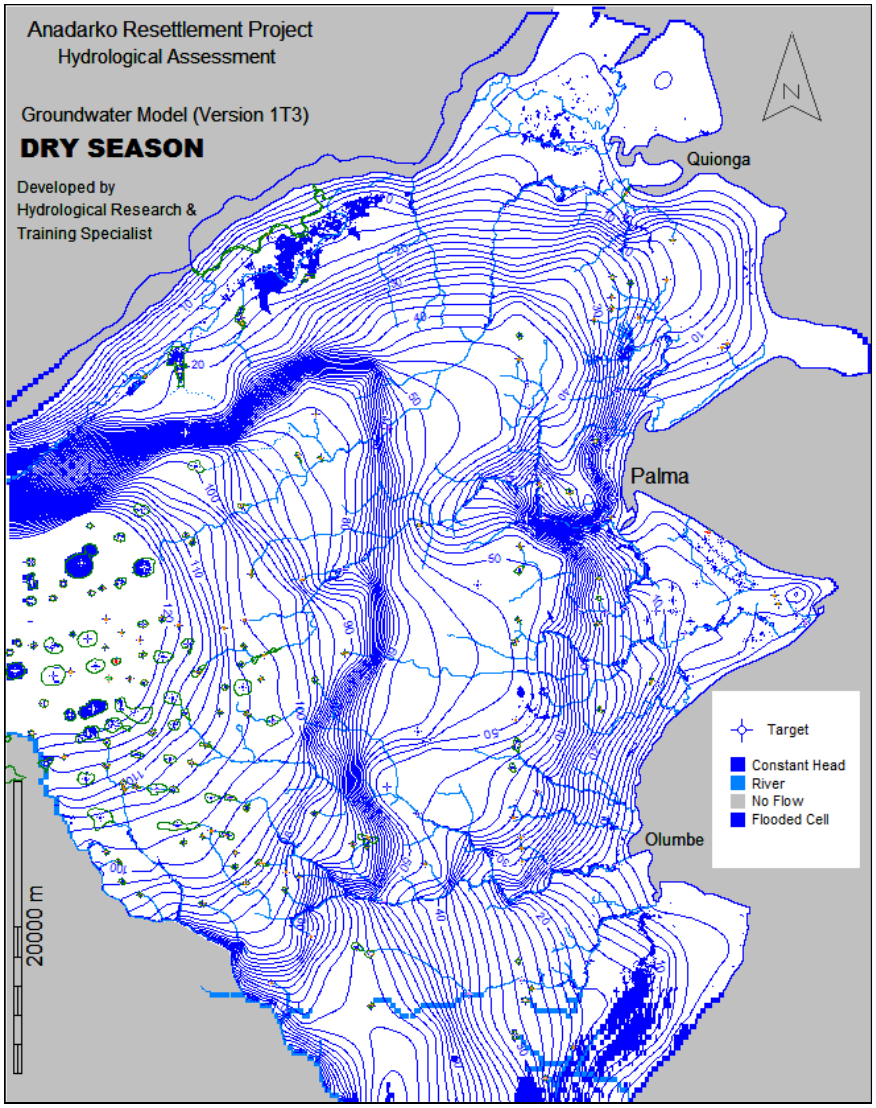


Figure 28: The simulated water table contours (mAMSL) for the middle of the dry period

The water quality constraints are discussed in the next section.

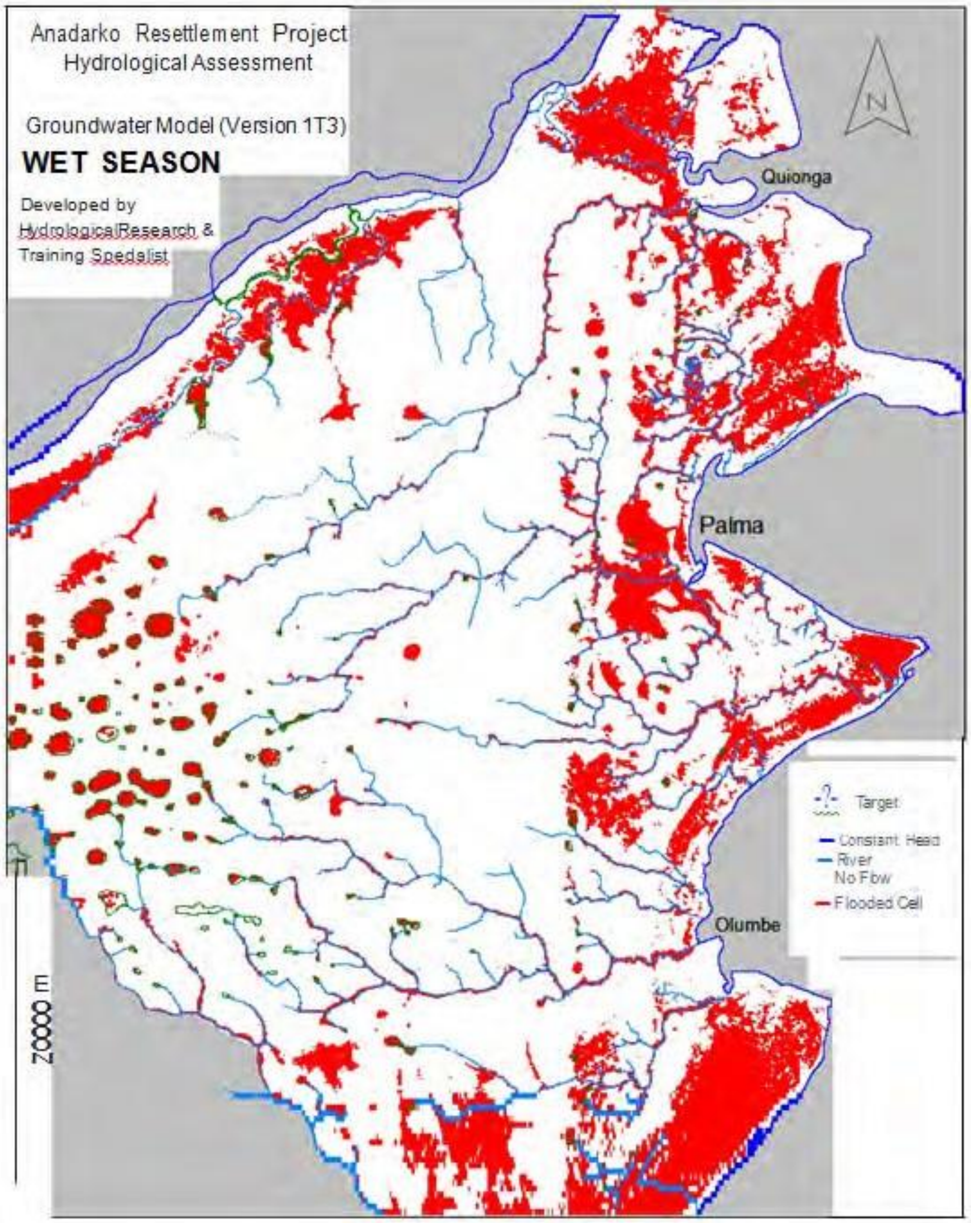


Figure 29: The simulated zones (red) where flooding could occur during the WET summer months

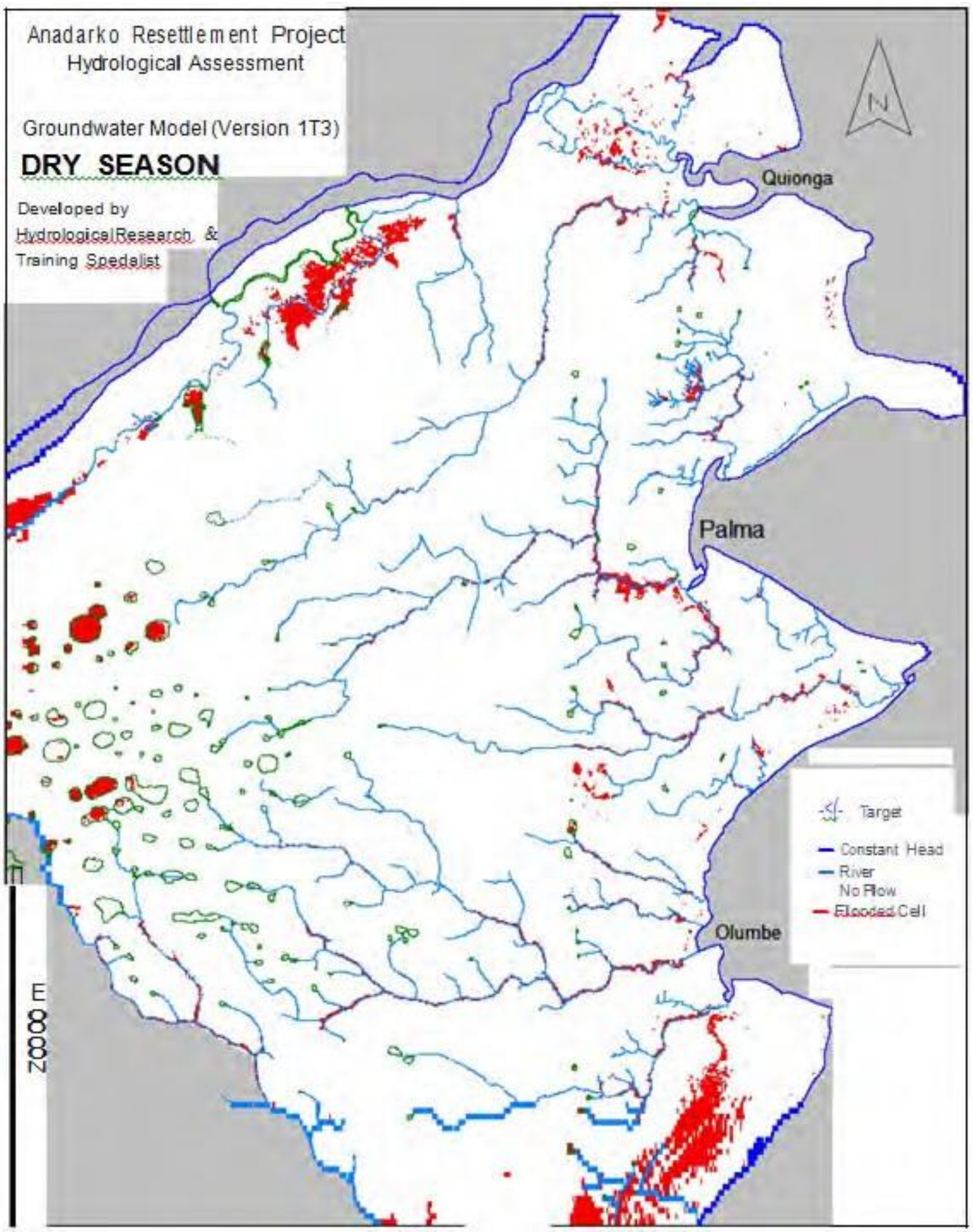


Figure 30: The simulated zones (red) where flooding could occur during the DRY winter months

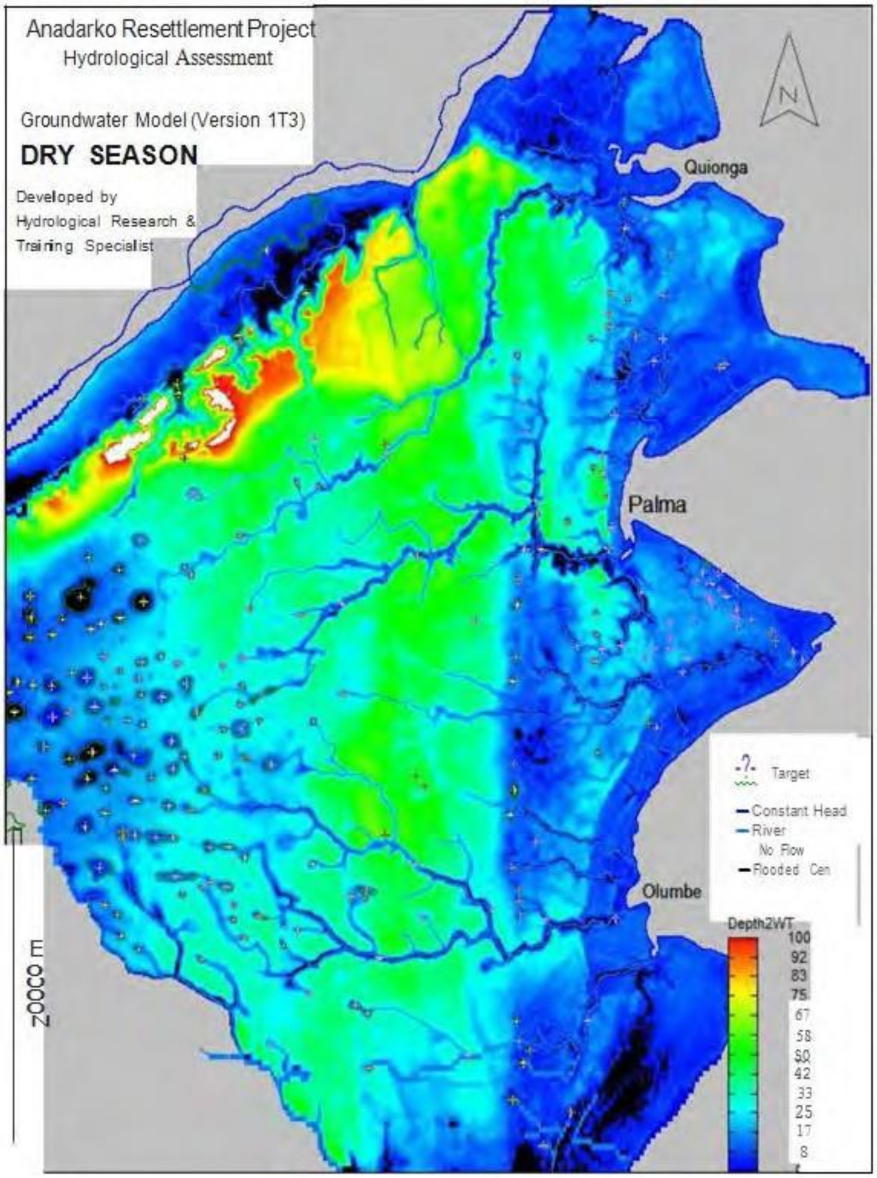


Figure 31: The simulated DEPTH (mBGL) to the water table during the middle of the DRY season

The potential flooded areas (wetlands) across the Study Area are plotted in Figures 32 to 34 from the groundwater model during the average wet and dry periods.

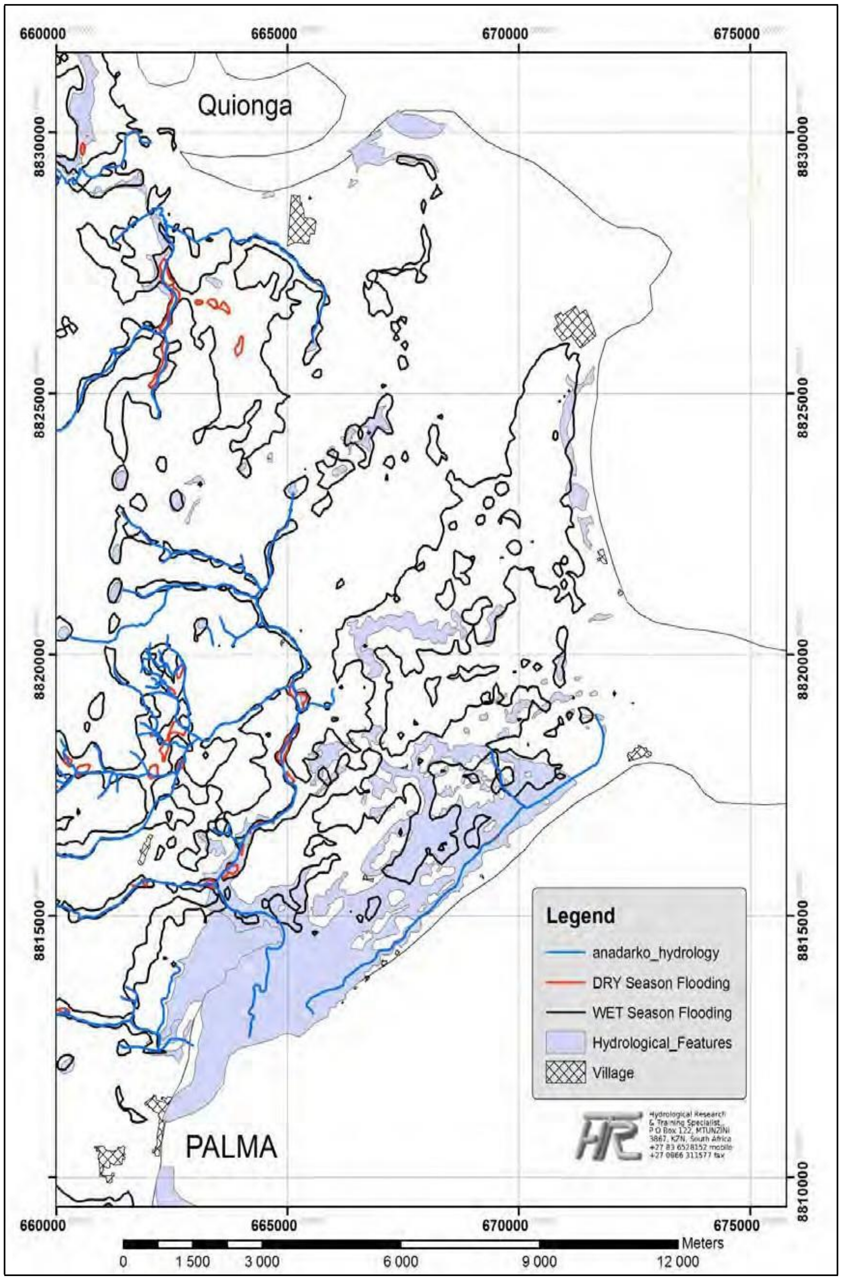


Figure 32: Simulated flood lines for the wet and dry season north of Palma

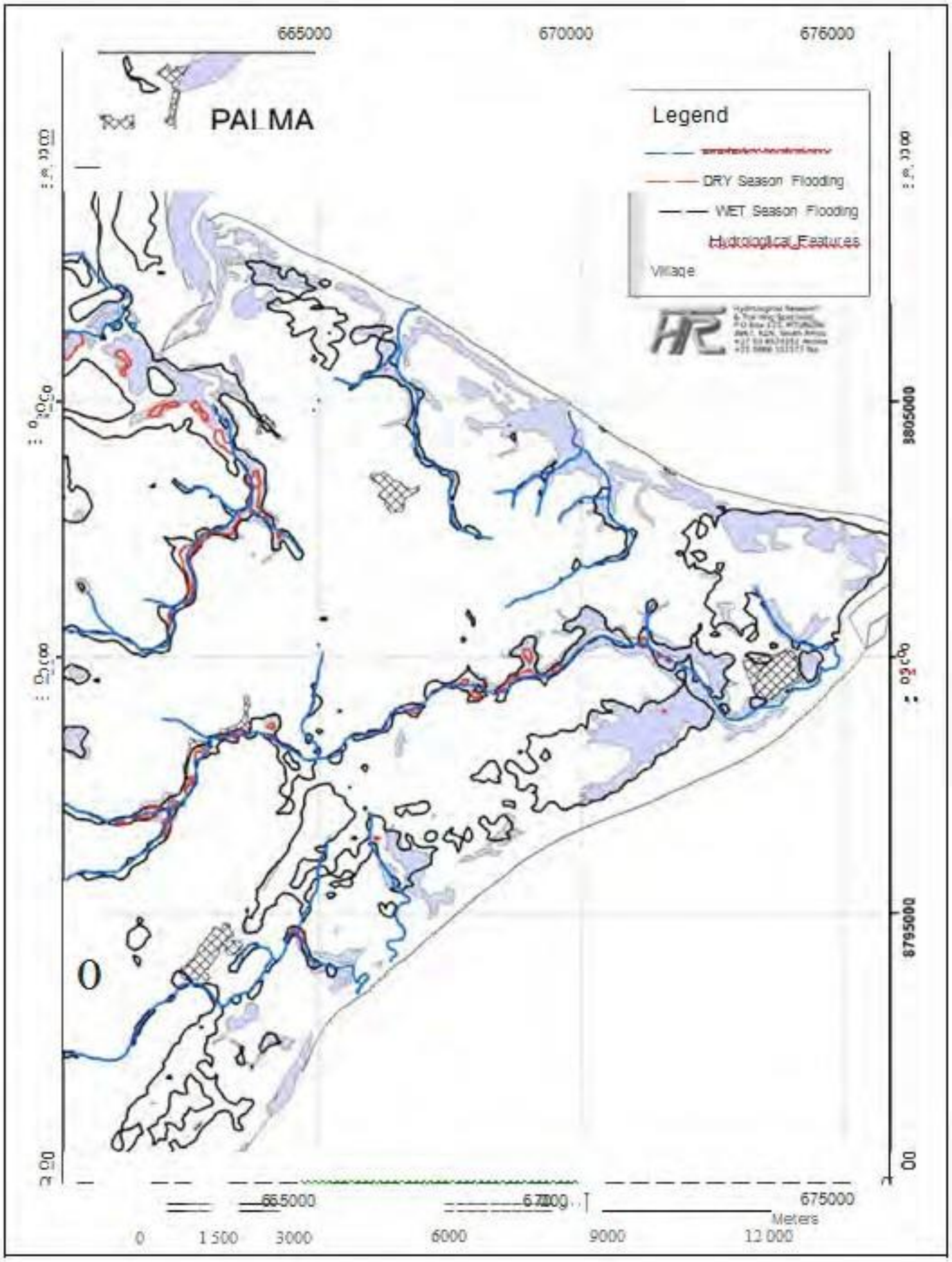


Figure 33: Simulated wet and dry period floodline for the Afungi Peninsular

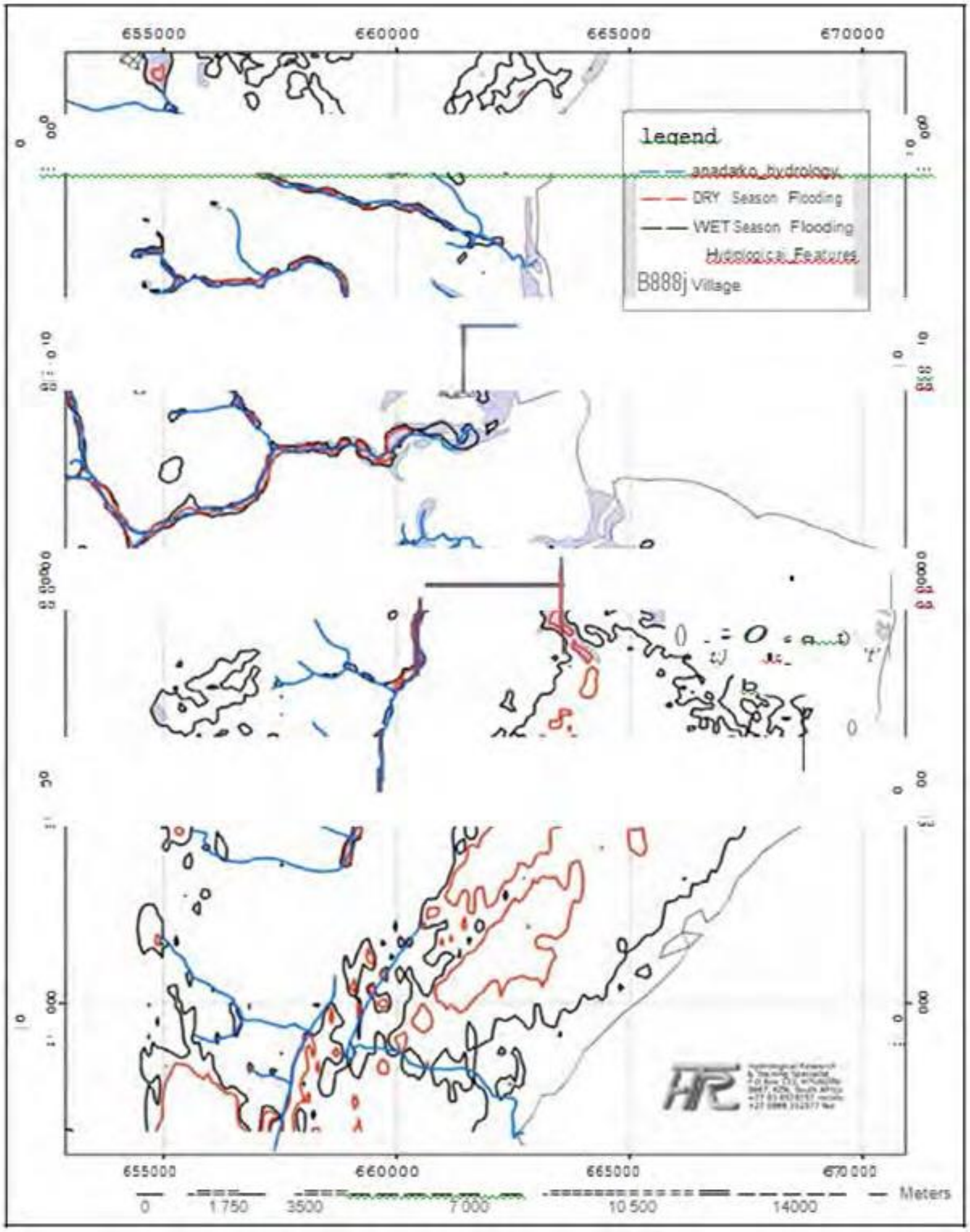


Figure 34: Simulated floodlines for the peninsular south of Olumbi

10 WATER QUALITY

Water qualities of the boreholes in the Afungi peninsular have been presented in the EIA by More Spence and Jones (2012). Of the 4 boreholes drilled only one had TDS of >1000mg/l. However, all the other water quality samples show potable groundwater at depth of between 2-5mBGL. In a separate investigation ERM (2012) sampled 14 boreholes and several community water sources, and found that all but one of these sites had constituent concentrations that exceeded the Mozambican Guidelines for Domestic Water Supply. Based on these two studies the water quality samples from the wells and hand-pumps collected during the field trip from 17 June to 27 June, 2013 were sent to the laboratory (Talbot and Talbot) for analysis of the major groundwater constituents shown in Table 5.

Twenty one (21) water samples were collected during the field trip from 17-27 June 2013 for an evaluation of the surface and groundwater quality at the sites shown in Figure 35. Only three rivers had flow to sample: all the others were dry. The two flow samples in the north (Figure 35) were from very small catchments but are assumed to represent perennial streams that are maintained by the groundwater discharge. The sample from the river in the south may have been part of the tidal flow and needs to be evaluated accordingly. The remainder of the samples were taken from hand-pumps, shallow community wells or from open water pans in an attempt to achieve the greatest coverage of the Study Area (Figure 35).

The details of the sample sites are given in Table 4. The analytical results are given in Appendix 1 and summarized in Table 5.

The water sample from the road crossing at the estuary (SW1) shows high salinity levels, indicating that there is an associated marine influence. The samples taken from the other two streams that were flowing just north of Palma (SW2 and SW3) were will within Mozambique and WHO water quality standards.

The hand dug wells generally had lower concentrations of all ions when compared to the hand pumps, which is surprising. The average of the TDS concentrations for all hand pumps was 290mg/l which was marginally higher than the TDS concentrations for the hand dug wells (230mg/l), where there was much greater risk of contamination. This difference could have been significantly larger but for the very high sulphate levels in the one hand dug well at BH5 just south of Palma. It is probable that the shallow groundwater (represented by the hand dug wells) reflects the influence of the direct recharge (with short residence time) when compared to the longer residence time in the deeper aquifer (represented by the hand pumps).

Generally the groundwater in the hand dug wells and hand pumps is potable by WHO and Mozambican standards, and can provide the necessary water requirements for the basic (domestic) needs of the rural communities. Consequently, the main hydrological constraint for relocating homesteads in the Palma region is the potential risk of flooding and hygiene.

Figure 35: The location of all the water sampling points. SW refers to river flow sites and BH refers to hand pumps, community wells and wetlands

Table 4: The details of the water quality sampling sites

Sample ID	X	Y	Z	Description
SW1	660966	8782765	5	River/estuary road crossing
SW2	664347	8819017	13	Road culvert
SW3	665013	8820378	16	Road culvert
BH1	661634	8784659	14	Village hand pump in Olumbi
BH2	654430	8784085	51	Village hand pump
BH3	645273	8784824	91	Hand dug well on edge of Pan
BH4	648106	8787559	92	Village hand pump
BH5	650204	8798842	80	Hand dug well on edge of wetland
BH6	654705	8791693	52	Hand dug well in wetland
BH7	662395	8793748	22	Village hand pump
BH8	648125	8791774	98	Mine camp water tank
BH9	654941	8801314	59	Hand dug well on edge of river wetland
BH10	652096	8802333	84	Hand dug well
BH11	658655	8808565	48	Edge of pan
BH12	657977	8809261	55	Excavation pit
BH13	646113	8812963	80	Hand dug well on edge of wetland
BH14	647318	8803760	89	Hand dug well
BH15	665222	8828243	28	Village hand pump in Quionga
BH16	671405	8826261	13	Village hand pump in fishing village
BH17	665156	8823203	20	Wetland
BH18	658126	8813358	60	Village hand pump

Table 5: The concentrations of selected ions for stream, wetland, wells and hand pump samples for the Study Area. Also included are the Mozambican and WHO standards for potable water quality

Name	Type	Bicarbonate	Chloride	Boron	Calcium	Iron	Lead	Magnesium	Nitrate	Potassium	Sodium	Sulphate	Tot_Alkalinity	TDS
Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Moz_Std	-	-	250	0.3	50	0.3	0.01	50	50	-	200	400	-	1000
WHO(2011)		-	250	2.4		0.3	0.01		50		200	500		
SW01	Estuary	67	565	0.213	18.0	0.05	0.0000	41.00	0.04	16.00	365.00	62.40	67	1210
SW02	Stream	26	52	0.05	5.9	0.04	0.0000	3.00	0.01	2.40	34.00	3.19	26	139
SW03	Stream	26	41	0.048	3.5	0.17	0.0000	2.20	0.05	3.30	25.00	3.79	26	130
BH01	Hand-pump	21	11	0.022	6.6	0.02	0.0000	1.50	2.41	6.90	6.90	5.60	21	112
BH02	Hand-pump	51	103	0.097	6.2	0.02	0.0000	5.00	0.08	5.60	81.00	23.60	51	354
BH03	Well	53	63	0.056	2.1	0.44	0.0012	1.10	0.34	5.90	151.00	25.80	53	330
BH04	Hand-pump	21	6	0.057	0.0	0.02	0.0000	0.30	3.75	1.30	17.00	4.27	21	136
BH05	Well	30	32	0.048	1.1	0.18	0.0020	0.80	2.09	13.00	14.00	603.00	30	730
BH06	Well	18	20	0.029	1.0	0.03	0.0000	2.20	0.44	2.50	15.00	11.40	18	118
BH07	Hand-pump	18	75	0.034	4.6	0.07	0.0000	3.40	0.04	2.20	41.00	4.73	18	194
BH08	BH Tank	70	142	0.131	8.0	0.04	0.0000	7.50	0.33	6.50	98.00	27.00	70	462
BH09	Well	0	13	0.057	2.1	0.03	0.0000	2.80	0.08	2.10	9.80	16.90	0	142
BH10	Well	17	7	0.056	0.0	0.07	0.0000	0.40	0.10	0.70	9.20	3.28	17	98
BH11	Pan	102	117	0.142	13.0	0.04	0.0000	12.00	0.05	13.00	75.00	11.40	102	374
BH12	Pit	18	27	0.064	1.3	0.01	0.0000	1.00	0.04	2.20	20.00	5.49	18	116
BH13	Well	51	17	0.035	2.0	0.15	0.0000	3.50	0.04	0.90	22.00	2.55	51	116
BH14	Well	0	11	0.024	0.3	0.04	0.0000	1.10	0.12	2.60	7.40	5.02	0	64
BH15	Hand-pump	0	57	0.038	15.0	0.04	0.0000	9.80	20.20	15.00	32.00	9.98	0	296
BH16	Hand-pump	285	70	0.062	81.0	0.03	0.0000	13.00	7.07	5.30	41.00	23.70	285	490
BH17	Wetland	15	25	0.065	0.7	0.31	0.0000	1.20	0.04	5.30	16.00	6.66	15	144
BH18	Hand-pump	62	161	0.025	15.0	0.04	0.0000	13.00	0.40	6.80	78.00	4.03	62	450

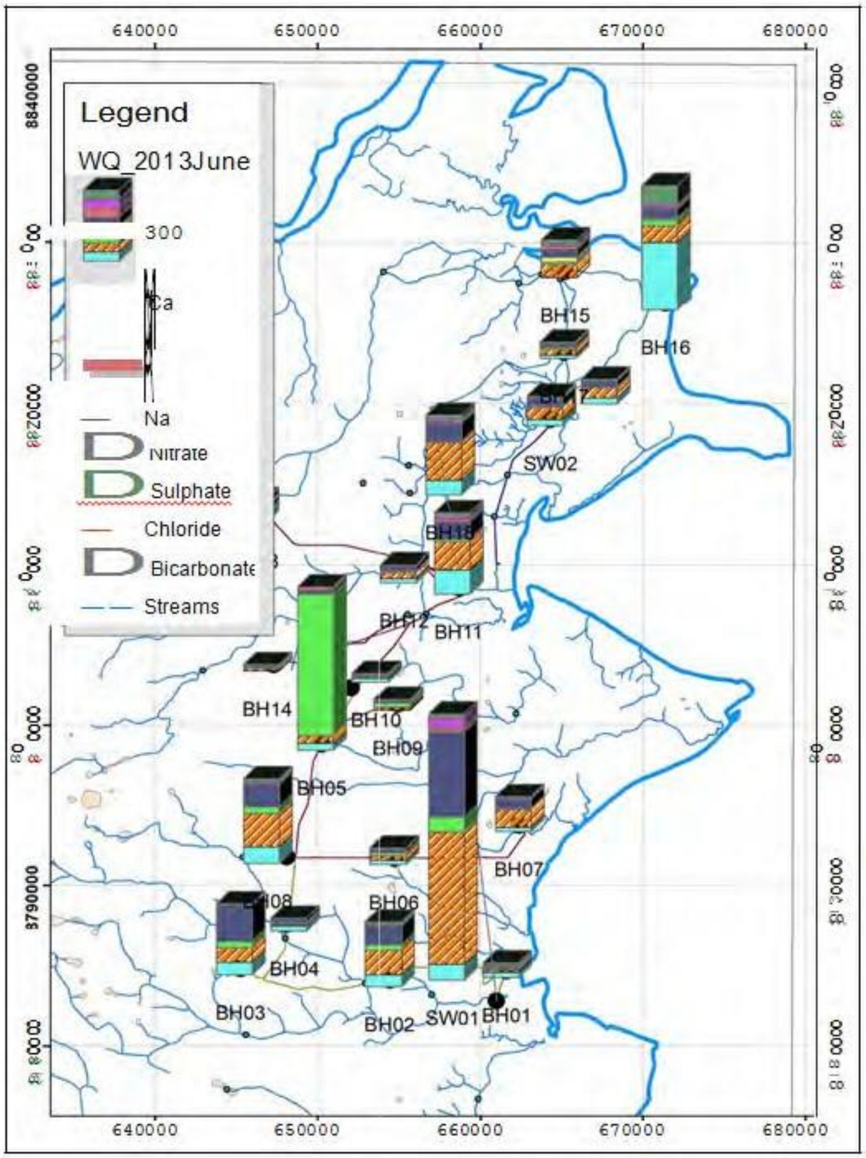


Figure 36: The location of all the water sampling points. SW refers to river flow sites and BH refers to hand pumps, community wells and wetlands

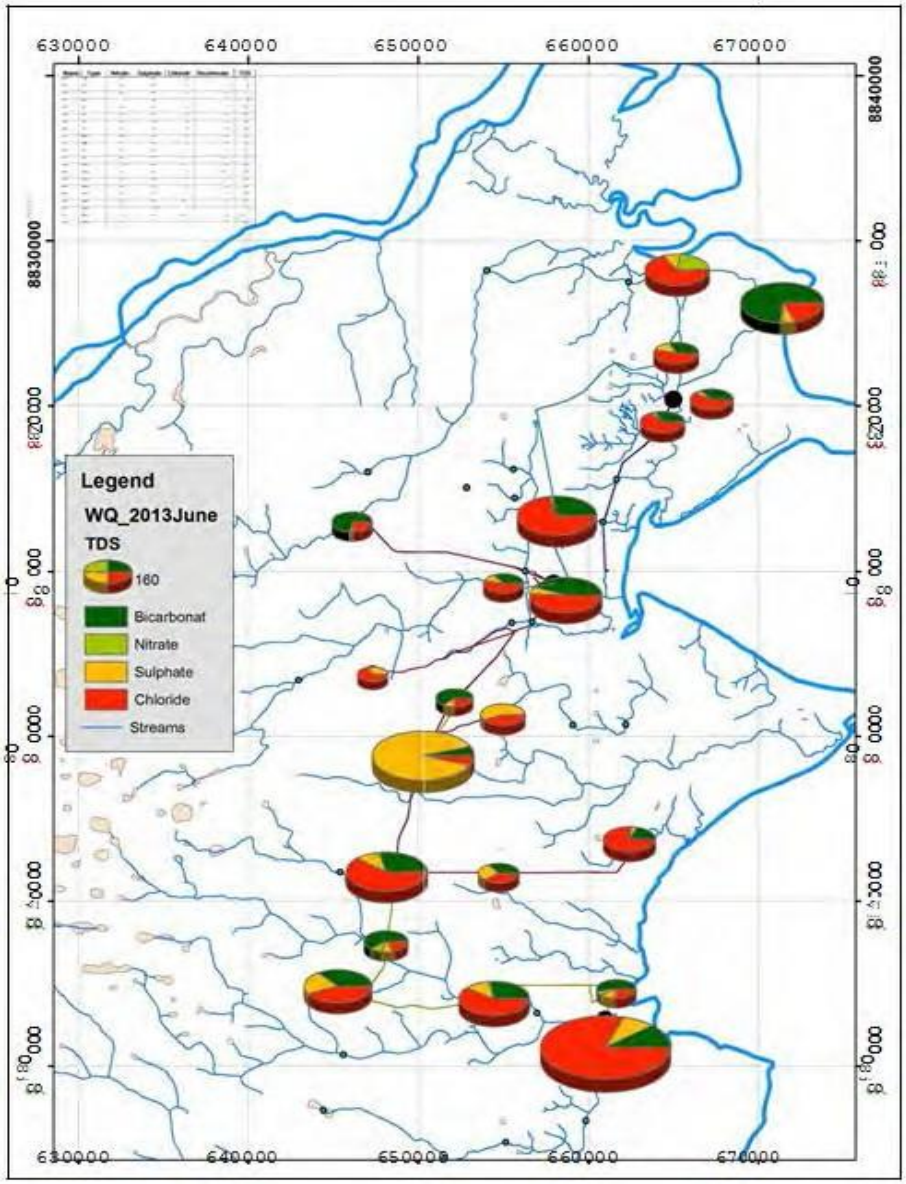
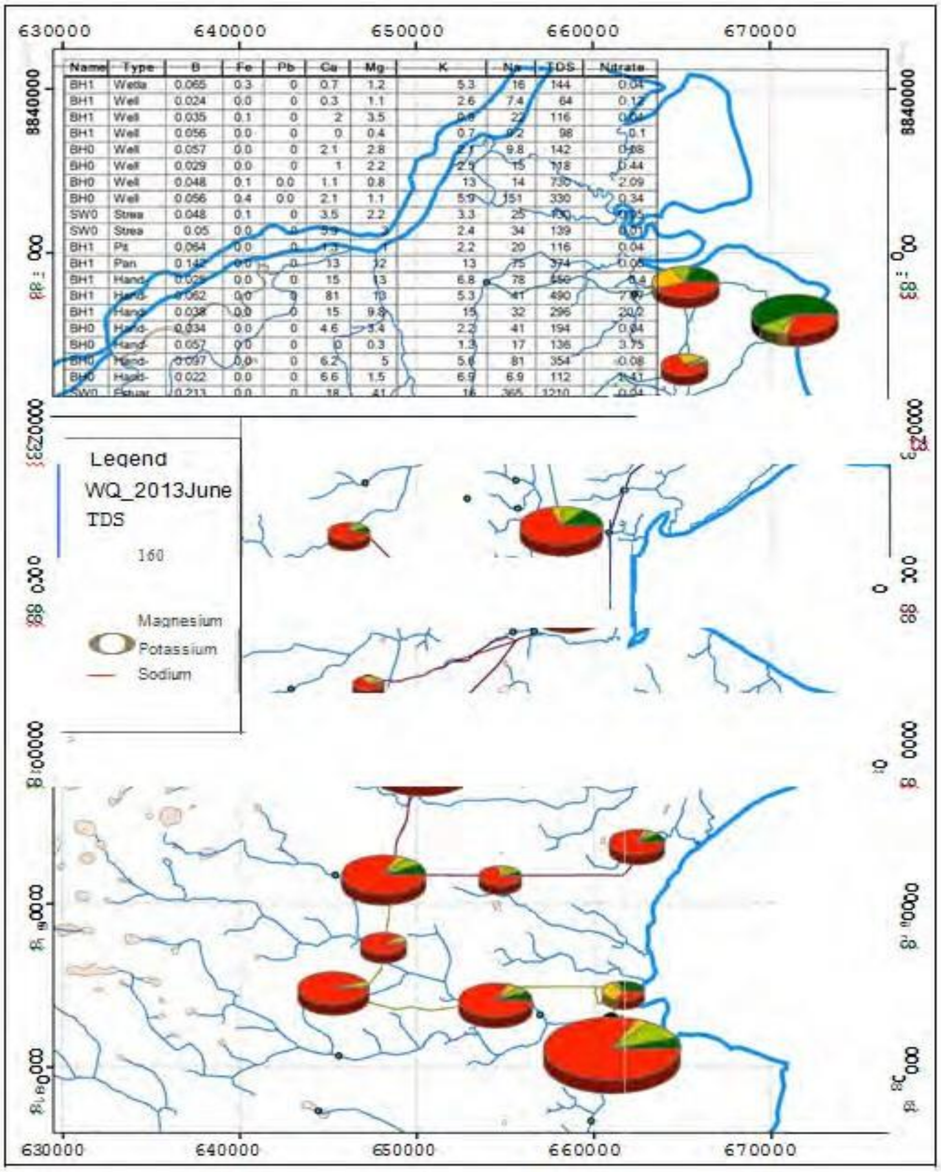


Figure 37: The relative occurrence of Anions in the water samples from the different sites. Radius of circle reflects the Total Dissolved Substance



Name	Type	B	Fe	Pb	Ca	Mg	K	Na	TDS	Nitrate
BH1	Wetla	0.065	0.3	0	0.7	1.2	5.3	16	144	0.04
BH1	Well	0.024	0.0	0	0.3	1.1	2.6	7.4	64	0.12
BH1	Well	0.035	0.1	0	2	3.5	[illegible]	22	116	[illegible]
BH1	Well	0.056	0.0	0	0	0.4	0.7	9.2	98	0.1
BH0	Well	0.057	0.0	0	2.1	2.8	2.1	9.8	142	0.08
BH0	Well	0.029	0.0	0	1	2.2	2.5	15	118	0.44
BH0	Well	0.048	0.1	0.0	1.1	0.8	13	14	730	2.09
BH0	Well	0.056	0.4	0.0	2.1	1.1	5.9	151	330	0.34
SW0	Strea	0.048	0.1	0	3.5	2.2	3.3	25	[illegible]	[illegible]
SW0	Strea	0.05	0.0	[illegible]	[illegible]	[illegible]	2.4	34	139	0.01
BH1	Pit	0.064	0.0	0	[illegible]	1	2.2	20	116	0.04
BH1	Pan	[illegible]	[illegible]	0	13	12	13	75	374	[illegible]
BH1	Hand-	[illegible]	0.0	0	15	13	6.8	78	[illegible]	0.4
BH1	Hand-	[illegible]	0.0	0	81	10	5.3	41	490	[illegible]
BH1	Hand-	0.038	0.0	0	15	9.8	15	32	296	20.2
BH0	Hand-	0.034	0.0	0	4.6	3.4	2.2	41	194	0.04
BH0	Hand-	0.057	0.0	0	0	0.3	1.3	17	136	3.75
BH0	Hand-	0.097	0.0	0	6.2	5	5.6	81	354	0.08
BH0	Hand-	0.022	0.0	0	6.6	1.5	6.9	6.9	112	[illegible]
SW0	Estuar	0.213	0.0	0	18	41	16	365	1210	0.04

Figure 38: The relative occurrence of Cations in the water samples from the different sites. Radius of circle reflects the Total Dissolved Substance (TDS)

11 SUMMARY AND CONCLUSIONS

Surface flow in the Palma region is highly seasonal. Most river valleys have no clear river channel and many of the valley bottoms comprise wetlands, many with open water pans. In a region with high rainfall (>1000mm/year), the lack of surface flow in deep river valley suggests that there is very little groundwater storage to sustain baseflow during the dry period. However, two small catchment streams were perennial that suggest there are areas where groundwater storage is sufficient to sustain baseflow during the dry period. These observations indicate that the regional water resources are groundwater dominated, but that there is a very rapid release of groundwater from storage from the highly permeable aquifers resulting in a lower than expected water table profile.

There are many interdunal depressions throughout the region with exposed water that is assumed to be a representation of the groundwater profile. The wetlands and pans generally have shallow water table profiles around their peripheral margins that have been targeted extensively by the local community for their water requirements using shallow hand dug wells.

While many communities tap the shallow water table conditions for water supply, it appears that most handpump boreholes that have been installed have targeted the deeper aquifers (possibly the Makindani Formation). Consequently there is slight difference in the water quality of the two different aquifers, but it is not sufficient to limit water supply options.

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Appendix 1 - Water Quality Results

Talbot & Talbot

sanas Talbot LABORATORIES

2013/07/16

ANALYTICAL REPORT

OUR REF: NA
CONTACT PERSON:
SAMPLE TYPE:
DATE RECEIVED:

Determinand		Method No.			
			[illegible]	111 [illegible]	117 [illegible]
			[illegible]	1M2	13
Bicarbonate alkalinity*	mg CaCO₃/l	[illegible]	[illegible]		[illegible]
Chloride	mg Cl/l	16	[illegible]	12	
Dissolved boron*	µg B/l		2		
Dissolved calcium	mg Ca/l	[illegible]	16	5[illegible]	15
Dissolved iron	mg Fe/l	[illegible]	[illegible]	[illegible]	[illegible]
Dissolved lead*	µg Pb/l	-	[illegible]	[illegible]	
Dissolved magnesium	mg Mg/l	[illegible]	[illegible]	30	22
Nitrate/Nitrite	mg N/l		[illegible]	[illegible]	[illegible]
p - Alkalinity*	mg CaCO₃/l	-	[illegible]	<10	<10
Potassium	mg K/l	7A	[illegible]	2	3
Sodium	mg Na/l	[illegible]	3[illegible]	3[illegible]	
Sulphate	mg SO₄/l	7	82[illegible]	1	1[illegible]
Total alkalinity	mg CaCO₃/l	10	[illegible]	[illegible]	[illegible]
Total dissolved solids at 180°C	mg/l	[illegible]	1210	[illegible]	W

Determinand	Unit	Method No.	Results		
			11[illegible]	[illegible]	117[illegible]
			EH 1	BH2	EH3
[illegible]	[illegible]	C[illegible]	21	[illegible]	111
[illegible]	[illegible]	16	11	111	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	97	[illegible]
[illegible]	1'19	[illegible]	[illegible]	0.01	[illegible]
[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1	50	1.1
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3
[illegible]	[illegible]	[illegible]	21	11	
Total dissolved solids at 180°C	[illegible]	[illegible]	112		[illegible]

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Determinand	Units	Method No	Results		
			11762/13	11763/13	11764/13
			BH 4	BH 5	BH 6
Bicarbonate alkalinity*	mg $CaCO_3$/l	Calc.	21	30	18
Chloride	mg Cl/l	16	6	32	20
Dissolved boron*	µg B/l	-	57	48	29
Dissolved calcium	mg Ca/l	8A	<0.2	1.1	1.0
Dissolved iron	mg Fe/l	20A	0.02	0.18	0.03
Dissolved lead*	µg Pb/l	-	<1	2.03	<1
Dissolved magnesium	mg Mg/l	9A	0.3	0.8	2.2
Nitrate/Nitrite	mg N/l	65	(3.75)	(2.09)	(0.44)
p - Alkalinity*	mg $CaCO_3$/l	-	<10	<10	<10
Potassium	mg K/l	7A	1.3	13	2.5
Sodium	mg Na/l	6A	17	14	15
Sulphate	mg SO_4/l	67	4.27	603	11.4
Total alkalinity	mg $CaCO_3$/l	10	21	30	16
Total dissolved solids at 180°C	mg/l	41	136	730	118

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DII fifillIlnd	Units	Method No	Results		
			11768/13	11769/13	11770/13
			BH 10	BH 11	BH 12
Bicarbonate alkalinity*	mg $CaCO_3$/l	Calc.	17	102	18
Chloride	mg Cl/l	16	7	117	27
Dissolved boron*	µg/l	-	56	142	64
Dissolved calcium	mg Ca/l	8A	<0.2	13	1.3
Dissolved iron	mg Fe/l	20A	0.07	0.04	0.01
Dissolved lead*	µg Pb/l	-	<1	<1	<1
Dissolved magnesium	mg Mg/l	9A	0.4	12	1.0
Nitrate/Nitrite	mg N/l	66	(0.10)	(0.05)	(0.04)
p - Alkalinity*	mg $CaCO_3$/l	-	<10	<10	<10
Potassium	mg K/l	7A	0.7	13	2.2
Sodium	mg Na/l	6A	9.2	75	20
Sulphate	mg SO_4/l	67	3.28	11.4	5.49
Total alkalinity	mg $CaCO_3$/l	10	17	102	18
Total dissolved solids at 180°C	mg/l	41	98	374	116

Determinand	Units	Method No	Results		
			11771/13	11772/13	11773/13
			BH 13	BH 14	BH 15
Bicarbonate alkalinity*	mg $CaCO_3$/l	Calc.	51	0	0
Chloride	mg Cl/l	16	17	11	57
Dissolved boron*	µg/l	-	35	24	38
Dissolved calcium	mg Ca/l	8A	2.6	0.3	15
Dissolved iron	mg Fe/l	20A	0.15	0.04	0.04
Dissolved lead*	µg Pb/l	-	<1	<1	<1
Dissolved magnesium	mg Mg/l	9A	1.5	1.1	9.8
Nitrate/Nitrite	mg N/l	55	(0.04)	(0.12)	(20.2)
p - Alkalinity*	mg $CaCO_3$/l	-	<10	<10	<10
Potassium	mg K/l	7A	9.9	2.8	15
Sodium	mg Na/l	6A	22	7.4	32
Sulphate	mg SO_4/l	67	2.65	5.02	9.98
Total alkalinity	mg $CaCO_3$/l	10	51	<10	<10
Total dissolved solids at 180°C	mg/l	41	116	64	296

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Determinand	Units	Method No	Results		
			11774/13	11775/13	11776/13
			BH 16	BH 17	BH 18
Bicarbonate alkalinity*	mg $CaCO_3$/l	Calc.	285	15	62
Chloride	mg Cl/l	16	70	25	161
Dissolved boron*	µg/l	-	62	65	25
Dissolved calcium	mg Ca/l	8A	81	0.7	15
Dissolved iron	mg Fe/l	20A	0.03	0.31	0.04
Dissolved lead*	µg Pb/l	-	<1	<1	<1
Dissolved magnesium	mg Mg/l	9A	13	1.2	13
Nitrate/Nitrite	mg N/l	66	(7.07)	(0.04)	(0.40)
p - Alkalinity*	mg $CaCO_3$/l	-	<10	<10	<10
Potassium	mg K/l	7A	5.3	5.3	8.8
Sodium	mg Na/l	6A	41	16	78
Sulphate	mg SO_4/l	67	23.7	6.66	4.03
Total alkalinity	mg $CaCO_3$/l	10	285	15	62
Total dissolved solids at 180°C	mg/l	41	490	144	450

Technical Signatory: Chemistry__________ Bacteriology__________

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  Test marked * in this report are not SANAS accredited and are not included in the SANAS accreditation sched our laboratory.
- Opinions and interpretations expressed herein are outside the scope of SANAS accreditation.
  Figures reported in () were analysed after preservation according to the laboratory's preservation procedure.
- Note: results marked "" have been sub-contracted to a peer laboratory.
- Note: Estimates of Uncertainty of Measurement may be obtained from the laboratory.

Appendix B – Palma Agricultural/Soil Survey

TABLE OF CONTENTS

APPENDIXES

FIGURES

Tables

1 INTRODUCTION

This document aims to provide the necessary detail, information and recommendations to satisfy WorleyParsons with the task that they received regarding the selection of potential resettlement sites in the Palma area, Cabo Delgado province, Mozambique.

All was done in good faith and to the best of my ability.

1.1 Location of Project Area

The Study Area for this soil component Rapid Assessment Field Study (i.e. area in which potential Replacement Village site(s) are to be identified) is defined as the area located in the north eastern part of Mozambique, in Cabo Delgado Province and which surrounds the town of Palma and is limited to the north by the Rovuma River (Tanzanian border) and extends southwards to approximately 10kms south of Olumbi.

The total extent of the area concerned is thus in the order of 400km2. The area is extensively populated with the main income derived from fishing and agricultural activities. There are almost no industrial operations.

1.2 Location Map

Figure 1-1: Survey Area marked by red circle

1.3 Road Infrastructure

There is a very limited network and number of roads in the area, many of which are only small tracks and are not drivable. During the survey all drivable roads were accessed using a 4x4 vehicle and were recorded on a map. The map below (Figure 2) shows all roads that were travelled within the Study Area. There is however a main road from Quinoa to Palma and then to Zambia; this road is a very good road which is currently being surfaced with tarmac. The map below also shows all the names of the villages that were encountered close to roads during the survey.

Figure 1-2: Road and villages in the Study Area

2 CLIMATE

The following data were retrieved from FAO data (CROPWAT) for Palma in Mozambique. Palma GPS Coordinates are as follows: 10.46 Deg. South, 40.30 Deg. East and an altitude of 60 m above sea level. The data was supplied by CROPWAT from FAO and the data was established over a 30 years period from 1978 to 2008.

2.1 Rainfall data

These are based on the actual rainfall and the effective rainfall, after all losses have been calculated (Figure 2-1). The effective rainfall is described as the rainfall available to crops and plants after losses to other processes. These losses are runoff, drainage, evaporation and water caught on leaves. Effective rainfall has been calculated according to

FAO standards:

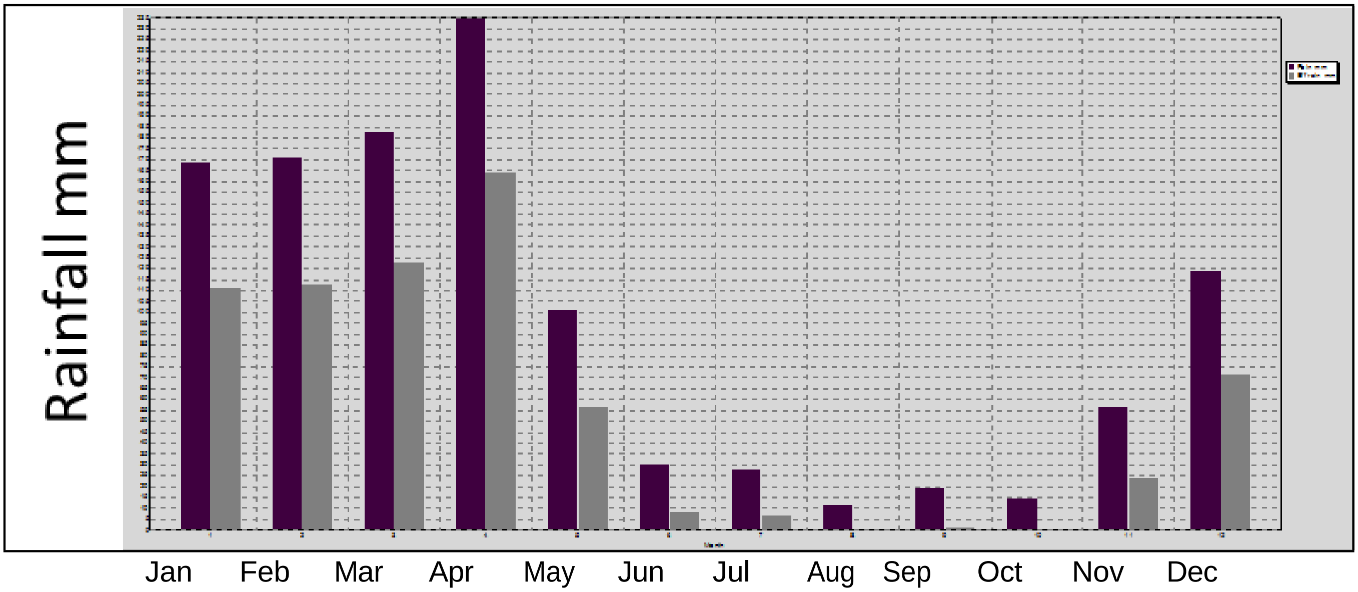

Figure 2-1: Monthly Rainfall & Effective Rainfall for the Palma region (FAO CROPWAT, 2008)

2.2 Temperature Data

These are based on the maximum and the minimum temperatures: the average monthly maximum temperature is around 32OC during February and March and a minimum monthly temperature of between 17OC and 18OC during July (Figure 2-2).

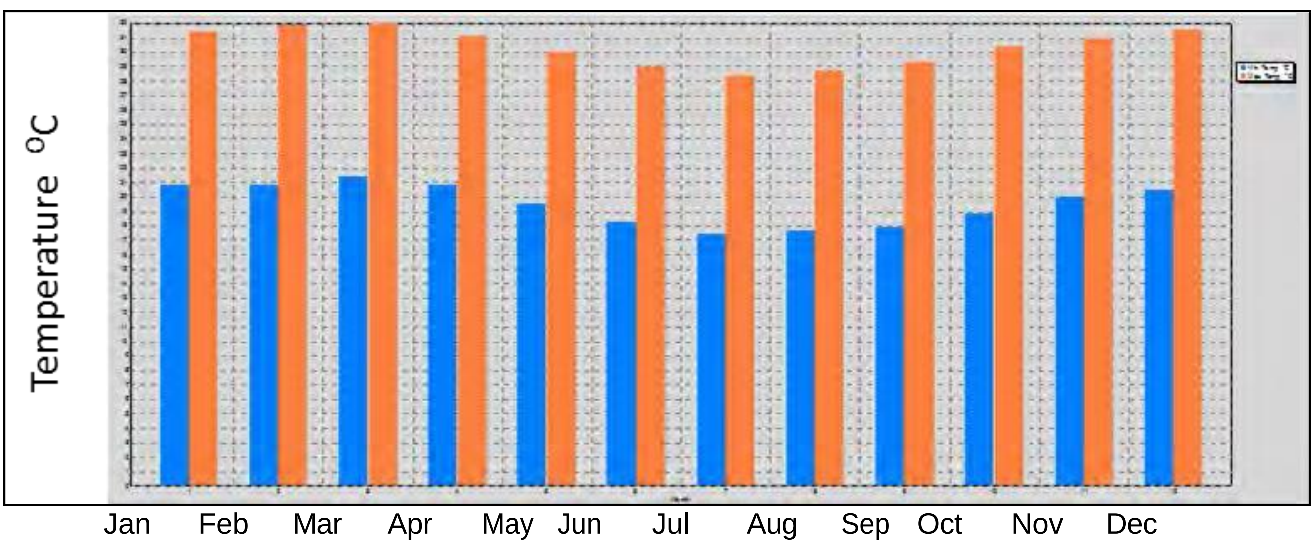

Figure 2-2: Minimum and Maximum monthly temperatures for the Palma region (FAO CROPWAT, 2008)

2.3 Humidity Data

Humidity in the region remains fairly constant during the year ranging from 75% to 82% (Figure 2-3).

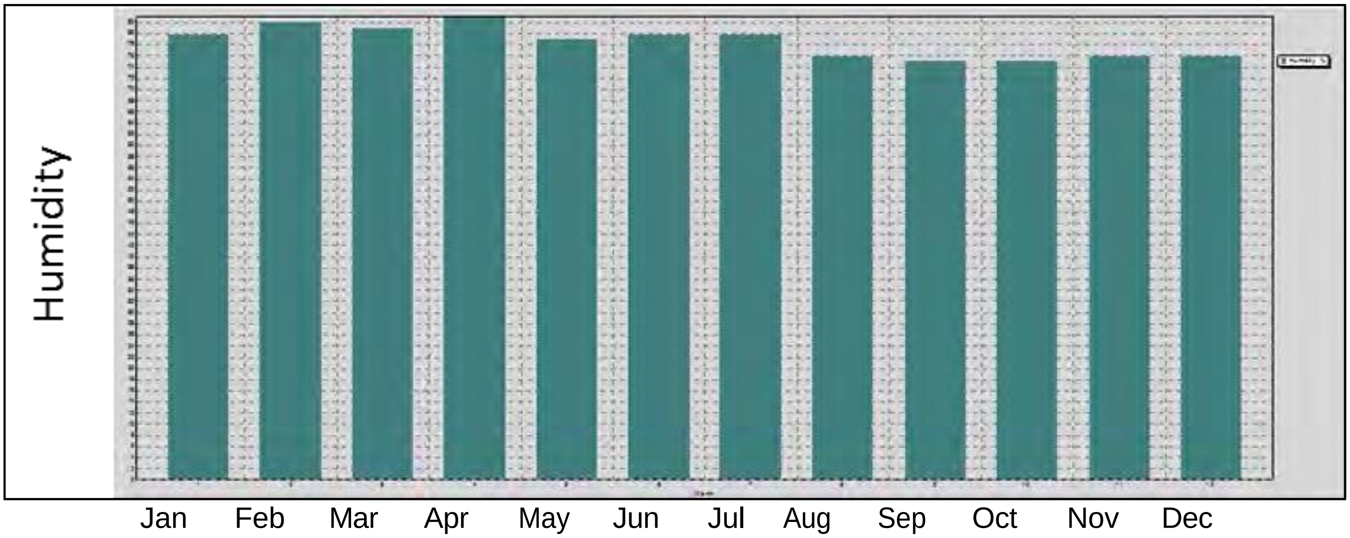

Figure 2-3: Annual humidity levels for the Palma region (FAO CROPWAT, 2008)

2.4 Sunshine and Radiation Data

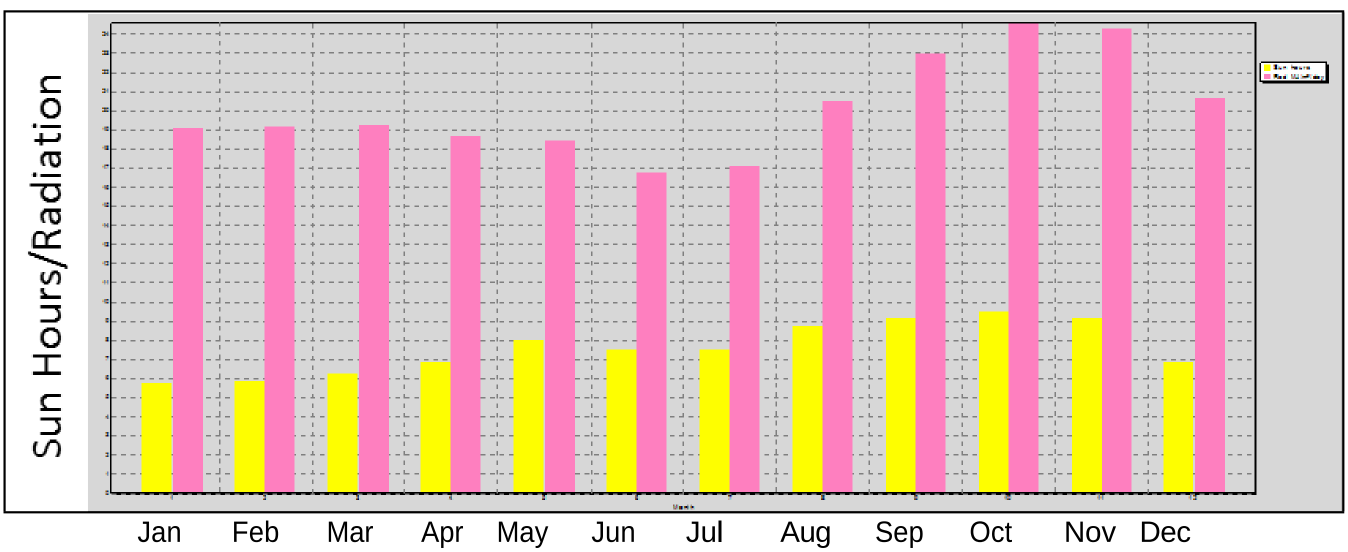

Figure 2-4: Annual Sunshine and Radiation levels for the Palma region (FAO CROPWAT, 2008)

2.5 Evapotranspiration Data

This is the data that was used for the calculation of crop water usage and has been calculated using the Pennman Montieth method.

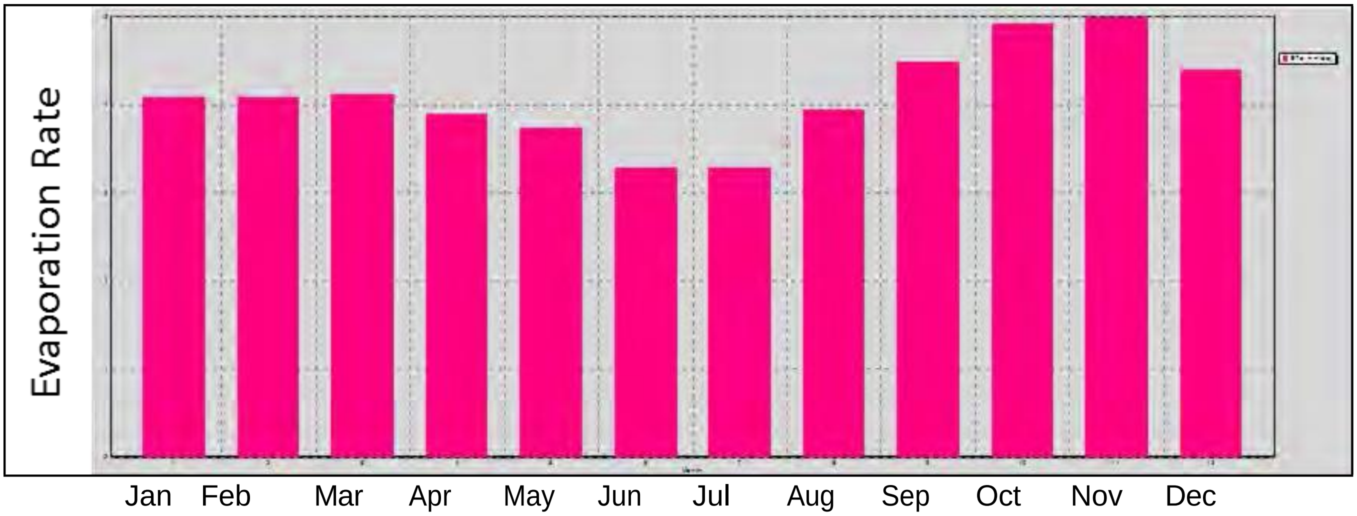

Figure 2-5: Annual Evapotranspiration rates for the Palma region (FAO CROPWAT, 2008)

2.6 Summary of basic climate data

The following table is a summary of the climate data for Palma (FAO CROPWAT, 2008)

Table 2-1: Tables showing the monthly climatic data for the Palma region (FAO CROPWAT, 2008)

Country: Mozambique — Station: PALMA

Altitude: 60 m. — Latitude: 10.46 °S — Longitude: 40.30 °E

Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m²/day	mm/day
January	20.8	31.4	80	86	5.8	19.1	4.10
February	20.8	31.9	82	78	5.9	19.2	4.09
March	21.4	32.0	81	86	6.3	19.2	4.12
April	20.8	31.1	83	112	6.9	18.7	3.91
May	19.6	30.0	79	130	8.0	18.4	3.76
June	18.3	29.0	80	121	7.5	16.8	3.30
July	17.5	28.4	80	121	7.5	17.2	3.30
August	17.7	28.8	76	121	8.8	20.5	3.95
September	17.9	29.4	75	121	9.2	23.0	4.49
October	18.9	30.4	75	121	9.5	24.6	4.93
November	20.0	31.0	76	121	9.2	24.3	5.01
December	20.5	31.6	76	86	6.9	20.7	4.41
Average	**19.5**	**30.4**	**79**	**109**	**7.6**	**20.1**	**4.11**

Station PALMA | Eff. rain method FAO/AGLW formula

	Rain	Eff rain
	mm	mm
January	169.0	111.2
February	171.0	112.8
March	183.0	122.4
April	235.0	164.0
May	101.0	56.8
June	30.0	8.0
July	28.0	6.8
August	12.0	0.0
September	19.0	1.4
October	15.0	0.0
November	57.0	24.2
December	119.0	71.2
Total	1139.0	678.8

2.7 Climatic Summary

From this data it is noted that the annual rainfall in the Palma area is around 1100 - 1200 mm/year. Potential evapotranspiration (Penman) significantly exceeds rainfall for the period May to November– December for most sites, giving a growing season of around 4–5 months. The rains generally start in early December, with a long hot dry period before that. Although there is a coastal influence and some effects from the Indian Ocean monsoon, the climate across the Study Area generally follows the more typical weather patterns of the continental interior, i.e. there is a long hot dry season May to November, before a single clearly- defined rainy season from December to April.

3 TOPOGRAPHY

The Study Area comprises a gently tilting interior plateau, rising from about 1 m above sea-level along the Palma–Mocímboa road to over 200 m in the west above the Mueda escarpment. To the east of the Palma– Mocímboa road the land drops down to a narrow coastal plain consisting of recent sediments. Much of the interior plateau, as seen from Landsat imagery (Figure 3-1), acts as a ‘sponge’ with pans and edaphic grasslands (a result of seasonally-poor drainage) and numerous drainage lines flowing to the south-east or, in the northernmost section, to the north-east. Some of these are deeply incised where they come down to the coast (Figure 3-2).

Figure 3-1: LANDSAT image showing the topography of the Palma region (Study Area boundary in blue)

The landscape in the central portion is relatively level and not that well drained. On the northern margin, along the Rio Rovuma has cut through these plateau sediments to create a wide valley (c. 10 km wide).

Most of the study sites lie between altitudes of 5 and 180 m.

Figure 3-2: 2m contours of the Palma Region illustrating the drainage relief of the area

4 VEGETATION

More comprehensive descriptions of the main vegetation types are presented in the Vegetation and Ecology report.

4.1 Coastal Dry Forest

Various types of dry forest can be described, ranging from those dominated by *Guibourtia schliebenii* to those with *Scorodophloeus fischeri*. *Dialium holtzii* and *Sterculia schliebenii* are also typical. In some areas there was dominance of *Micklethwaitia carvalhoi*. Species composition between patches is varied, with perhaps only *Manilkara sansibarensis* and *Pteleopsis myrtifolia* being commonly found across sites.

Figure 4-1: Typical Dry Forest found in the Palma region

4.2 Miombo and Similar Woodland

Woodland, sometimes dense and almost closed-canopy, characterized by one or more of *Brachystegia spiciformis, Julbernardia globiflora, Afzelia quanzensis* and *Berlinia orientalis*. Small patches ('lenses') of dry forest are often found inside woodland areas in slightly elevated patches. The understory in woodland is generally better developed than that under dry forest, and often characterized by grasses, which are mostly not present in dry forests.

Figure 4-2: Typical Miombo Woodlands found in the Palma region

4.3 Palm Savannah

This vegetation type consists of wooded grassland dominated by *Borassus aethiopum* palms (Figure 4-3) and is commonly encountered along the upper parts of the Rovuma floodplain. Smaller areas characterised by *Hyphaene compressa* and *Phoenix reclinata* palms are commonly seen associated with pan margins and poorly-drained margins.

Figure 4-3: Borassus palms typical of the Palm Savannahs (Borassus aethiopum)

4.4 Pan Grassland

Open grasslands associated with pans and other areas with seasonally poor drainage are very common in the Nhica–Pundanhar area in the lower parts of the gently undulating landscape. The main trees found here are *Parinari curatellifolia*, along with *Uapaca nitida* and *Pseudolachnostylis maprouneifolia*.

Figure 4-4: Grasslands surrounding a pan found in the north-east of the Study Area

4.5 Riparian or Lakeshore Woodland

A narrow fringe of dense woodland is found along permanent drainage lines or on some lake margins.

4.6 Regenerating Fallow

Where dry forest or woodland has been cleared for agriculture, or where there has been recent extensive logging, fallow vegetation is found comprising regenerating woody plants. Many of these are widespread, while others reflect the previous vegetation type. *Berlinia orientalis*, which has a restricted distribution along the Eastern African coast, is surprisingly common in such areas.

Figure 4-5: Regenerating Fallow vegetation found throughout the study site

4.7 Coral Rag

An almost impenetrable thicket to low early-deciduous dry forest on raised coral rock with minimal soil cover. This is a relatively recent formation only found close to the sea (e.g. on the Cabo Delgado peninsula) and has little relationship to the dry forests or woodlands further inland, although some species are common.

Figure 4-6: Coral Rag found on the Cabo Delgado peninsular

5 GEOLOGY

At a national level north-eastern Cabo Delgado is seen to have a different geological origin from the rest of the country. There is an elongated triangle (Bacia de Rovuma Moçambique) of relatively younger formations dating from the Lower Cretaceous period (145–97 Mya) up to the Neogene (23–1.6 Mya), adjacent to the much older continental block that comprises Precambrian granites and other rocks. As elsewhere in the country, there is also a narrow coastal strip comprising recent Quaternary (1.6 Mya–present) deposits. The strata in these apparently marine deposits from the Cretaceous and Neogene are relatively level (6° slope, Smelror et al. 2006), hence the area's landform is primarily determined by differential resistance to erosion by the different strata, resulting in numerous flat- topped plateau.

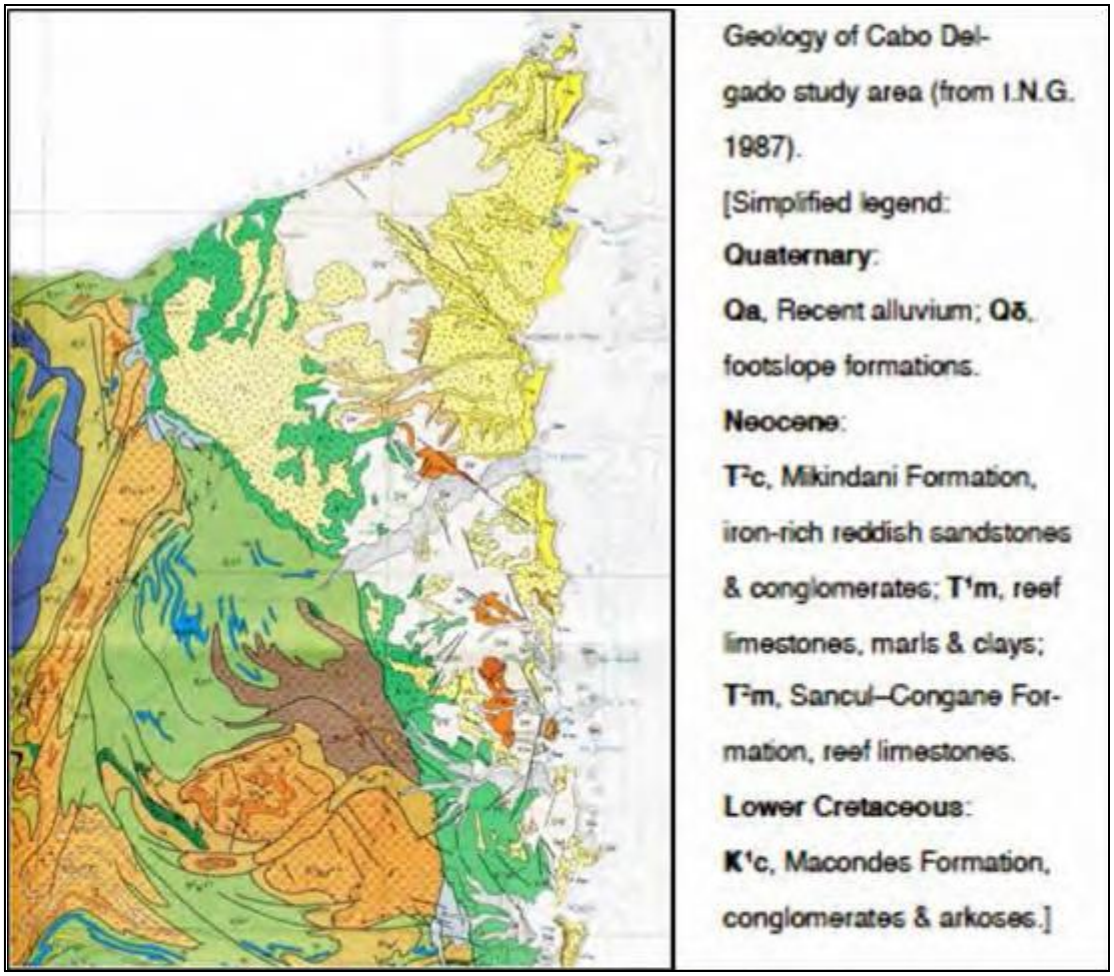

Figure 5-1: Geology of Cabo Delgado Study Area (ING 1987)

6 SOILS

6.1 Existing Available Soil Information

Nearly all the dense forest patches encountered were located on iron-rich sandstone and conglomerates of the Mikindani Formation (mid-Neogene, ± 15–10 Mya), while associated miombo and similar woodlands were mostly found on more recent Quaternary formations (Pleistocene, ± 1.6–0.01 Mya). The Mikindani Formation strata are generally found the plateau which rises about 20–30 m above the surrounding miombo woodland.

Most soil data referenced in this report are derived from the 1: 1 million scale national geological map (Figure 5-1) above (ING 1987) and from the soils map of Cabo Delgado Province (Figure 6-1).

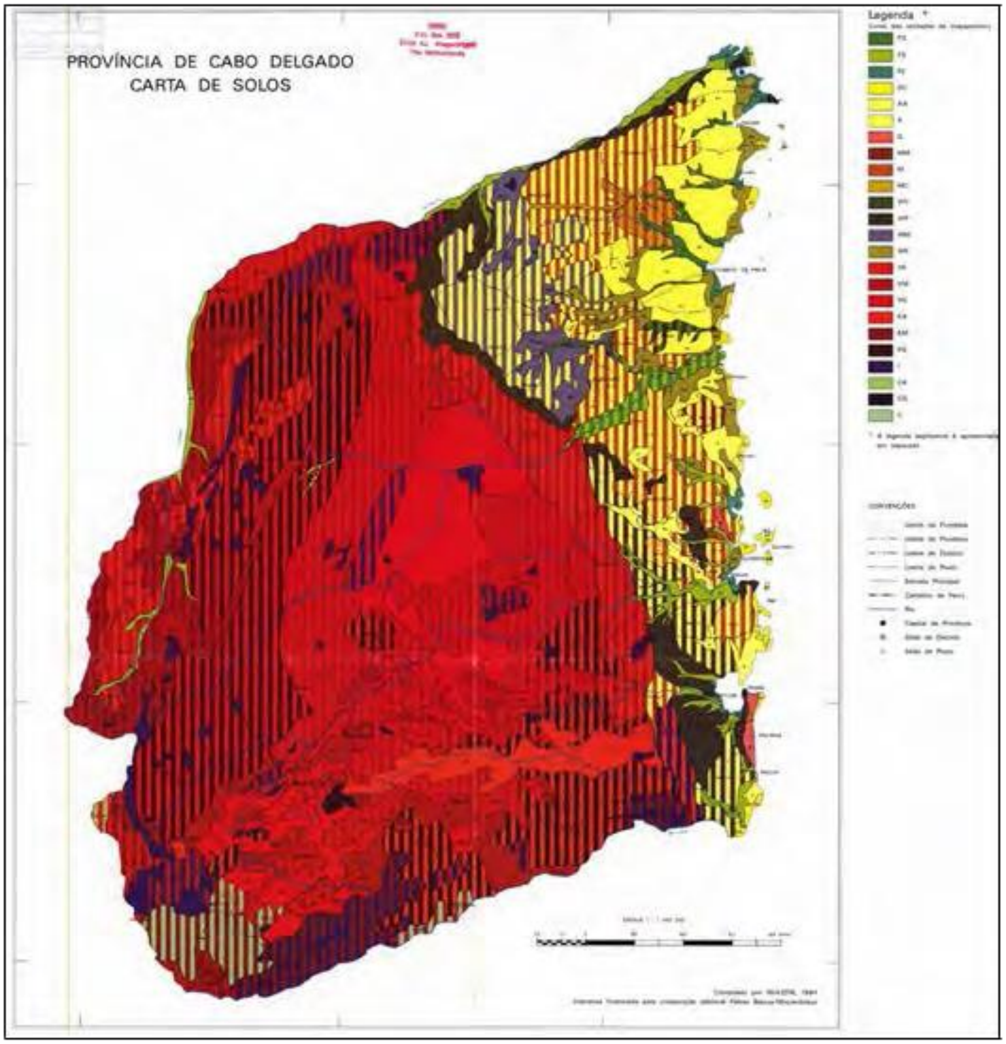

Figure 6-1: Soils Map of Cabo Delgado Province

These two maps are very much the same and are in accordance with the findings described later in this report.

6.2 Basic Soil Classifications

The soils in this report were classified under the "World reference base for soil resources 2006"; a framework for international soil classification devised by the FAO.

It was found that through the entire project area the soils can be classified into three groups;

6.2.1 Ferralsols

Ferralsols occur in tropical and subtropical regions of the world, mainly on old and stable land surfaces. Soils having a ferralic horizon (strongly weathered horizon with low-activity clays and very low amounts of weather able minerals) between 25 and 200 cm from the soil surface. They lack a nitric horizon (a horizon with strongly developed, nut-shaped structure) and do not have a layer which fulfils the requirements of an argic horizon and which has, in the upper 30 cm, 10 per cent or more water- dispersible clay.

Ferralsols are characterised with an argilluvic B and an oxic B horizon. The dominant color of these soils is red, but at some places a yellowish brown horizon overlies the red horizon (Figure 6-2). The clay content varies from 5 – 8% in the topsoil to 22% in the subsoil. The concept of these macroscopically weakly structured or structure-less materials embraces the kind of weathering that takes place in a well-drained oxidizing environment to produce coatings of iron oxide on individual soil particles, giving the red color, and clay minerals dominated by non-swelling 1:1 clay types. They have developed under a wide range of climatic conditions and parent material. A wide range of base status is therefore encountered, giving it a nutrient status from low to high. These soils have a high potential for farming and should be utilized to the maximum where possible. The soils generally have a good to very good water holding capacity, as well as an exchange capacity due to the moderate to high clay content. These types of soils would be preferred for agriculture where settlement occurs.

Figure 6-2: Ferralsols from the Study Area

6.2.2 Arenosols

Arenosols occur over large areas in Africa, central and Western Australia, the Middle East and central China. Smaller areas are found along coastlines all over the world.

Arenosols, with a topsoil light (bleached) in color with a very low organic carbon content, and a clay content of less than 15% in the rest of the horizon. This is essentially a greyish horizon which is usually paler than the overlying topsoil or the horizon which underlies it, if present. The greyish color is the result of reduction, together with a lateral flow of water through the horizon, resulting in a loss of coloring material such as iron oxides and organic material, as well as clay particles, producing the characteristic bleached appearance and coarse texture. Sometimes the greyish color is the direct result of the parent material from which it forms. Also included in this unit is regic sand deposits close to the beach area, which are a young, recent deposit with little or no profile development that has taken place. The soils of map unit A have a low water holding capacity due to the very low clay content (3 – 5%), as well as a low nutrient state due to the bleached color. The nutrient state can, however be improved by good farming practices.

The soils of this mapping unit can be divided into two parts. The one part has a pale grey color throughout the profile, while the other has a greyish brown to brownish grey color (up to 80 – 100cm depth) on top of a pale grey horizon (Figure 6-3). The latter will be the better soils for farming due to their higher nutrient state and organic carbon content.

Figure 6-3: Arenosols from the Study Area

6.2.3 Planosols

The wetland areas consist of a combination of Planosols and Plinthic Arenosols. The underlying gleyed material and plinthic horizon is poorly formed, not showing all the characteristics of these horizons properly. They are very sandy and also white to light grey in color. There also less than 2% clay content. These areas are used mainly for rice production but not good for crop production.

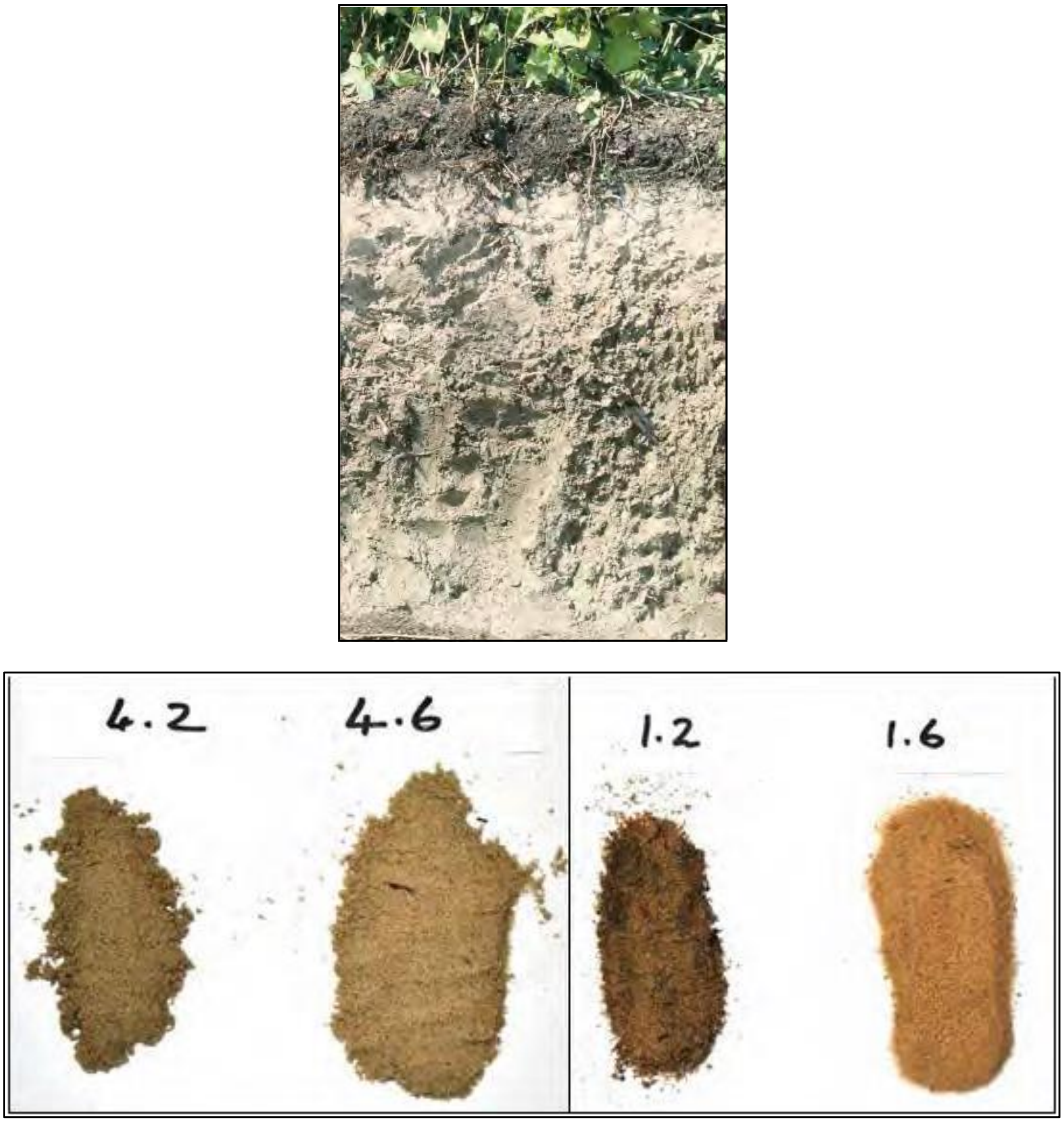

Figure 6-4: Planosols from the Study Area

The criteria for assessing the agricultural suitability of the soils are discussed below and are based on the known properties of these soil types:

6.3 Total Available Moisture (TAM) / Available Water Capacity (AWC)

Total Available Moisture (TAM) or Available Water Capacity (AWC) is a measure of the water available to crop roots, expressed as Mm per meter, and is dependent both on soil depth and soil texture. From information available in respect of the same soils elsewhere in the region (IUSS Working Group WRB, 2006), the estimated range of Total Available Moisture values for each of the soil types occurring in theStudy Area are given below;

Soil	Mm/m
Ferralsols	80 - 100
Arenosols	50 - 90
Planosols	40 - 60

6.4 Steady Water Intake Rate (Infiltration Rate)

The estimated Steady Water Intake (infiltration) Rate is the rate at which the soil can absorb water and is measured as mm per hour. The Steady Water Intake Rate for the soils occurring in the Study Area is given in table below;

Soil	Steady Water Intake Rate (mm/hr) (moist soil)
Ferralsols	20 - 50
Arenosols	40 - 60
Planosols	50 - 100

6.5 Organic Matter (Organic Carbon)

An important component for assessing the agricultural potential of the soils in the Study Area is the organic matter content of the topsoil. This will be determined in the laboratory analysis as the % of carbon.

6.6 pH

The pH values of the topsoil in the Study Area will vary depending on the soil type present. In the case of the Ferralsol soils, they have a neutral to slightly acid subsoil, to slightly acid topsoil.

6.7 Cation Exchange Capacity and Exchangeable Cations

The cation exchange capacity (CEC) of the soils in the Study Area will **give** an indication of their inherent fertility, especially in respect of calcium and magnesium and the levels of nitrogen which are required to ensure optimum crop yields.

6.8 Salinity

Salinity can seriously affect crop yields especially in areas where the high evapo-transpiration, as a result of high temperature in arid and semi-arid zones, is the basic cause for salt accumulation on the soil surface (Khalid, 2007).

Soil salinity thresholds commonly applied in respect of soils for the cultivation of crops therefore are:

Salt Thresholds	Salinity
0 - 200 mS/m	Non saline
200 - 400 mS/m	Slightly
400 - 600 mS/m	Moderately saline
600 - 800 mS/m	Highly
> 800 mS/m	Very highly saline

7 SITE VISIT

The project area was visited during the period 22nd June to 5th July 2013 in the company of CES and WorleyParsons for the purpose of determining the soil types and agricultural potential of these soils for farmers that have to be relocated to new farming areas.

Due to difficulties of restricted access as a result of potential unexploded ordinance and availability of roads, soil sampling had to be confined to road-side pits along the vehicle-accessible roads and tracks within the area. Nevertheless, it is considered that the representative areas sampled were sufficient to confirm the nature and extent of the various soils occurring in the Study Area. The range of soil types are shown on the soil maps below.

74 soil samples were taken from 37 positions across the survey area to determine the soil/agricultural potentials as well as those areas most suitable for farming. The 37 soil sampling sites are shown in Figure 7-1 below.

Figure 7-1: Soil sample sites from the Study Area

8 SOIL STUDY & SOIL SAMPLING METHODS

A total of 74 samples were taken over the area and each sample was 500 grams in weight and packed in plastic bags. A specific soil auger was used for retrieving the samples (Figure 8-1). At each sampling point two samples were collected and recorded. One at 200mm deep and marked as, for example, CES
9.2, while the second was taken at the same pit at a depth of 600mm, which represents the depth of most crop roots. This sample was marked as, for example, CES 9.6.

Other observations were also made and recorded using river valleys, culverts, dug outs, water holes and erosion pits. For example, by conducting a visual comparison of soil samples taken from the top of a river valley and then half way down the slope and again at the bottom, and repeated on the opposite bank, it was possible to determine that the soil composition along whole valleys was the same. Only one of the samples taken from valley observations was sent for laboratory analysis.

All soil samples were also photographed for examination of soil color which also aids in classification (Figure 8-2).The samples were then exported to South Africa for analysis. An accredited soil testing laboratory in Cape Town was used for determining the soil characteristics and parameters; Bemlab, part of Pathcare, a chemical analysis laboratory in South Africa.

The results of the complete soil sample analysis are discussed in the Soil Laboratory Analysis chapter and are shown in Tables 8-1 and 8-2 below and Appendix A. In addition, each of the samples was photographed to aid with classification.

Figure 8-1: Soil Sampling and examination of soil profiles

Figure 8-2: Examples of photographs of soil samples used for examination of soil colors

8.1 Soil Laboratory Report

In order to determine the agricultural potential of each of the three soils types identified in the Study Area all the soil samples were analyzed for the following parameters: pH, resistance, Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Lead (P), Bray II, titratable acidity, stone fraction, Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Boron (B), and Carbon (C). Also assessed were Total Available Moisture (TAM) / Available Water Capacity (AWC), Steady Water Intake Rate (Infiltration Rate), Cation Exchange Capacity and Exchangeable Cations.

The findings of the laboratory soil analysis are summarized in the tables below (Table 8-1 and Table 8-2).

The sample numbers shown in table, for example CES N1.2, corresponds to the sampling site N01 and represents the sample collected at 200mm depth. Sample number CES N1.6 corresponds to the sample collected at site N01 at 600mm depth.

Table 8-1: Results of soil analysis for samples 1 – 40

Soil Analyses Report
Date received:
08/07/2013 Date tested:

Sample		hrchard	Lab.	Depth	Soil	pH	Resist.	H+	Stone	P Bray LL	K	Exchangeable cations (cmol(+)/kg)				Cu	Zn	Mn	B	Fe	C	Na	K	Ca	Mg	T-Value
No.			No.	(cm)		(KCl)	(hhm)	(cmol/kg)	(Vol %)	mg/kg		Na	K	Ca	Mg	mg/kg				mg/kg	%	%	%	%	%	cmol/kg
1		CES N1.2	22964	60	Sand	4.7	19450	0.25	1	1	23	0.01	0.06	0.39	0.16	0.71	3.9	9.4	0.03	17.38	0.15	1.64	6.58	44.78	18.44	0.88
2		CES N1.6	22965	60	Sand	4.7	20000	0.25	1	1	30	0.03	0.08	0.36	0.14	0.68	2.9	2.6	0.03	8.34	0.15	3.56	8.95	41.47	16.82	0.86
3		CES N2.2	22966	60	Sand	5.2	12300	0.25	1	8	30	0.01	0.08	1.39	0.35	1.29	1.5	126.7	0.03	44.71	0.27	0.58	3.66	67	16.69	2.07
4		CES N2.6	22967	60	Sand	5.3	12350	0.25	1	3	31	0.01	0.08	0.95	0.29	1.44	13.1	124.1	0.03	30.42	0.23	0.64	4.96	60.05	18.57	1.58
5		CES 3.2	22926	60	Sand	5.4	12960	0.3	1	2	17	0.02	0.04	1.17	0.27	1.05	1	161.7	0.07	62.47	0.23	1.08	2.48	64.91	14.88	1.8
6		CES 3.6	22927	60	Sand	5.4	15360	0.25	1	1	29	0.01	0.07	0.62	0.23	1.08	1.3	128.3	0.05	44.95	0.15	0.69	6.25	52.27	19.72	1.19
7		CES 4.2	22928	60	Sand	5.4	20000	0.25	1	1	6	0.01	0.02	0.2	0.1	0.75	0.7	4.3	0.03	6.59	0.17	0.98	2.83	34.83	17.44	0.57
8		CES 4.6	22929	60	Sand	5.4	17560	0.25	1	1	14	0.01	0.04	0.13	0.11	0.75	1.4	1.3	0.03	6.59	0.17	1.85	6.76	24.84	20.22	0.54
9		CES 5.2	22930	60	Sand	5.6	3460	0.25	1	1	77	0.03	0.2	1.64	0.51	1.24	2.3	178.3	0.15	218.36	0.39	1.02	7.52	62.34	19.59	2.62
10		CES 5.6	22931	60	Sand	5.7	6610	0.25	1	1	49	0.01	0.12	0.96	0.36	0.8	8.2	84.3	0.21	22.92	0.19	0.66	7.28	56.18	21.28	1.71
11		CES 6.2	22932	60	Sand	5.8	8350	0.2	2	1	24	0.02	0.06	0.95	0.24	0.98	12.6	116.5	0.07	42.46	0.18	1.35	4.19	64.47	16.47	1.48
12		CES 6.6	22933	60	Sand	5.8	13680	0.25	2	1	41	0.01	0.1	0.6	0.49	0.82	7.2	78.8	0.09	16.1	0.17	0.63	7.17	41.35	33.71	1.46
13		CES 7.2	22934	60	Sand	4.7	20000	0.45	1	1	14	0.01	0.04	0.13	0.07	0.67	1.6	1.8	0.01	6.62	0.19	1.43	5.18	18.63	10.27	0.7
14		CES 7.6	22935	60	Sand	4.7	20000	0.35	1	2	7	0.01	0.02	0.1	0.05	0.74	3.7	0.6	0.02	4.49	0.14	1.89	3.21	18.46	10.17	0.53
15		CES 8.2	22936	60	Sand	5.3	9180	0.25	1	2	31	0.01	0.08	1.02	0.27	0.84	0.5	20.7	0.04	14.95	0.3	0.46	4.87	62.51	16.76	1.62
16		CES 8.6	22937	60	Sand	5.4	5000	0.25	1	1	15	0.04	0.04	0.32	0.15	0.81	0.7	5.4	0.06	18.54	0.12	5.43	4.87	39.89	19.03	0.81
17		CES 9.2	22938	60	Sand	4.9	1810	0.35	1	1	27	0.19	0.07	0.45	0.27	0.74	0.9	54.6	0.09	20.26	0.25	14.19	5.18	33.9	20.43	1.33
18		CES 9.6	22939	60	Sand	4.9	10340	0.3	1	1	24	0.02	0.06	0.34	0.33	0.71	0.6	20.5	0.13	12.3	0.12	1.65	5.89	32.39	31.26	1.04
19		CES 10.2	22940	60	Sand	5.1	7180	0.25	1	2	26	0.02	0.07	1.1	0.36	0.88	0.6	91.1	0.17	21.44	0.34	0.86	3.67	61.4	20.07	1.78
20		CES 10.6	22941	60	Sand	5.2	9880	0.3	1	1	23	0.01	0.06	0.72	0.28	0.74	2.2	51.2	0.1	14.51	0.18	0.95	4.22	52.56	20.5	1.38
21		CES 11.2	22942	60	Sand	5.4	13320	0.25	2	5	19	0.02	0.05	1.33	0.35	0.78	2.8	23.9	0.03	11.41	0.27	0.77	2.46	66.51	17.72	1.99
22		CES 11.2	22943	60	Sand	5.2	19710	0.25	2	2	43	0.03	0.11	0.46	0.18	0.68	4	2.4	0.04	15.78	0.19	2.45	10.77	44.82	17.52	1.02
23		CES 12.2	22944	60	Sand	5.5	4960	0.25	1	1	86	0.05	0.22	1.4	0.31	0.86	8.3	65.4	0.36	44.81	0.26	2.31	9.9	62.76	13.8	2.23
24		CES 12.6	22945	60	Sand	5.6	8210	0.25	1	1	41	0.04	0.11	0.82	0.37	0.71	5.7	24.7	0.26	17.21	0.12	2.33	6.68	51.85	23.36	1.58
25		CES 13.2	22946	60	Sand	5.1	10940	0.3	1	2	41	0.02	0.11	0.38	0.29	0.9	0.5	61.6	0.16	21.53	0.18	1.7	9.64	34.87	26.29	1.09
26		CES 13.6	22947	60	Sand	5.1	12170	0.3	1	1	40	0.01	0.1	0.36	0.36	0.91	0.8	36.9	0.11	11.23	0.17	1.3	9.07	31.47	31.61	1.13
27		CES 14.2	22948	60	Sand	5.1	16050	0.3	1	1	21	0.03	0.05	0.74	0.34	0.91	0.7	78.4	0.06	28.15	0.23	1.97	3.63	50.75	23.07	1.46
28		CES 14.6	22949	60	Sand	5	17840	0.25	1	1	22	0.03	0.06	0.61	0.39	0.96	2.2	85.7	0.05	19.88	0.17	2.21	4.19	45.97	28.89	1.33
29		CES 15.2	22950	60	Sand	5.1	7210	0.3	1	0	30	0.02	0.08	0.69	0.27	0.74	0.6	80.9	0.04	17.09	0.35	1.65	5.61	50.79	19.99	1.37
30		CES 15.6	22951	60	Sand	5	15960	0.3	1	1	35	0.02	0.09	0.4	0.35	0.71	3.1	46	0.02	11.7	0.12	1.52	7.78	34.36	30.34	1.15
31		CES 16.2	22952	60	Sand	5.2	15970	0.25	1	2	31	0.05	0.08	0.65	0.26	0.74	1.4	65.4	0.02	17.46	0.15	3.75	6.11	50.59	20.1	1.29
32		CES 16.6	22953	60	Sand	5.2	14910	0.25	1	1	45	0.05	0.11	0.7	0.14	0.73	10.1	50.1	0.02	21.38	0.19	4.18	9.02	55.64	11.4	1.27
33		CES 17.2	22954	60	Sand	5.2	5720	0.45	1	1	79	0.06	0.2	2.1	0.59	1.06	2.5	258.9	0.06	97.55	0.58	1.71	5.96	61.69	17.43	3.41
34		CES 17.6	22955	60	Sand	5.3	7850	0.35	1	1	54	0.01	0.14	0.96	0.57	0.84	27.7	178.1	0.06	40.48	0.17	0.61	6.77	47.3	28.06	2.03
35		CES 18.2	22956	60	Sand	5	20000	0.3	1	3	21	0.01	0.05	0.59	0.18	1.29	2	123	0.02	43.78	0.25	1.21	4.64	51.86	15.71	1.13
36		CES 18.6	22957	60	Sand	5	15400	0.3	1	2	28	0.01	0.07	0.49	0.15	1.09	5.5	121.8	0.02	43.47	0.12	1.19	7.04	47.65	14.95	1.03
37		CES 19.2	22958	60	Sand	4.6	9800	0.4	1	1	31	0.02	0.08	0.49	0.15	0.74	1.1	63.8	0.04	28.17	0.34	1.35	7.07	43.18	12.93	1.13
38		CES 19.6	22959	60	Sand	4.7	13100	0.4	1	1	36	0.05	0.09	0.58	0.13	0.7	14.7	28	0.04	16.26	0.28	4.16	7.4	46.36	10.38	1.26
39		CES 20.2	22960	60	Sand	4.7	5910	0.45	1	1	95	0.04	0.24	0.39	0.6	0.88	2.9	240.9	0.09	77.48	0.23	2.3	14.06	22.78	34.9	1.73

Soil Analyses Report
Date received:
08/07/2013 Date tested:

Sample		hrchard	Lab.	Depth	Soil	pH	Resist.	H+	Stone	P Bray LL	K	Exchangeable cations (cmol(+)/kg)				Cu	Zn	Mn	B	Fe	C	Na	K	Ca	Mg	T-Value
No.			No.	(cm)		(KCl)	(hhm)	(cmol/kg)	(Vol %)	mg/kg		Na	K	Ca	Mg	mg/kg				mg/kg	%	%	%	%	%	cmol/kg
40		CES 20.6	22961	60	Sand	4.7	8840	0.45	1	1	98	0.04	0.25	0.34	0.51	0.81	26.9	225.8	0.06	73.12	0.24	2.65	15.81	21.27	32	1.59

Table 8-2: Results of soil analysis for samples 41- 74

41	CES 23.2	22962	60	Sand	4.4	10810	0.5	1	1	45	0.02	0.11	0.21	0.21	0.75	3.8	82.9	0.05	45.54	0.19	1.65	10.84	20.32	19.69	1.05
42	CES 23.6	22963	60	Sand	4.4	12580	0.55	1	1	36	0.02	0.09	0.19	0.31	0.71	9.4	78.1	0.06	24.26	0.27	1.79	7.85	16.69	26.31	1.16
43	CES 29.2	22968	60	Sand	5	7170	0.35	1	1	50	0.03	0.13	0.86	0.4	0.98	1.3	258.9	0.08	93.72	0.26	1.51	7.21	48.72	22.76	1.77
44	CES 29.6	22969	60	Sand	4.9	6510	0.4	1	1	71	0.03	0.18	0.43	0.64	0.79	10.9	178.6	0.15	48.76	0.12	1.56	10.76	25.79	38.05	1.68
45	CES 32.2	22970	60	Sand	4.6	9600	0.55	1	1	42	0.02	0.11	0.83	0.2	0.89	1	167.6	0.12	66.78	0.37	1.44	6.28	48.54	11.54	1.71
46	CES 32.6	22971	60	Sand	4.7	12350	0.35	1	0	53	0.02	0.14	0.78	0.27	0.75	9.1	108.6	0.09	46.48	0.22	1.34	8.77	49.85	17.58	1.56
47	CES 33.2	22972	60	Sand	5	5730	0.3	1	1	72	0.02	0.19	0.9	0.4	0.95	5.1	191.5	0.09	96.63	0.19	1.12	10.27	49.87	22.08	1.8
48	CES 33.6	22973	60	Sand	5	9060	0.35	1	1	64	0.02	0.16	0.44	0.82	0.78	32.4	138.8	0.18	29.5	0.11	1.34	9.12	24.26	45.83	1.8
49	CES 34.2	22974	60	Sand	5.1	5710	0.3	2	1	44	0.01	0.11	0.66	0.3	0.77	1.7	94	0.11	39.01	0.25	0.99	8.14	47.8	21.36	1.38
50	CES 34.6	22975	60	Sand	5.1	9730	0.25	2	1	82	0.02	0.21	0.57	0.35	0.72	54.7	44.4	0.04	15.26	0.23	1.26	15.01	41	24.88	1.4
51	CES 35.2	22976	60	Sand	5.2	8960	0.3	3	1	46	0.11	0.12	1.53	0.51	1.03	3.2	173	0.04	59.85	0.43	4.36	4.58	59.69	19.69	2.57
52	CES 35.6	22977	60	Sand	5.2	12490	0.3	3	2	31	0.16	0.08	0.99	0.7	0.84	10.2	102.8	0.03	41.46	0.12	7.11	3.59	44.27	31.55	2.23
53	CES 36.2	22978	60	Sand	4.8	14230	0.35	2	2	8	0.01	0.02	0.28	0.12	0.75	1.5	9.4	0.01	8.24	0.17	1.88	2.61	35.83	15.26	0.79
54	CES 36.6	22979	60	Sand	4.7	20000	0.35	1	2	4	0.01	0.01	0.16	0.07	0.75	0.3	2	0.01	8.06	0.23	1.2	1.83	27	11.92	0.6
55	CES 37.2	22980	60	Sand	5	8150	0.3	1	1	34	0.01	0.09	0.61	0.45	0.83	1.1	105.7	0.05	37.33	0.3	0.99	5.95	41.69	30.93	1.47
56	CES 37.6	22981	60	Sand	4.6	15960	0.45	1	1	37	0.02	0.09	0.21	0.66	0.85	12	103	0.04	20.03	0.17	1.69	6.52	14.82	45.71	1.44
57	CES 38.2	22982	60	Sand	5	12430	0.25	1	2	16	0.02	0.04	0.69	0.25	0.72	1.2	33.4	0.03	19.53	0.23	1.69	3.31	55.12	19.9	1.25
58	CES 38.6	22983	60	Sand	5	11740	0.25	2	1	33	0.02	0.08	0.72	0.28	0.7	13.9	7.4	0.07	14.76	0.16	1.44	6.25	52.9	20.95	1.35
59	CES 39.2	22984	60	Sand	5.2	8410	0.3	1	1	55	0.02	0.14	0.47	0.51	0.81	17.3	101.6	0.07	33.55	0.13	1.18	9.7	32.68	35.58	1.44
60	CES 39.6	22985	60	Sand	5.2	6070	0.25	1	1	55	0.01	0.14	0.79	0.38	0.89	1.9	142.4	0.07	74.34	0.18	0.76	8.89	50.51	23.91	1.57
61	CES 40.2	22986	60	Sand	5.3	17570	0.25	1	3	13	0.01	0.03	1.37	0.29	1.09	2.1	55.8	0.03	20.83	0.31	0.47	1.72	70.13	14.91	1.96
62	CES 40.6	22987	60	Sand	5.3	14900	0.2	1	2	13	0.01	0.03	0.53	0.16	0.9	1.2	22.6	0.03	9.89	0.19	1.07	3.44	56.62	17.47	0.94
63	CES 41.2	22988	60	Sand	4.7	16760	0.35	2	1	31	0.07	0.08	0.33	0.19	0.74	0.7	4.5	0.05	7.9	0.2	6.92	7.78	32.04	18.94	1.02
64	CES 41.6	22989	60	Sand	4.5	20000	0.35	2	1	31	0.02	0.08	0.2	0.18	0.69	4.5	1.5	0.05	8.96	0.14	1.88	9.77	24.42	21.44	0.82
65	CES 42.2	22990	60	Sand	4.9	6420	0.35	1	1	56	0.03	0.14	0.6	0.77	1.24	1.2	316.8	0.1	56.03	0.18	1.55	7.55	31.8	40.68	1.9
66	CES 42.6	22991	60	Sand	5.1	8630	0.35	1	1	47	0.01	0.12	0.6	0.7	1.24	12.4	248.2	0.1	54.74	0.19	0.82	6.7	33.61	39.21	1.78
67	CES 43.2	22992	60	Sand	5.2	7460	0.25	1	1	43	0.01	0.11	0.82	0.35	0.8	0.7	107.3	0.08	49.98	0.17	0.59	7.2	53.32	22.67	1.54
68	CES 43.6	22993	60	Sand	5.2	5440	0.3	1	1	122	0.03	0.31	0.31	0.41	0.81	18.3	109.8	0.12	86.61	0.23	2.44	22.71	22.71	30.21	1.37
69	CES 45.2	22994	60	Sand	4.7	8710	0.45	1	1	37	0.05	0.09	0.77	0.29	0.87	20.6	109.7	0.1	53.4	0.14	3.09	5.73	46.39	17.6	1.65
70	CES 45.6	22995	60	Sand	4.8	10620	0.35	1	1	40	0.07	0.1	0.66	0.26	0.97	78.3	120.3	0.05	40.16	0.24	5.13	7.09	45.71	17.86	1.45
71	CES 47.2	22996	60	Sand	4.9	17480	0.25	1	1	15	0.01	0.04	0.38	0.16	0.7	2.7	14.5	0.05	5.68	0.18	1.77	4.54	45.24	18.68	0.84
72	CES 47.6	22997	60	Sand	4.5	20000	0.3	1	0	29	0.01	0.07	0.19	0.17	0.73	3.1	5.3	0.02	3.8	0.12	1.09	10.15	25.8	22.35	0.74
73	CES 49.2	22998	60	Sand	4.9	8020	0.35	2	3	20	0.03	0.05	1.22	0.2	1.06	2	48.1	0.04	30.89	0.23	1.46	2.74	66.12	10.78	1.85
74	CES 49.6	22999	60	Sand	5	20000	0.2	2	2	11	0.01	0.03	0.39	0.29	0.72	3.7	7.7	0.05	10.32	0.1	0.96	3.15	42.68	31.45	0.92
	Methods #				3108	3106	3109		3117		3113	3113	3113	3113	3115	3115	3115	3114		3107					

8.2 Summary of Soils

Using the information regarding soils from this area coupled with observations from the field (soil profiles, texture and color) the soil classification and distribution map for the Study Area will look as follows (Figure 8-3).

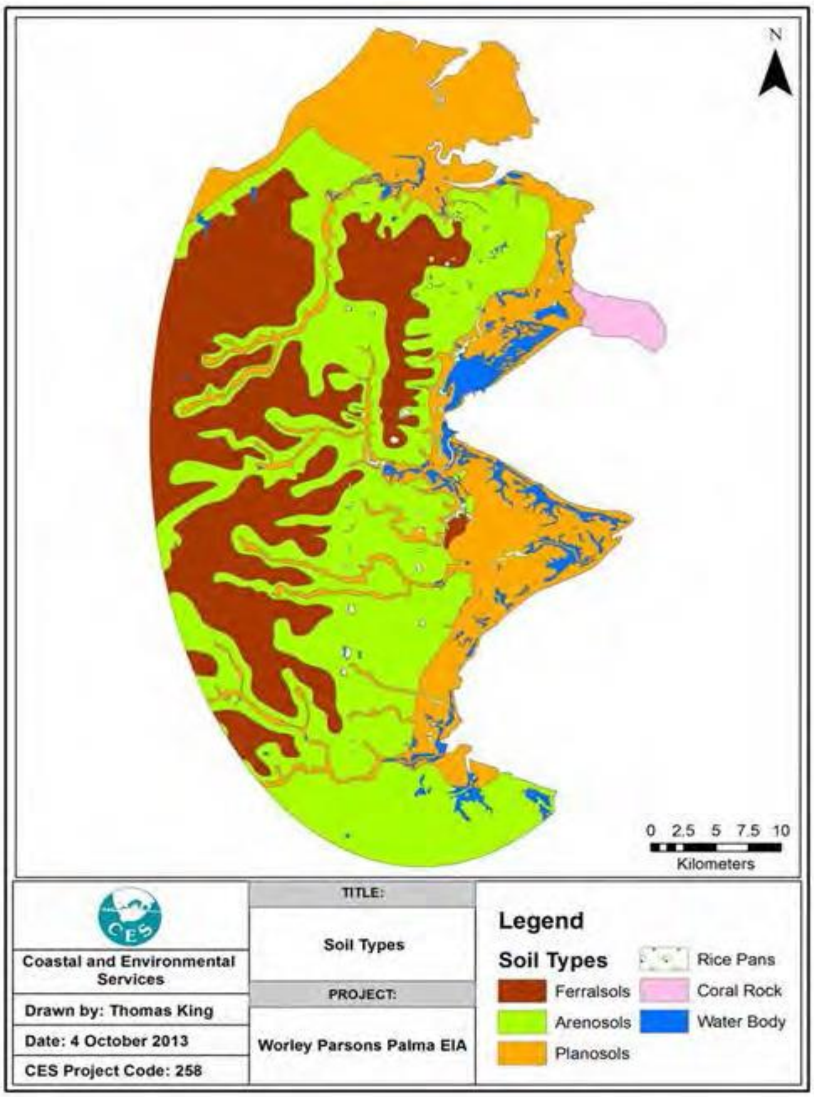

Figure 8-3 - Soil types of the Study Area

8.3 Summary of Soil Suitability for Agricultural Purposes

Based on the known properties of these soil types, as described by the "World Reference Base for Soil Resources 2006" (IUSS Working Group WRB, 2006), and from the results of the soil analysis (Tables

8-1 and 8-2) each of these soils was assigned a suitability rating when considered for the production of the typical crops grown and agricultural practices used in the Study Area (Table 8-3).

Table 8-3: Agricultural Suitability of the three soil types described in the Palma Region

Soil	Suitability
Ferralsols	Very high
Arenosols	High
Planosols	Moderate

The Ferralsols were considered to be the most suitable of the three soils present because of their higher Total Available Moisture (TAM) and Steady Water Intake Rate (Infiltration Rate). They were therefore assigned an agricultural/soil suitability rating of very high. The arenosols are considered to have better Total Available Moisture (TAM) and Steady Water Intake Rate (Infiltration Rate) properties than the Planosols and therefore they were assigned suitability ratings of high and moderate respectively.

Ideally it was required that the agricultural potential of soil types found in the Study Area be classified into five different classes. However, observations from the field study revealed that there was very little variation or differentiation in the soils across the Study Area and therefore only the three soils types and three suitability classes could be assigned (see Table 8-3 above).

However, for the purposes of this study and the requirement to provide five classes for agricultural potential, the soils identified have been assigned a “Very High”, “High”, and “Moderate” as summarized in Table 8-3. The Coral Rock area found on the Cabo Delgado peninsular was considered to be of unsuitable agricultural potential because of the very thin soils that exist there. Most of the water bodies in the Study Area were also considered as unsuitable agricultural areas. The exceptions are those areas where the water level during the year was such that it allowed for the growing of rice and therefore they were considered to have limited or low agricultural potential.

Based on the agricultural potential of the three soil types found across the Study Area and also taking into consideration the wetland areas and the coral rock area on the Cabo Delgado peninsula, a map of agricultural suitability was developed for the whole Study Area (Figure 8-4).

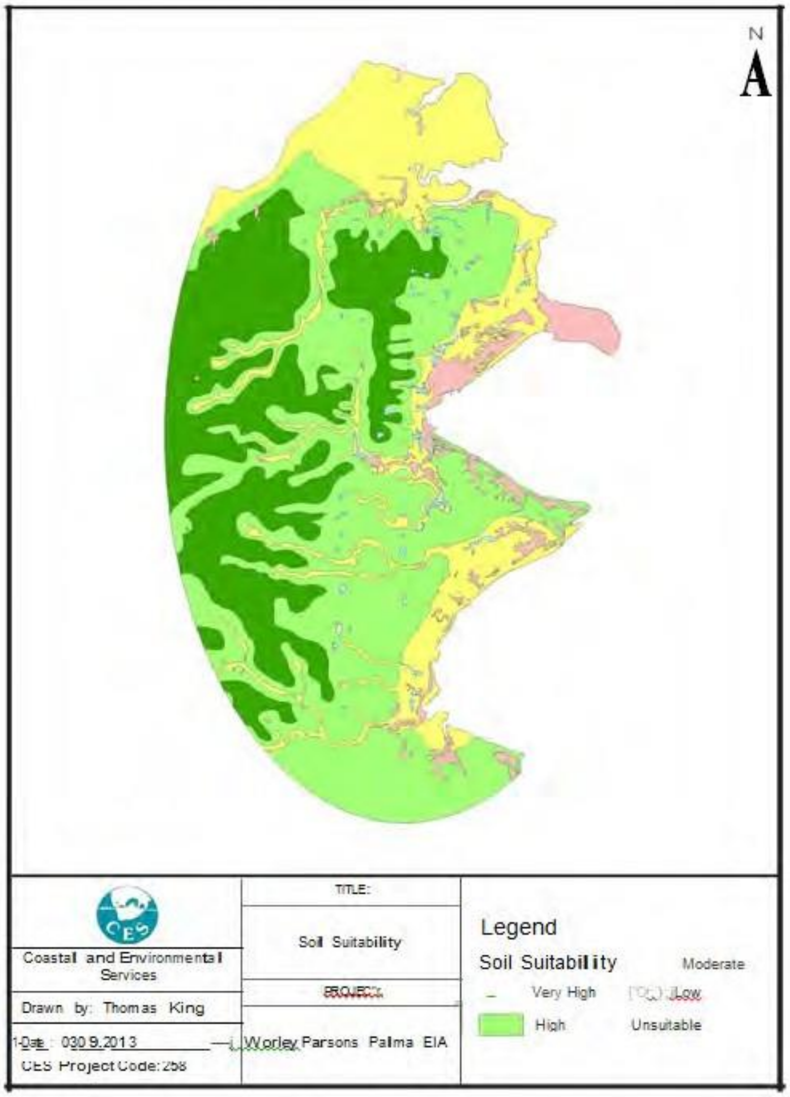

Figure 8-4: Agricultural Suitability of the soil types, wetlands and Coral rock area of the Study Area depicting five agricultural suitability classes

9 AGRICULTURAL POTENTIAL AND EXISTING CROPS

Based on observations in general across the Study Area the most commonly grown crops observed growing were cassava, millet, and maize, most of which is grown during the rainy season (November to April). During the drier season, cultivation of rice can be found in many of the wetland areas and pans where water is available for a majority of the year (Figure 9-1). Further information on each of these key crop types is provided below.

Figure 9-1: Rice being cultivated in a wetland along the R6 road

9.1 Cassava

Cassava (Manihot esculenta), also called manioc, is the third-largest source of food carbohydrates in the tropics, after rice and maize. Cassava is a woody shrub of the Euphorbiaceae (spurge) family, and is extensively cultivated as an annual crop in tropical and sub-tropical Africa for its edible starchy tuberous root. It is also one of the most drought-tolerant crops with the capability of growing in the climatic conditions and soils found in the Palma area (Figure 9-2).

Figure 9-2: Cassava crop grown extensively in the Palma region

9.2 Millet

Millet is a member of a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for both human food and fodder. It is an important crop in the semi-arid tropics of Africa where the crop is favored due to its high productivity and short growing season under dry and high temperature conditions. Millet is not only adapted to poor, droughty, and infertile soils, but they are also more reliable under these conditions than most other grain crops. This has, in part, made millet production suitable for the climatic and soil conditions found in the Palma area (Figure 9-3).

Millet does respond well to increased soil fertility and moisture. On a per hectare basis, millet grain produced per hectare can be two to four times higher with use of proper irrigation and sustainable soil supplements. This makes it a valuable crop in areas where there is access to fertilizers and irrigation.

Figure 9-3: Millet typical of the Palma region

9.3 Maize

Maize was introduced into Africa in the 1500s and has since become one of Africa's dominant food crops. Like many other regions, it is consumed as a vegetable although it is a grain crop. The grains are rich in vitamins A, C and E, carbohydrates, and essential minerals, and contain 9% protein. They are also rich in dietary fiber and calories which are a good source of energy. Maize accounts for 30−50% of low-income household expenditures in Eastern and Southern Africa, but heavy reliance on maize in the diet, however, can lead to malnutrition and vitamin deficiency diseases such as night blindness and kwashiorkor.

Maize is the most widely grown grain crop in Africa because of its ability to grow in climatic and soil condition found here. However, because of its shallow roots, maize is susceptible to droughts, intolerant of nutrient-deficient soils, and prone to be uprooted by severe winds. The importance of sufficient soil moisture is shown in many parts of

Africa, where periodic drought regularly causes maize crop failure and consequent famine.

While maize is grown across the Palma region, the sandy free-draining soils typical of the area do not make it ideal for growing maize and since most maize production in the area is rain fed and any irregular rainfall can trigger famines during occasional droughts.

9.4 Rice

Mozambique's hot to warm moist climate is suitable for rice production as it fulfils all the requirements of the crop. However in the Palma region the majority of the soils are of a permeable sandy natural with poor water retention. Consequently the growing of rice in the area is limited to wetlands, pans and riverine areas which retain water for a majority of the year.

10 CONCLUSIONS AND RECOMMENDATIONS

By comparing the overlapping the soils suitability map as well as the constraint maps, it would appear that there are potential areas that would be suitable for resettlement from an agricultural perspective. However, it was not within the scope of work for this assessment to identify the most suitable areas that could be considered for Resettlement of Agricultural Farmers.

While the quality of the soils is an important consideration in selecting a potential resettlement area it is worth noting that with the addition of fertilizers, some irrigation during the dry season and some agriculture/farm training provided to the local farmers, many of these areas can potentially produce large quantities of crops and vegetables for self-support of for sale in local markets.

Soil productivity can be increased with the appropriate use of fertilizers. This may be considered on the areas selected for resettlement to improve the agricultural output.

Based on the characterization of the soil identified in the soil survey, the appropriate fertilization schedule is suggested (Table 10-1 and Appendix A).

Table 10-1: Fertilization schedule

Cassava						
Land	Gypsum (ton/ha)	Lime (ton/ha)		Fertiliser requirement (kg element/ha)		
		Calcitic	Dolomitic	P	K	N
CES 3.2	0	0	0	280	490	260
CES 4.2	0	0	0	285	595	260
CES 5.2	0	0	0	285	230	260
CES 6.2	0	0	0	285	435	260
CES 7.2	0	6	0	285	515	260
CES 8.2	0	0	0	280	390	260
CES 9.2	0	4	0	285	415	260
CES 10.2	0	0	0	280	425	260
CES 11.2	0	0	0	265	475	260
CES 12.2	0	0	0	285	210	260
CES 13.2	0	0	0	280	335	260
CES 14.2	0	4	0	285	460	260
CES 15.2	0	3	0	290	395	260
CES 16.2	0	0	0	280	390	260
CES 17.2	0	0	0	285	225	260
CES 18.2	0	5	0	275	460	260
CES 19.2	0	5	0	285	390	260
CES 20.2	0	5	0	285	195	260
CES 23.2	0	5	0	285	320	260
CES N1.2	0	3	0	285	445	260
CES N2.2	0	0	0	250	395	260
CES 29.2	0	4	0	285	300	260
CES 32.2	0	8	0	285	335	260
CES 33.2	0	4	0	285	240	260
CES 34.2	0	0	0	285	325	260
CES 35.2	0	0	0	285	315	260
CES 36.2	0	5	0	280	575	260
CES 37.2	0	3	0	285	375	260
CES 38.2	0	3	0	280	500	260
CES 39.2	0	0	0	285	280	260
CES 40.2	0	0	0	275	525	260
CES 41.2	0	4	0	285	390	260
CES 42.2	0	4	0	285	280	260
CES 43.2	0	0	0	285	330	260
CES 45.2	0	6	0	285	355	260
CES 47.2	0	3	0	285	510	260
CES 49.2	0	5	0	275	465	260

Some general fertilizer guidelines for improving the soils in the Palma region are proposed listed below:

- Apply lime and phosphorus on the soil surface before ploughing. The lime requirement is calculated for a depth of 30 cm. For vegetables it is not necessary to cultivate deeper.
- The fertilizer requirements indicated in the table below are based on kg element per hectare.
- Adjust the amount of fertilizer applied according to the element content of the fertilizer used.
- Nitrogen and potassium should be applied as topdressing and the amount of nitrogen applied can be adjusted downwards depending on the vigor of the crop.
- For most crops nitrogen application is ceased after flowering.

In conclusion there appears to be sufficient access to water and potentially productive soils in many parts of the Study Area. There also appears to be large enough area of unoccupied land available north of Palma Town and west of the Cabo Delgado peninsular which would most suit the requirements of the people to be resettled.

During a detailed Environmental and Social Impact Assessment of a selected area it would be critical to closely determine the access to water, the soil quality for agriculture and the potential for improving those soils, along with being fully aware social constraints and the opinions and desires of the people being resettled.

Appendix A – Laboratory Analysis of Soil Samples

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Report No.:GR22926_a (Supplement to Test Report No: GR022926.DOC)

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Soil Analyses Report

Date received: 08/07/2013
Date tested: 10/07/2013

Orchard	Lab. No.	Depth (cm)	Soil	pH (KCl)	Resist. (Ohm)	H+ (cmol/kg)	Stone (Vol %)	P Bray II mg/kg	K mg/kg	Exchangeable cations (cmol(+)/kg) Na	K	Ca	Mg	Cu mg/kg	Zn mg/kg	Mn mg/kg	B mg/kg	Fe mg/kg	C %
CES 3.2	22926	60	Sand	5.4	12960	0.30	1	2	17	0.02	0.04	1.17	0.27	1.05	1.0	161.7	0.07	62.47	0.23
CES 3.6	22927	60	Sand	5.4	15360	0.25	1	1	29	0.01	0.07	0.62	0.23	1.08	1.3	128.3	0.05	44.95	0.15
CES 4.2	22928	60	Sand	5.4	20000	0.25	1	1	6	0.01	0.02	0.20	0.10	0.75	0.7	4.3	0.03	6.59	0.17
CES 4.6	22929	60	Sand	5.4	17560	0.25	1	1	14	0.01	0.04	0.13	0.11	0.75	1.4	1.3	0.03	6.59	0.17
CES5.2	22930	60	Sand	5.6	3460	0.25	1	1	77	0.03	0.20	1.64	0.51	1.24	2.3	178.3	0.15	218.36	0.39
CES 5.6	22931	60	Sand	5.7	6610	0.25	1	1	49	0.01	0.12	0.96	0.36	0.80	8.2	84.3	0.21	22.92	0.19
CES 6.2	22932	60	Sand	5.8	8350	0.20	2	1	24	0.02	0.06	0.95	0.24	0.98	12.6	116.5	0.07	42.46	0.18
CES 6.6	22933	60	Sand	5.8	13680	0.25	2	1	41	0.01	0.10	0.60	0.49	0.82	7.2	78.8	0.09	16.10	0.17
CES 7.2	229 4	60	Sand	4.7	20000	0.45	1	1	14	0.01	0.04	0.13	0.07	0.67	1.6	1.8	0.01	6.62	0.19
CES 7.6	22.935	60	Sand	4.7	20000	0.35	1	2	7	0.01	0.02	0.10	0.05	0.74	3.7	0.6	0.02	4.49	0.14
CES 8.2	22936	60	Sand	5.3	9180	0.25	1	2	31	0.01	0.08	1.02	0.27	0.84	0.5	20.7	0.04	14.95	0.30
CES 8.6	22937	60	Sand	5.4	5000	0.25	1	1	15	0.04	0.04	0.32	0.15	0.81	0.7	5.4	0.06	18.54	0.12
CES92	22938	60	Sand	4.9	1810	0.35	1	1	27	0.19	0.07	0.45	0.27	0.74	0.9	54.6	0.09	20.26	0.25
CES 9.6	22.939	60	Sand	4.9	10340	0.30	1	1	24	0.02	0.06	0.34	0.33	0.71	0.6	20.5	0.13	12.30	0.12
CES 10.2	22940	60	Sand	5.1	7180	0.25	1	2	26	0.02	0.07	1.10	0.36	0.88	0.6	91.1	0.17	21.44	0.34
CES 10.6	22941	60	Sand	5.2	9880	0.30	1	1	23	0.01	0.06	0.72	0.28	0.74	2.2	51.2	0.10	14.51	0.18
CES 11.2	22942	60	Sand	5.4	13320	0.25	2	5	19	0.02	0.05	1.33	0.35	0.78	2.8	23.9	0.03	11.41	0.2.7
CES 11.2	22943	60	Sand	5.2	19710	0.25	2	2	43	0.03	0.11	0.46	0.18	0.68	4.0	2.4	0.04	15.78	0.19
CES 12.2	22944	60	Sand	5.5	4960	0.25	1	1	86	0.05	0.22	1.40	0.31	0.86	8.3	65.4	0.36	44.81	0.26
CES 12.6	22945	60	Sand	5.6	8210	0.25	1	1	41	0.04	0.11	0.82	0.37	0.71	5.7	24.7	0.26	17.21	0.12
CES 13.2	22946	60	Sand	5.1	10940	0.30	1	2	41	0.02	0.11	0.38	0.29	0.90	0.5	61.6	0.16	21.53	0.18
CES 13.6	22947	60	Sand	5.1	12170	0.30	1	1	40	0.01	0.10	0.36	0.36	0.91	0.8	36.9	0.11	11.23	0.17
CES 14.2	22948	60	Sand	5.1	16050	0.30	1	1	21	0.03	0.05	0.74	0.34	0.91	0.7	78.4	0.06	28.15	0.23
CES 14.6	22949	60	Sand	5.0	17840	0.25	1	1	22	0.03	0.06	0.61	0.39	0.96	2.2	85.7	0.05	19.88	0.17
CES 15.2	22951	60	Sand	5.1	7210	0.30	1	0	30	0.02	0.08	0.69	0.27	0.74	0.6	80.9	0.04	17.09	0.35
CES 15.6	22951	60	Sand	5.0	15960	0.30	1	1	35	0.02	0.09	0.40	0.35	0.71	3.1	46.0	0.02	11.70	0.12
CES 16.2	2295	60	Sand	5.2	15970	0.25	1	2	31	0.05	0.08	0.65	0.26	0.74	1.4	65.4	0.02	17.46	0.15

Orchard	Lab. No.	Depth (cm)	Soil	pH (KCl)	Resist. (Ohm)	H^+ (cmol/kg)	Stone (Vol %)	P Bray II (mg/kg)	K (mg/kg)	Exchangeable cations (cmol(+)/kg) Na	K	Ca	Mg	Cu (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	B (mg/kg)	Fe mg/kg	C %
CES 16.6	22953	60	Sand	5.2	14910	0.25	1	1	45	0.05	0.11	0.70	0.14	0.73	10.1	50.1	0.02	21.38	0.19
CES 17.2	229 4	60	Sand	5.2	5720	0.45	1	1	79	0.06	0.20	2.10	0.59	1.06	2.5	258.9	0.06	97.55	0.58
CES 17.6	22955	60	Sand	5.3	7850	0.35	1	1	54	0.01	0.14	0.96	0.57	0.84	27.7	178.1	0.06	40.48	0.17
CES 18.2	22956	60	Sand	5.0	20000	0.30	1	3	21	0.01	0.05	0.59	0.18	1.29	2.0	123.0	0.02	43.78	0.25
CES 18.6	22957	60	Sand	5.0	15400	0.30	1	2	28	0.01	0.07	0.49	0.15	1.09	5.5	121.8	0.02	43.47	0.12
CES 19.2	22958	60	Sand	4.6	9800	0.40	1	1	31	0.02	0.08	0.49	0.15	0.74	1.1	63.8	0.04	28.17	0.34
CES 19.6	22959	60	Sand	4.7	13100	0.40	1	1	36	0.05	0.09	0.58	0.13	0.70	14.7	28.0	0.04	16.26	0.28
CES 20.2	22960	60	Sand	4.7	5910	0.45	1	1	95	0.04	0.24	0.39	0.60	0.88	2.9	240.9	0.09	77.48	0.23
CES 20.6	22961	60	Sand	4.7	8840	0.45	1	1	98	0.04	0.25	0.34	0.51	0.81	26.9	225.8	0.06	73.12	0.24
CES 23.2	22962	60	Sand	4.4	10810	0.50	1	1	45	0.02	0.11	0.21	0.21	0.75	3.8	82.9	0.05	45.54	0.19
CES 23.6	22963	60	Sand	4.4	12580	0.55	1	1	36	0.02	0.09	0.19	0.31	0.71	9.4	78.1	0.06	24.26	0.27
CES N1.2	22964	60	Sand	4.7	19450	0.25	1	1	23	0.01	0.06	0.39	0.16	0.71	3.9	9.4	0.03	17.38	0.15
CES N1.6	22965	60	Sand	4.7	20000	0.25	1	1	30	0.03	0.08	0.36	0.14	0.68	2.9	2.6	0.03	8.34	0.15
CES N2.2	22966	60	Sand	5.2	12300	0.25	1	8	30	0.01	0.08	1.39	0.35	1.29	1.5	126.7	0.03	44.71	0.27
CES N2.6	22967	60	Sand	5.3	12350	0.25	1	3	31	0.01	0.08	0.95	0.29	1.44	13.1	124.1	0.03	30.42	0.23
CES 29.2	22968	60	Sand	5.0	7170	0.35	1	1	50	0.03	0.13	0.86	0.40	0.98	1.3	258.9	0.08	93.72	0.26
CES 29.6	22969	60	Sand	4.9	6510	0.40	1	1	71	0.03	0.18	0.43	0.64	0.79	10.9	178.6	0.15	48.76	0.12
CES 32.2	22970	60	Sand	4.6	9600	0.55	1	1	42	0.02	0.11	0.83	0.20	0.89	1.0	167.6	0.12	66.78	0.37
CES 32.6	22971	60	Sand	4.7	12350	0.35	1	0	53	0.02	0.14	0.78	0.27	0.75	9.1	108.6	0.09	46.48	0.22
CES 33.2	22972	60	Sand	5.0	5730	0.30	1	1	72	0.02	0.19	0.90	0.40	0.95	5.1	191.5	0.09	96.63	0.19
CES 33.6	22973	60	Sand	5.0	9060	0.35	1	1	64	0.02	0.16	0.44	0.82	0.78	32.4	138.8	0.18	29.50	0.11
CES 34.2	22974	60	Sand	5.1	5710	0.30	2	1	44	0.01	0.11	0.66	0.30	0.77	1.7	94.0	0.11	39.01	0.25
CES 34.6	22975	60	Sand	5.1	9730	0.25	2	1	82	0.02	0.21	0.57	0.35	0.72	54.7	44.4	0.04	15.26	0.23
CES 35.2	22976	60	Sand	5.2	8960	0.30	3	1	46	0.11	0.12	1.53	0.51	1.03	3.2	173.0	0.04	59.85	0.43
CES 35.6	22977	60	Sand	5.2	12490	0.30	3	2	31	0.16	0.08	0.99	0.70	0.84	10.2	102.8	0.03	41.46	0.12
CES 36.2	22978	60	Sand	4.8	14230	0.35	2	2	8	0.01	0.02	0.28	0.12	0.75	1.5	9.4	**0.01**	8.24	0.17
CES 36.6	22979	60	Sand	4.7	20000	0.35	1	2	4	0.01	0.01	0.16	0.07	0.75	0.3	2.0	**0.01**	8.06	0.23
CES 37.2	22980	60	Sand	5.0	8150	0.30	1	1	34	0.01	0.09	0.61	0.45	0.83	1.1	105.7	0.05	37.33	0.30
CES 37.6	22981	60	Sand	4.6	15960	0.45	1	1	37	0.02	0.09	0.21	0.66	0.85	12.0	103.0	0.04	20.03	0.11
CES 38.2	22982	60	Sand	5.0	12430	0.25	1	2	16	0.02	0.04	0.69	0.25	0.72	1.2	33.4	0.03	19.53	0.23
CES 38.6	22983	60	Sand	5.0	11740	0.25	2	1	33	0.02	0.08	0.72	0.28	0.70	13.9	7.4	0.07	14.76	0.16
CES 39.2	22984	60	Sand	5.2	8410	0.30	1	1	55	0.02	0.14	0.47	0.51	0.81	17.3	101.6	0.07	33.55	0.13
CES 39.6	22985	60	Sand	5.2	6070	0.25	1	1	55	0.01	0.14	0.79	0.38	0.89	1.9	142.4	0.07	74.34	0.18
CES 40.2	22986	60	Sand	5.3	17570	0.25	1	3	13	0.01	0.03	1.37	0.29	1.09	2.1	55.8	0.03	20.83	0.31
CES 40.6	22987	60	Sand	5.3	14900	0.20	1	2	13	0.01	0.03	0.53	0.16	0.90	1.2	22.6	0.03	9.89	0.19
CES 41.2	22988	60	Sand	4.7	16760	0.35	2	1	31	0.07	0.08	0.33	0.19	0.74	0.7	4.5	0.05	7.90	0.20
CES 41.6	22989	60	Sand	4.5	20000	0.35	2	1	31	0.02	0.08	0.20	0.18	0.69	4.5	1.5	0.05	8.96	0.14
CES42.2	22990	60	Sand	4.9	6420	0.35	1	1	56	0.03	0.14	0.60	0.77	1.24	1.2	316.8	0.10	56.03	0.16
CES 42.6	22991	60	Sand	5.1	8630	0.35	1	1	47	0.01	0.12	0.60	0.70	1.24	12.4	248.2	0.10	54.74	0.19
CES43.2	22992	60	Sand	5.2	7460	0.25	1	1	43	0.01	0.11	0.82	0.35	0.80	0.7	107.3	0.08	49.98	0.17
CES43.6	22993	60	Sand	5.2	5440	0.30	1	1	122	0.03	0.31	0.31	0.41	0.81	18.3	109.8	0.12	86.61	0.23
CES45.2	22994	60	Sand	4.7	8710	0.45	1	1	37	0.05	0.09	0.77	0.29	0.87	20.6	109.7	0.10	53.40	0.14
CES 45.6	22995	60	Sand	4.8	10620	0.35	1	1	40	0.07	0.10	0.66	0.26	0.97	78.3	120.3	0.05	40.16	0.24
CES47.2	22996	60	Sand	4.9	17480	0.25	1	1	15	0.01	0.04	0.38	0.16	0.70	2.7	14.5	0.05	**5.68**	0.18
CES47.6	22997	60	Sand	4.5	20000	0.30	1	0	29	0.01	0.07	0.19	0.17	0.73	3.1	5.3	0.02	**3.80**	0.12
CES49.2	22998	60	Sand	4.9	8020	0.35	2	3	20	0.03	0.05	1.22	0.20	1.06	2.0	48.1	0.04	30.89	0.23
CES 49.6	22999	60	Sand	5.0	20000	0.20	2	2	11	0.01	0.03	0.39	0.29	0.72	3.7	7.7	0.05	10.32	0.10
Methods				3108	3106	3109		3117		3113	3113	3113	3113	3115	3115	3115	3114		3107

Values in bold is smaller than the lowest quantifiable concentration.

[illegible] Soils Analysis for CES July 2013 Page 2 of 3

If the pH> 7.0 the Olsen method(3.118) is used to determine P. "Refer to Bemlab.wotl instructions

Fore E S

Sample condition: Samples received in good condition.

Statement: The reported results may be applied only to samples received. Any recommendations included with this report are based on the assumption that the samples were representative of the bulk from which they were taken.

Base Saturation

Orchard No.	Lab. No.	Na %	K %	Ca %	Mg %	T-Value cmol/kg
CES3.2	22926	1.08	2.48	64.91	14.88	1.80
CES3.6	22927	0.69	6.25	52.27	19.72	1.19
CES 4.2	22928	0.98	2.83	34.83	17.44	0.57
CES 4.6	22929	1.85	6.76	24.84	20.22	0.54
CES5.2	22930	1.02	7.52	62.34	19.59	2.62
CES 5.6	229311	0.66	7.28	56.18	21.28	1.71
CES6.2	22932	1.35	4.19	64.47	16.47	1.48
CES6.6	22933	0.63	7.17	41.35	33.71	1.46
CES7.2	229 4	1.43	5.18	18.63	10.27	0.70
CES 7.6	22935	1.89	3.21	18.46	10.17	0.53
CES8.2	22936	0.46	4.87	62.51	16.76	1.62
CES8.6	22937	5.43	4.87	39.89	19.03	0.81
CES9.2	22938	14.19	5.18	33.90	20.43	1.33
CES9.6	22939	1.65	5.89	32.39	31.26	1.04
CES 10.2	22940	0.86	3.67	61.40	20.07	1.78
CES 10.6	22941	0.95	4.22	52.56	20.50	1.38
CES 11.2	22942	0.77	2.46	66.51	17.72	1.99
CES 11.2	22943	2.45	10.77	44.82	17.52	1.02
CES 12.2	22944	2.31	9.90	62.76	13.80	2.23
CES 12.6	22945	2.33	6.68	51.85	23.36	1.58
CES 13.2	22946	1.70	9.64	34.87	26.29	1.09
CES 13.6	22947	1.30	9.07	31.47	31.61	1.13
CES 14.2	22948	1.97	3.63	50.75	23.07	1.46
CES 14.6	22949	2.21	4.19	45.97	28.89	1.33
CES 15.2	22950	1.65	5.61	50.79	19.99	1.37
CES 15.6	22951	1.52	7.78	34.36	30.34	1.15
CES 16.2	22952	3.75	6.11	50.59	20.10	1.29
CES 16.6	22953	4.18	9.02	55.64	11.40	1.27
CES 17.2	22954	1.71	5.96	61.69	17.43	3.41
CES 17.6	22955	0.61	6.77	47.30	28.06	2.03
CES 18.2	22956	1.21	4.64	51.86	15.71	1.13
CES 18.6	22957	1.19	7.04	47.65	14.95	1.03
CES 19.2	22958	1.35	7.07	43.18	12.93	1.13
CES 19.6	22959	4.16	7.40	46.36	10.38	1.26
CES 20.2	22960	2.30	14.06	22.78	34.90	1.73
CES 20.6	22961	2.65	15.81	21.27	32.00	1.59
[illegible]	22962	1.65	10.84	20.32	19.69	1.05

Bemlab Soils Analysis for CES July 2013

Page 3of5

Orchard No.	Lab. No.	Na %	K %	Ca %	Mg %	T-Value cmol/kg
CES23.6	22963	1.79	7.85	16.69	26.31	1.16
CES N1.2	22964	1.64	6.58	44.78	18.44	0.88
CES N1.6	22965	3.56	8.95	41.47	16.82	0.86
CES N2.2	22966	0.58	3.66	67.00	16.69	2.07
CES N2.6	22967	0.64	4.96	60.05	18.57	1.58
CES29.2	22968	1.51	7.21	48.72	22.76	1.77
CES29.6	22969	1.56	10.76	25.79	38.05	1.68
CES 32.2	22970	1.44	6.28	48.54	11.54	1.71
CES 32.6	22971	1.34	8.77	49.85	17.58	1.56
CES33.2	22972	1.12	10.27	49.87	22.08	1.80
CES33.6	22973	1.34	9.12	24.26	45.83	1.80
CES34.2	22974	0.99	8.14	47.80	21.36	1.38
CES34.6	22975	1.26	15.01	41.00	24.88	1.40
CES 35.2	22976	4.36	4.58	59.69	19.69	2.57
CES35.6	22977	7.11	3.59	44.27	31.55	2.23
CES36.2	22978	1.88	2.61	35.83	15.26	0.79
CES36.6	22979	1.20	1.83	27.00	11.92	0.60
CES37.2	22980	0.99	5.95	41.69	30.93	1.47
CES37.6	22981	1.69	6.52	14.82	45.71	1.44
CES 38.2	22982	1.69	3.31	55.12	19.90	1.25
CES38.6	22983	1.44	6.25	52.90	20.95	1.35
CES 39.2	22984	1.18	9.70	32.68	35.58	1.44
CES39.6	22985	0.76	8.89	50.51	23.91	1.57
CES40.2	22986	0.47	1.72	70.13	14.91	1.96
CES 40.6	22987	1.07	3.44	56.62	17.47	0.94
CES 41.2	22988	6.92	7.78	32.04	18.94	1.02
CES41.6	22989	1.88	9.77	24.42	21.44	0.82
CES42.2	22990	1.55	7.55	31.80	40.68	1.90
CES42.6	22991	0.82	6.70	33.61	39.21	1.78
CES43.2	22992	0.59	7.20	53.32	22.67	1.54
CES 43.6	22993	2.44	22.71	22.71	30.21	1.37
CES45.2	22994	3.09	5.73	46.39	17.60	1.65
CES45.6	22995	5.13	7.09	45.71	17.86	1.45
CES47.2	22996	1.77	4.54	45.24	18.68	0.84
CES 47.6	22997	1.09	10.15	25.80	22.35	0.74
CES 49.2	22998	1.46	2.74	66.12	10.78	1.85
CES49.6	22999	0.96	3.15	42.68	31.45	0.92

FERTILISER GUIDELINES FOR VEGETABLES

1. Apply lime and phosphorus on the soil surface before ploughing. The lime requirement is calculated for a depth of 30 cm. For vegetables it is not necessary to cultivate deeper.
2. The fertiliser requirement is indicated as kg element per hectare. Adjust the amount of fertiliser applied according to the element content of the fertiliser used.
3. Nitrogen and potassium is applied as topdressing and the amount of nitrogen applied can be adjusted downwards depending on the vigour of the crop.
4. For most crops nitrogen application is ceased at flowering.
5. For onions nitrogen application is ceased 9 weeks after planting.

Bemlab Soils Analysis for CES July 2013 | Page 4 of 5

Potato

land	Gypsum (ton/ha)	Lime (ton/ha) Calcitic	Dolomitic	Fertiliser requirement (kg element/ha) P	K	N
CES32	0	0	0	280	490	260
CES 4.2	0	0	0	285	595	260
CES5.2	0	0	0	285	230	260
CES6.2	0	0	0	285	435	260
CES7.2	0	6	0	285	515	260
CES8.2	0	0	0	280	390	260
CES9.2	0	4	0	285	415	260
CES 10.2	0	0	0	280	425	260
CES 11.2	0	0	0	265	475	260
CES 12.2	0	0	0	285	210	260
CES 13.2	0	0	0	280	335	260
CES 14.2	0	4	0	285	460	260
CES 15.2	0	3	0	290	395	260
CES 16.2	0	0	0	280	390	260
CES 17.2	0	0	0	285	225	260
CES 18.2	0	5	0	275	460	260
CES 19.2	0	6	0	285	390	260
CES 20.2	0	5	0	285	195	260
CES23.2	0	6	0	285	320	260
CES N1.2	0	3	0	285	445	260
CES N2.2	0	0	0	250	395	260
CES29.2	0	4	0	285	300	260
CES32.2	0	8	0	285	335	260
CES33.2	0	4	0	285	240	260
CES 34.2	0	0	0	285	325	260
CES35.2	0	0	0	285	315	260
CES36.2	0	5	0	280	575	260
CES37.2	0	3	0	285	375	260
CES38.2	0	3	0	280	500	260
CES39.2	0	0	0	285	280	260
CES40.2	0	0	0	275	525	260
CES 41.2	0	4	0	285	390	260
CES 42.2	0	4	0	285	280	260
CES 43.2	0	0	0	285	330	260
CES45.2	0	6	0	285	355	260
CES 47.2	0	3	0	285	510	260
CES 49.2	0	5	0	275	465	260

Dr. Pieter Raath | 12.07.2013

forBemlab | Date Reported

Bemlab Soils Analysis forCES July 2013 | Page 5 of 5

Appendix C – Minutes of Meetings, Palma District June/July 2013

MEETING NOTES

Project Title: Afungi AMA Resettlement Project
Date: 21 June and 01 July 2013
Purpose: Introduce the consulting team and the purpose of the visit as well as ask for collaboration and support from all District structures including local and traditional authorities.

1. Palma District Administration (21/06/2013)

Present:

- Abdul Piconês – Permanent Secretary of the District
- Gervácio Horácio – Anadarko
- José Pereira – Worley Parsons
- Elisa Inguane Vicente – CES, Lda

	Matters Arising	Action
1	Introduction of the purpose of the meeting. The purpose of the meeting was to introduce the consultant team and inform that the team would be in the district in the follow two weeks to collect baseline data related to water, soil, vegetation and land use patterns. Additionally, the meeting also aimed at collecting information/documents relating to the urban plan of the district and the land use patterns, as well as the Strategic Development Plan of the District.	
2	The Permanent Secretary thanked the presence of the team. He informed that resettlement is very sensitive and that the government and the company should deal with proper care. Also emphasized that we should be very careful and not to alarm the people as the government will announce the resettlement to the villages and their reactions are unpredictable. He informed as well that the population of Palma is less prepared and may wrongly perceive any information received. Additionally, he informed that there is an urban plan for the district being revised by the government and it is expected to be approved in September.	
	Recommendation given	
	He recommended at the time of resettlement we take into account that people living in the coastal zone may need access for fishing. He also recommended the consultants look to the household survey study done by ENH in district, as that survey raised some constraints. The Permanent Secretary advised us to contact him in the following week so that he could provide the draft of the urban plan that was being revised and other relevant documents.	

2. Palma District Administration (01/07/2013)

Present:

- Abdul Piconês – Permanent Secretary of the District
- Acácio Ntauma – Anadarko
- Elisa Inguane Vicente – CES, Lda

	Matters Arising	Action
1	Introduction of the purpose of the meeting. The purpose of the meeting was to collect the documents requested in the previous week.	
2	The Permanent Secretary of the District said he could not provide the urban plan as this was already in Pemba for review by MICOA. The only information he could provide was the Strategic Development Plan of the District of 2008-2012. We received the plan, however, this is outdated to the current context of the district, and therefore will not bring many elements to the research intended.	
	Recommendation given	

3. District Services for Economic Activities (SDAE) (01/07/2013)

Present:

- Carlos Paulo – SDAE Technician
- Acácio Ntauma – Anadarko
- Elisa Inguane Vicente – CES, Lda

	Matters Arising	Action
1	Introduction of the purpose of the meeting. The purpose of the meeting was to gather information concerning the existence and location of forest concessions in the district and agricultural and tourism development areas and game reserves.	

	Matters Arising	Action
2	The Director of SDAE was absent from the district and appointed a technician to represent him. The technician informed us that there are two forest concessions in the district, located respectively in the Administrative Post of Pundanhar and in the Administrative Post of Olumbi. He informed us that there are still many requests for land use rights (DUATs) for agricultural projects, but these have not yet been approved. Regarding game reserves he informed that there are no game reserves in the district. In the area of tourism, he said that there are many plans, but presently they are restricted only to the islands.	
	Recommendation given	

Appendix D – Talbot and Talbot Accreditation

CERTIFICATE OF ACCREDITATION

In terms of section 22(2) (b) of the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act 2006 (Act 19 of2006), read with sections 23(1), (2) and (3) of the said Act, I hereby certify that:-

TALBOT LA BORATORIES (PTY) LTD
Co. Reg. No.: 2000/021732/07

PIETERMA RITZBUR G
Facility Accreditation Number: T0122

is a South African National Accreditation System accredited Testing laboratory provided that all SANAS conditions and requirements are complied with

This certificate is valid as per the scope as stated in the accompanying schedule of accreditation Annexure "A", bearing the above accreditation number for

CHEMICAL AND MICROBIOLOGICA L ANALYSIS

The facility is accredited in accordance with the recognised International Standard

ISO/IEC 17025:2005

The accreditation demonstrates technical competency for a defined scope and the operation of a laboratory quality management system

While this certificate remains valid, the Accredited Facility named above is authorised to use the relevant SANAS accreditation symbol to issue facility reports and/or certificates

Mr R Josias
Chief Executive Officer

Effective Date: 01August 2011
Certificate Expires: 31July 2016

Appendix E – Palma District Hand Pump Details

Palma District Hand Pump Detail 4 July 2013

Produced by:

Francois Humphries - Worley Parsons

Esade van Zyl - Esade van ZylConsulting

Region	District		Pump no.	Serial no.	UTM zone 37 Coordinate East	UTM zone 37 Coordinate North	Lat/Long Lat	Lat/Long Long
					664033	8828268	-10.5962	40.50770
[redacted]								
		[illegible]	AI 1(... 1.0		66521:	8828245	-10.3964	40.510
					663196	8827333	-10.6006	40.
[redacted]								
					664632	8828778	-10.5916	40.5071
			[illegible]		663334	8828499	-10.5941	-40.51.
			NO [illegible]		6663..	8828030	-10.59823	40.5226
		[illegible]	021		650696	8831349	-10.56894	40.37916
[redacted]								
	[illegible]	[illegible]	NO		671729		-10.6169	40.5698
			NO		671123	8826104	-10.6133	40.564..
			PA06 1.75		671256	8826230	-10.6144	40.5625
					671412	88265..	-10.6141	
		[illegible]			6.. 134	8826324	-10.61348	40.56435
[redacted]								
		[illegible]	NO NUMBER NO	5578	6..746	8818098	-10.6378	40.5795
			NUMBER	5576	672641	8818076	-10.6...	40.5...
			PA17/01.88.4.0			8818031	-10.6884	40.5..4
			PA17/08/88...		672564	881..144	-10.6874	40.5..8
[redacted]								
				3920	661406	8784..	-10.9881	40.4773
					66166..	8783..	-1..	40.4796
		[illegible]	NO NUMBER	5561	661610	8783..	-1	40.4..
			26/9/1	51260	661696	8783..	-1	..1..
			PA14/7.69/33	5571	661797	8784..	-1	..1..
					661828	8784640	-1	
			NO NUMBER		661503	8784533	-1	
	[illegible]				661..	8784050	-10.9961	
					661..	8784104	-10.9931	40.4..9
			PA14 17/1		661..		-10.9928	40.4794
			[illegible] 2..906		661..		-10.9922	40.4804
			W.E		661..		-10.9918	40.4807
			PA14 02/8.. 1.6		661..		-10.9886	4D.48
				3929	663019	8794284	10.9081	40.4916
				391	663102	8794582	-10.9009	40.492..
				3930	662863	8794239	-10.904	40..02..
		[illegible]			663418	8794598	-10.900	40.4952
			21/9/1..		5663306	8794333	-10.9031	40.4942
				51246	663137	8..94013	-10.906	40.4929
		25 de Junho			654440	8784079	-10.9962	4.4135
		Junh..			645696	8784040	-10.9969	40.347..
			02101 ..14..		64533..	8788251	-10.958..	40.3375
[redacted]								

Appendix F – Bemlab Accreditation Letter

bemLab

16 Van der Berg Crescent
Gant's Centre
Strand

Tel. (021) 853-1490
Fax (021) 853-1423

E-Mail admin@bemlab.co.za

PO Box 684
Somerset Mall
7137

Vat Reg. No. 4200161414

27 September 2013

Dear Client

As a valued client of Bemlab laboratory we wish to keep you informed of events in our business that might be of interest to you.

Bemlab laboratory is an ISO 17025 accredited laboratory with the South African National Accreditation System (SANAS). Accreditation is achieved only by meeting and maintaining a number of conditions that are determined by SANAS – an independent authority that gives formal recognition that laboratories are competent to conduct their business. Bemlab first received this formal recognition in 2010 when we observed all the necessary criteria required to achieve the ISO 17025 accreditation status.

However, recent resignations by two staff members who were SANAS registered and certified signatories for releasing results have affected one of the number of conditions required by SANAS to achieve and maintain our accreditation status. Although our analysts remain competent and we have not changed our analy1ical procedures, this technical point in the accreditation system has led us to apply for voluntary suspension of our accreditation. This decision - a temporary measure until we have recruited suitable candidates to fill these vacant posts by which point we can reapply for accreditation – is a reflection of our commitment to honour the SANAS accreditation system while maintaining the highest quality agricultural analy1ical service available in South Africa.

Please be assured that this development does not in any way affect the quality of our service. We have changed none of our analy1ical procedures or any of the quality control systems that we've been using since 2010 when we first became an accredited laboratory. Furthermore, we are supported and audited by the Quality Assurance Division of PathCare - which has an impeccable reputation for quality assurance.

Lastly, with reference to GlobaiGAP (version 4) requirements regarding water analyses, points FV 5.7.3 and CB 6.3.4: All chemical analyses on water are validated via the proficiency test schemes of AgriLASA and SABA and have been included in our SANAS accreditation. The same applies to other analyses, e.g. leaves, soils and fertilizers (Section CB 5.6.1 of GlobaiGAP). Microbial analyses on water are done using the IDEXX Laboratories Defined Substrate Technology method to detect Total coliforms, Faecal coliforms, E.coli and Enterococci. A AFNOR Certified Most Probable Number method and the Standard Plate Count, using Pour plate agar SABS approved methods or Aerobic Plate count Petri film agar: 3M Petri film TM method. All microbiology analyses on water and fruit are validated via the NLA proficiency test schemes for Water and Food analysis. 3M is an ISO 9000 accredited company.

Please advise us should you specifically require SANAS accredited water analyses and we will ensure such specimens are submitted to our referral laboratory for analysis.

We trust that you will find the above in order but should you have any related queries please do not hesitate to contact me on 021-8531490 or 0824184006.

Yours sincerely,

Pieter Raath (PhDAgric)
Laboratory Manager

Appendix G – List of IUCN Red Data Mammal Species Recorded in Northern Mozambique, and Mammal Species Observed During Site Survey June-July 2013

Scientific Name	English Name	Red List Status	Comments
Lycaon pictus	African Wild Dog	EN	Reported
Hipposideros vittatus	Striped Leaf-nosed bat	NT	Reported
Eidolon helvum	Straw-coloured Fruit Bat	NT	Reported
Panthera pardus	Leopard	NT	Reported
Loxodonta africana	African Elephant	vu	Evidence seen on road north-west of Quionga
Hippopotamus amphibius	Common Hippopotamus	vu	Observed in the Rovuma River
Panthera leo	African Lion	vu	Reported by local residents in south of the Study Area
Potamochoerus larvatus	Bush Pig	LC	Footprints observed in wetland east of Lipoca
Petrodromus tetradactylus	Four-toed Elephant-shrew	LC	Observed in forests west of
Crocuta crocuta	Spotted Hyaena	LC	Footprints observed south of Patacua
Papio cynocephalus	Yellow Baboon	LC	Reported
Chlorocebus pygerythrus	vervet monkey	LC	Seen near Rovuma River
Cercopithecus mitis samango	Samango monkey	LC	Observed near Tanzanian border
Lepus saxatilis	Scrub Hare	LC	Droppings found on various roads in Study Area
Paraxerus flavovittis	Striped Bush Squirrel	LC	Seen in wooded and forested areas
Tadarida ventralis	African Giant Free-tailed Bat	DD	Reported
Pipistrellus flavescens	Yellow Serotine	DD	Reported
Pipistrellus melckorum	Melck's House Bat	DD	Reported

EN - Endangered vu - vulnerable
NT - Near Threatened LC - Least Threatened DD - Data Deficient

APPENDIX D – POST RAPID ASSESSMENT FIELD STUDY MODELS

CONTENTS

Figures

Tables

SITE SELECTION – RESULTS: *EXTENDED STUDY AREA* (Post *Rapid Assessment FIELD STUDY*)

D 1. Introduction

This *appendix* presents the results of the implementation of the *Site Selection Methodology* developed to the *Extended Study Area* (oval shape around the DUAT Area).

In the following sections, the main *Assumptions* and *Limitations* associated with the development of the *Suitability Models* in the *Extended Study Area* (one for the *Village(s) Infrastructure* and one for *Livelihood Restoration / Agriculture*) will be presented. After this, the implementation of the *methodology* to the *Extended Study Area* will be described in detail, with each of the sub-sections presenting and explaining, step by step, the specifics regarding each of the phases of the methodology develop.

The *Suitability Models* supported the identification of a number of *Potential Sites*, located in the *Extended Study Area*, where to resettle and restore the livelihoods of the households that will need to be displaced. Additionally, these *Potential Sites* are located within the *most suitable areas* found inside the Study Area.

These models and the proposed *Potential Sites* were presented, at a higher level within Project (including the LNG Project Director), on a workshop held in Centurion, on the 6th of September, 2013.

D 2. Assumptions

The following assumptions were considered in the assessment:

- Some of the villagers to be resettled engage in both fishing and agricultural activities.
- Resettlement will occur to one or more villages integrating both fishing and agricultural communities.
- Palma is considered the main commercial centre in the Study Area.
- The Project is considered the main potential employer in the area.
- Location of existing settlements is determined by livelihood requirements.
- Uncertainty with regards to Administrative and Commercial factors, specifically the development of the Industrial Zone.

D 3. Limitations

The limitations of the assessment are as follows:

- No consultation with the communities with regard to:

- Community socio-economic parameters that reflect community aspirations (constraints and criteria);
- Ranking and weights assigned to criteria.

- Limited information available on:
  - Land Use.

D 4. Implementation of the Methodology to the Extended Study Area

This section describes in detail the way in which the phased GIS-supported *Multi-Criteria Assessment and Site Selection Methodology* developed was implemented specifically *to the Extended Study Area*.

As mentioned in Chapter 3 and Appendix A, the *Suitability Models* were developed based on real, larger scale, and ground-truthed data and information compiled during the *Rapid Assessment Field Study*, with regards to the parameters considered as *Constraints* and *Comparison Criteria*.

Each of the following sub-sections explains, step by step, the implementation of each of the phases of the methodology and presents the specifics regarding the development of the resulting *Suitability Models*, namely identifying the *Site Selection parameters* considered.

D4.1. Phase 1 – Definition of the Study Area

The *Study Area*, as per agreed in the May 2013 Workshop in Maputo, was considered to be the area 20 km away from Palma town to the west, extending north to the border with Tanzania and south, to south of Olumbe (oval shape represented in yellow, in Figure D-1) with the exception of the DUAT Area.

This is the area that will be subjected to the assessment in accordance with the subsequent phases of the *Site Selection Methodology* developed, and from within which the *Potential Sites* for the location of the *Replacement Village(s)* will ultimately be identified.

It is important to note that, at this stage, the assumption was that the whole of the DUAT Area would need to be for the exclusive use of the LNG Project. For this reason, all communities residing there would need to be resettled into replacement accommodation at an alternative site or sites. The DUAT Area, considered the "origin" for the resettlement, could not be a *candidate* for the location of the *Replacement Village(s)*, reason why it was excluded from the *Study Area*.

This *Study Area* is referred to as *Extended Study Area* as it corresponds to an extension further north and south, when compared to the original (circular) *Study Area* proposed during the first exercise of implementation of the *Site Selection Methodology*.

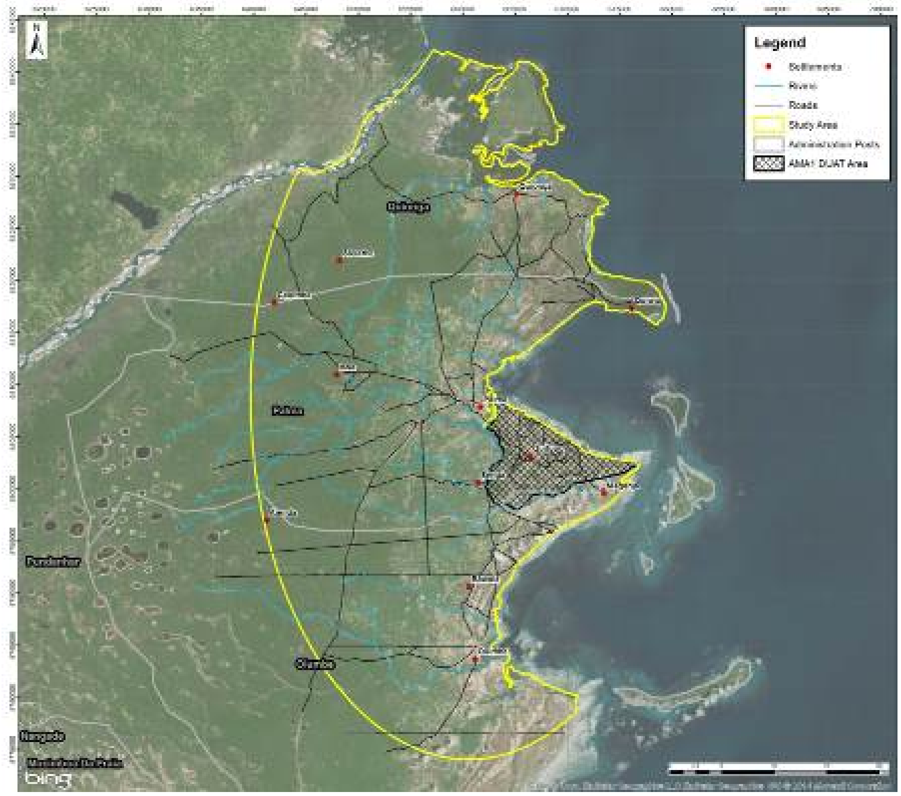


Figure D-1 *Extended Study Area* (excluding the DUAT Area)

D4.2. Phase 2 – Constraints Mapping

The *Study Area* was then assessed in terms of the availability and suitability of areas for both the construction of the physical infrastructure associated with the villages, and for the establishment of the associated agricultural plots.

The parameters that may pose serious constraints to the use of the land (*Constraints*) for each of these two purposes differ, and have been identified in Table D-1. This Table presents the technical, environmental and social *Constraints* (*no-go* areas) considered relevant for each *Suitability Model*.
For each *Suitability Model*, the areas that correspond to each of the relevant *Constraints* have been mapped and systematically excluded / *blocked out* from the *Study Area*, as they are deemed *unavailable* and/or *unsuitable* for the respective purposes.

Table D-1 Relevant Constraints (no-go areas) considered for the two Suitability Models

PARAMETER	CONSTRAINT (NO GO)	RELEVANT CONSTRAINTS	
		LIVELIHOOD RESTORATION – AGRICULTURE MODEL	VILLAGES / INFRASTRUCTURE MODEL
DUAT area	Inside DUAT area	✓	✓
Floodable areas	Inside floodable areas		✓

PARAMETER	CONSTRAINT (NO GO)	RELEVANT CONSTRAINTS	
		LIVELIHOOD RESTORATION – AGRICULTURE MODEL	VILLAGES / INFRASTRUCTURE MODEL
Wetlands and Pans	Inside wetlands and pans		✓
Forested areas	Inside densely forested areas, including the Dry Coastal Forest	✓	✓
Mangroves	Inside dense mangrove areas and the Rovuma river delta (with mangroves	✓	✓
Transport and Social Infrastructure	Inside Buffer around social and transport infrastructure: - Airfields - Health facilities, schools, tourism assets - Roads (150 m buffer)	✓	✓
Cultivated areas – existing agriculture	Inside cultivated areas (existing agriculture)	✓	

This process reveals, for each *Suitability Model*, the *Potentially Suitable Areas*: all the remainder (non-constrained) areas within the *Study Area*. The subsequent analysis (following phases of the *Site Selection Methodology*) will only be carried out over these areas.

The following sections present additional information about each of the *Constraints* considered for each *Suitability Model*, such as the reasoning for including the *Constraints* (in either one or both models) and the sources of information used to produce the respective mapping exercise.

D.4.2.1 DUAT Area

As mentioned, at this stage, the assumption was that the DUAT Area would need to be for the exclusive use of the LNG Project. For this reason:

- all communities residing in DUAT Area would need to be resettled, and
- the *Replacement Village(s)* and/or associated agricultural plots cannot be located in the DUAT Area.

For these reasons, the DUAT Area (considered the “origin” for the resettlement) could not be a *candidate* for the location of the *Replacement Village(s)*. This area has therefore been excluded from the *Study Area* and blocked out (considered a *Constraint*) for the construction of the physical infrastructure associated with the villages and for the establishment of the areas for livelihood restoration/agricultural plots.

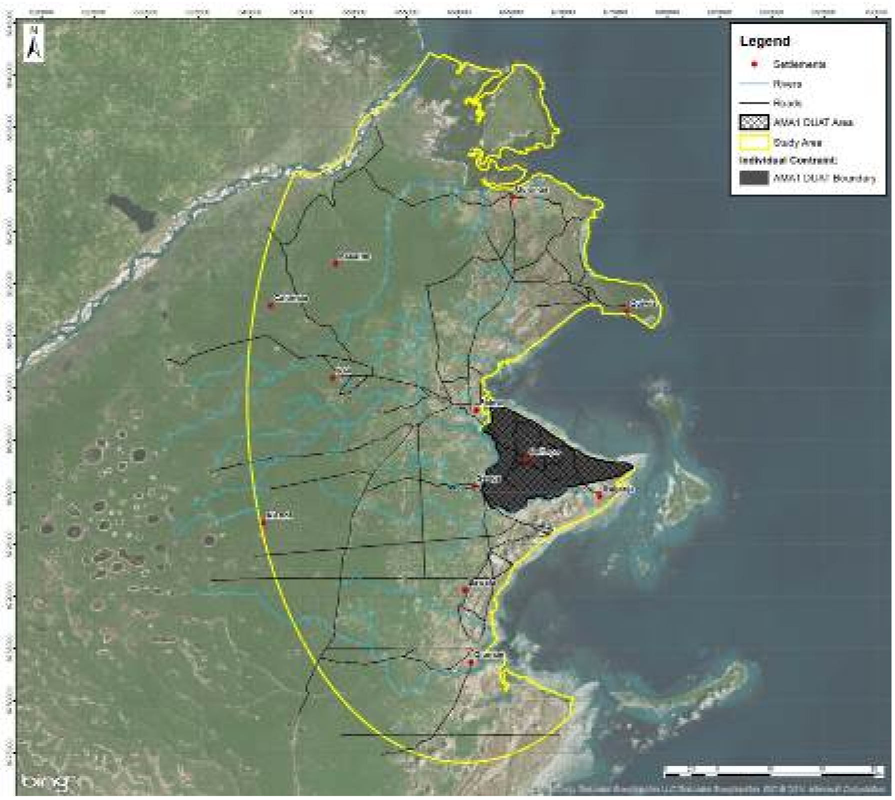


Figure D-2 *Individual Constraint: DUAT Area*

D.4.2.2 Floodable Areas

Floodable areas are areas that are very likely to get flooded, either with surface and/or ground water, for what have been considered unsuitable for the construction of the physical infrastructure associated with the villages. These areas have therefore been identified as no-go areas (*Constraint*) for construction purposes.

Some *floodable areas* may, however, be suitable for the conduction of certain subsistence activities (namely certain types of agriculture and/or intertidal collection), for what this *Constraint* has not been considered for the establishment of the areas for livelihood restoration.

The source of the data/information used in order to map these areas was:

- <u>Surface Water</u>: “Surface Water Modelling”: (WP Surface Water Modelling);
- <u>Groundwater</u>: "Groundwater Flood Extents" (WP Groundwater Modelling, modified from CES data).

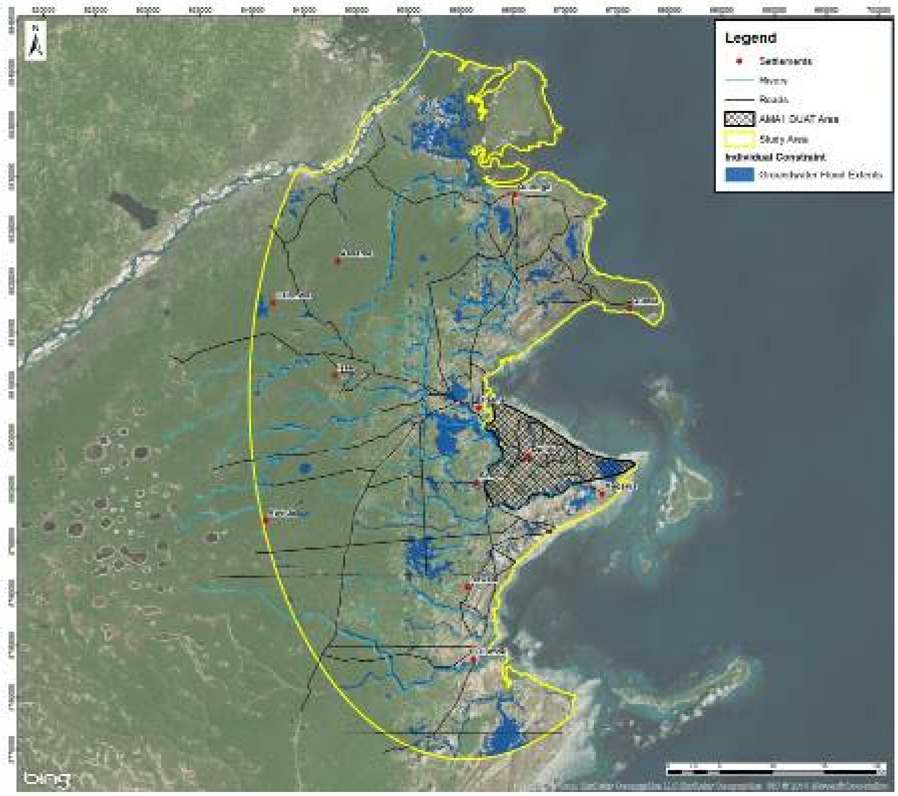


Figure D-3 *Individual Constraint: Floodable areas*

D.4.2.3 Wetlands and Pans

The importance of wetlands and pans has been explained in detail in Section 4.4.2.4.

Areas inside ***wetlands and pans*** have been considered unsuitable for the construction of the physical infrastructure associated with the villages. As a consequence, this has been identified as a *Constraint* (no-go areas) for the *Village(s) / Infrastructure Model*.

Once these areas are traditionally used by the Local Communities for their livelihood activities, they were not defined as "no-go" areas for livelihood restoration purposes, for what this *Constraint* has not been considered for the establishment of the areas for livelihood restoration.

These areas should be avoided and preserved to the extent possible, even for the conduction of such activities, considering the important benefits they provide.

The source of the data/information used in order to map these areas was:

- Wetlands and Pans: WP Groundwater Modelling, modified from CES data.

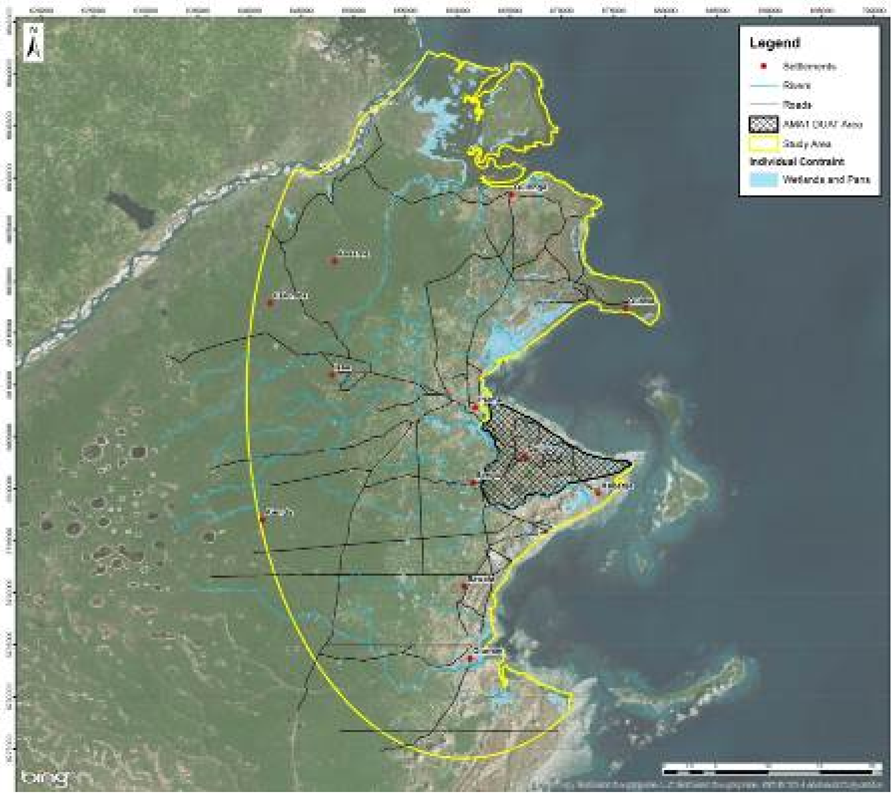


Figure D-4 *Individual Constraint: Wetlands and Pans*

D.4.2.4 Dense Forested Areas

Dense forested areas play an important role in providing essential ecosystem services to the area. Of particular ecological and environmental concern within the *Study Area* is the presence of Coastal Dry Forest.

The current extend of these forested areas in the *Study Area*, including the Coastal Dry Forests, was determined by CES during the Rapid Assessment Field Study. It was found that there are still intact areas of dense forest in the west and north of the *Study Area* but the extent of the forests has been significantly reduced.

For ecological reasons, the *Dense Forested Areas* have been identified as a *Constraint* (no-go areas) and blocked out for the construction of the physical infrastructure associated with the villages and for the establishment of the areas for livelihood restoration/agricultural plots.

The source of the data/information used in order to map these areas was:

- Dense Forest: Figure 4.34: *Vegetation* map *of the Palma Study Area* (report presented in Appendix C – "*Rapid Assessment Field Study Report*" (September 2013); Coastal & Environmental Services (CES).

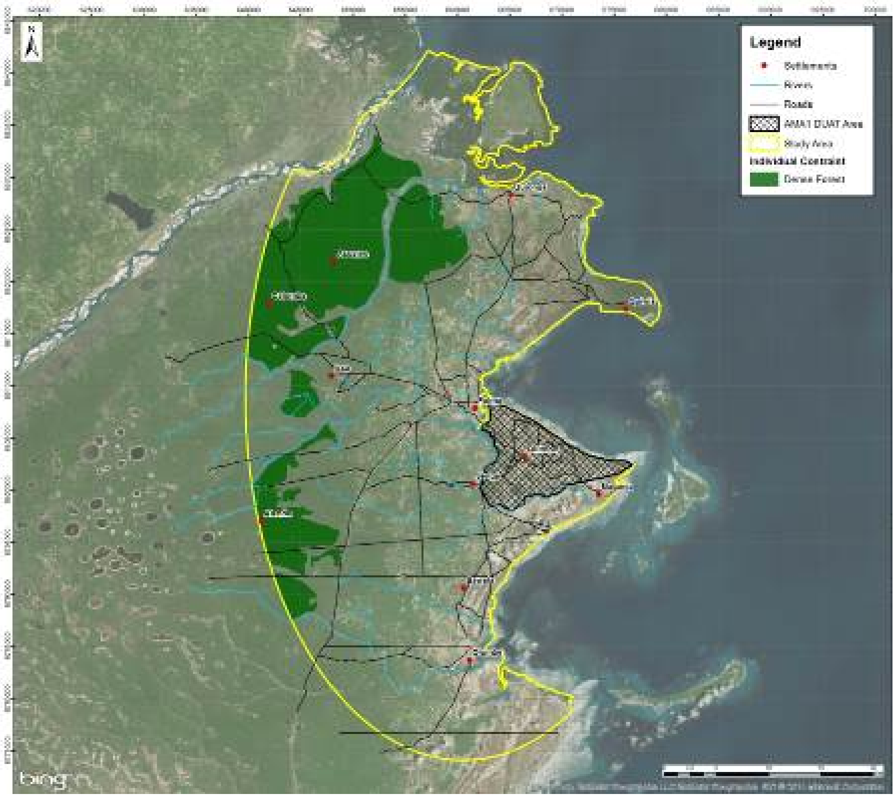


Figure D-5 *Individual Constraint: Forested areas*

D.4.2.5 Mangrove and the Rovuma river delta

The importance of *mangroves* has been explained in detail in Section 4.4.2.3. For the benefit of all communities, for ecological and economic (and therefore social) reasons, these ecosystems should be preserved by all.

Areas of dense mangroves and the Rovuma river delta (with mangroves) have therefore been identified as a *Constraint* (no-go area) and blocked out for both the construction of the physical infrastructure associated with the villages and the establishment of the areas for livelihood restoration (namely the agricultural plots and for other subsistence activities), in an attempt to preserve these ecological/economical important ecosystems.

The source of the data/information used in order to map these areas was:

- <u>Dense Mangrove Areas and the Rovuma river delta (with mangroves)</u>: Figure 4.34: *Vegetation map of the Palma Study Area* (report presented in Appendix C – "*Rapid Assessment Field Study Report*" (September 2013); Coastal & Environmental Services (CES).

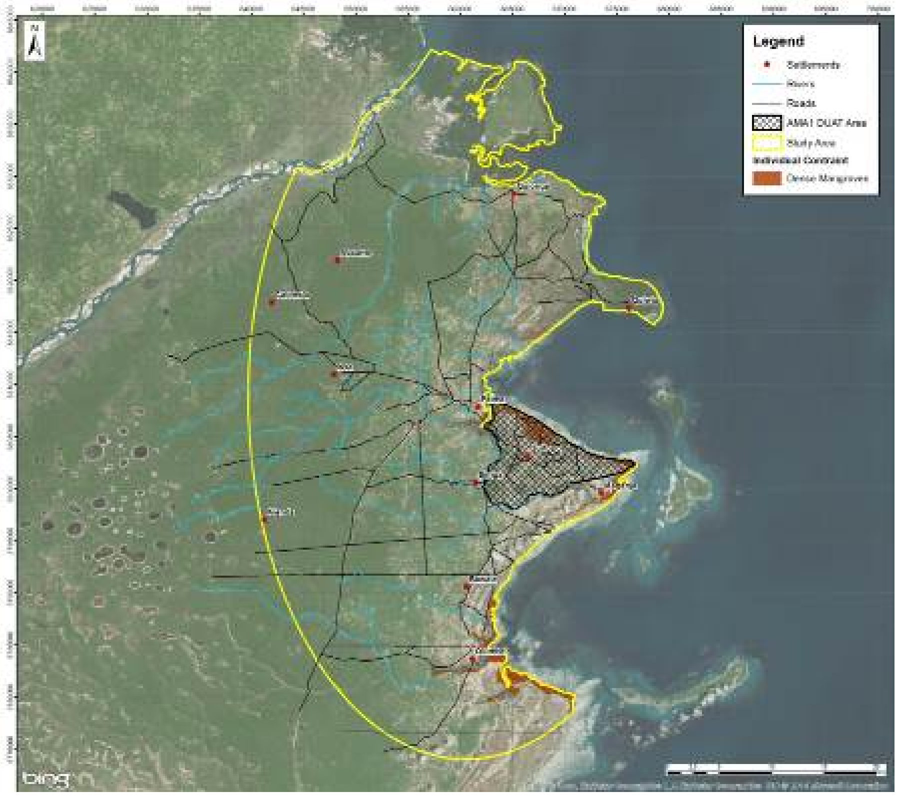


Figure D-6 *Individual Constraint: Dense mangroves*

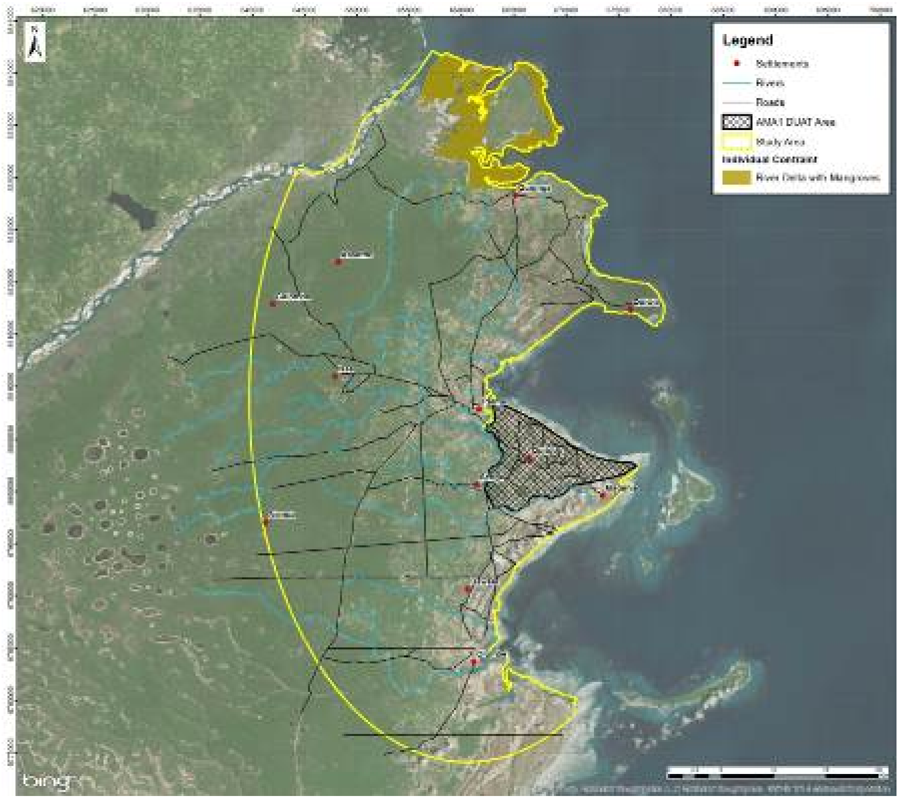


Figure D-7 *Individual Constraint: Rovuma river delta (with mangroves)*

D.4.2.6 Transport and Social Infrastructure

The areas identified as corresponding to social and transport infrastructure (roads, air fields, health facilities, schools, tourism assets) and associated buffer areas have been considered *unsuitable* for both the construction of the physical infrastructure associated with the villages and the establishment of the areas for livelihood restoration (namely the agricultural plots). These areas have therefore been blocked out (identified as *Constraints*) for both the *Village(s)* and the *Agricultural* Models.

The reason is obvious: it would not make sense to destroy existing social and transport infrastructure in order to build a new *Village(s)* or to use that land for agriculture. There is an exception, though, in the case a *Potential Site* is identified as *Suitable* for the construction of a *Village* in areas involving such social and transport infrastructure. In this case, however, the infrastructures affected would be upgraded or replaced by new ones provided by the Project.

These areas (buffer areas around existing roads, air fields, health facilities, schools and tourism assets) have initially been identified using desktop data/information and then ground-truthed/complemented by CES during the *Rapid Assessment Field Study*.

The sources of the data/information used in order to map the existing social and transport infrastructure were:

- Figure 3.8: Map illustrating the drivable roads in the Study Area as identified by the survey team – "*Rapid Assessment Field Study Report*"; Coastal & Environmental Services (CES); September 2013 (presented in Appendix C);

- Figure 4-2: Individual constraints – "*Replacement Village Multi-Criteria Assessment & Site Selection Study*"; WorleyParsons, June 2013 (presented in Appendix B);

- Dobbin International Inc. Anadarko LNG Presentation, 2012.

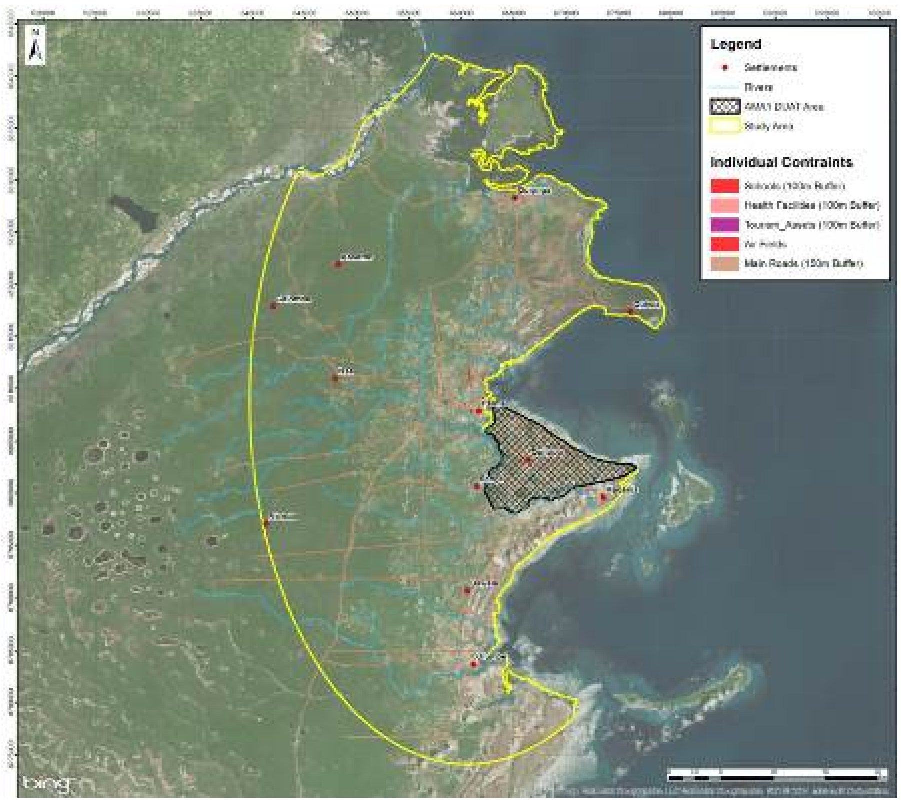


Figure D-8 *Individual Constraint: Transport and Social Infrastructure*

D.4.2.7 Cultivated Areas (existing agriculture)

Areas inside ***already cultivated areas (existing agriculture)*** have been considered *unsuitable* for the establishment of the areas for livelihood restoration, namely for the agricultural plots, and therefore identified as a *Constraint* (no-go areas) for the *Agricultural Model*. As a matter of fact, it was considered that it would cause significant additional disturbance (to additional people) to make available, to the communities to be resettled, agricultural land currently in use by other people. On one hand, these other people would then also be disturbed (and have to move and/or be compensated) and, on the other hand, this whole process would add significant negotiation needs with the current users of the land.

Nevertheless, these areas (***already cultivated***) have not been considered *unsuitable* for the construction of the physical infrastructure associated with the villages, for what this has not been considered as a *Constraint* for the *Village(s) Model*. Although the construction of the *Replacement Village(s)* in areas currently used for agriculture would also cause additional disturbance (to additional people) – as those who currently farm that land would also have to move and/or be compensated – this disturbance was considered to be far less significant.

On one hand the total area (extension) in question of the agricultural land to be used would be much smaller (limited to the area of the Village(s) – not vast areas for agriculture). On the other hand, it was considered that if a certain area is really suitable for the location of a *Replacement Village*, building it there would benefit a significant number of people, whilst disturbing just a few. This situation would be different to "*replacing current agricultural land*" for "*agricultural land for the communities to be resettled*", in which the number of people to that would benefit would be similar to the number of people disturbed.

The ***already cultivated areas*** (existing agriculture) have been identified / determined by CES during the *Rapid Assessment Field Study*. The methodology used to delineate these agricultural fields was a combination of interpretation of satellite imagery of the *Extended Study Area* and *ground-truthing* of information.

Ground-truthing of information consisted in establishing a correspondence between *existing agricultural fields*, observed on-site, and "*the way such fields look like*" in the satellite imagery. After visiting a number of agricultural fields, with similar and different characteristics, in areas spread across the *Extended Study Area*, it was possible to establish such correspondence. Based on this correspondence, it was then possible to reliably extrapolate the existence of *agricultural fields* in the rest of the *Study Area*, using the available satellite imagery.

It should be noted, however, that the satellite imagery used was from 2010, for what fields may have become disused and new fields opened up since 2010.

The source of the data/information used in order to map the *existing agriculture* was:

- Figure 4.34: Vegetation map of the Palma Study Area – "*Rapid Assessment Field Study Report*"; Coastal & Environmental Services (CES); September 2013 (presented in Appendix A).

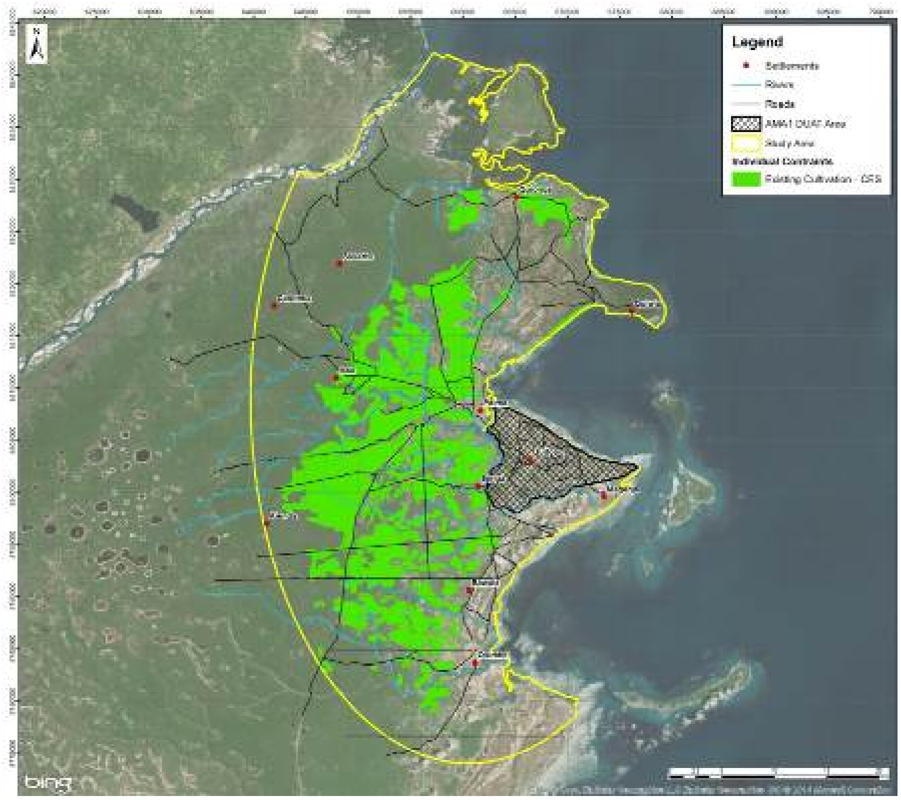


Figure D-9 *Individual Constraint: Cultivated areas - existing agriculture*

D.4.2.8 Summary – Individual Constraints

The *Individual Constraints* that apply to the *Village(s) Infrastructure Model* are represented in Figure D-10 in different colours, allowing an understanding of the reason why a given area is deemed *unavailable* or *unsuitable* for the construction of the *Replacement Village(s)*.

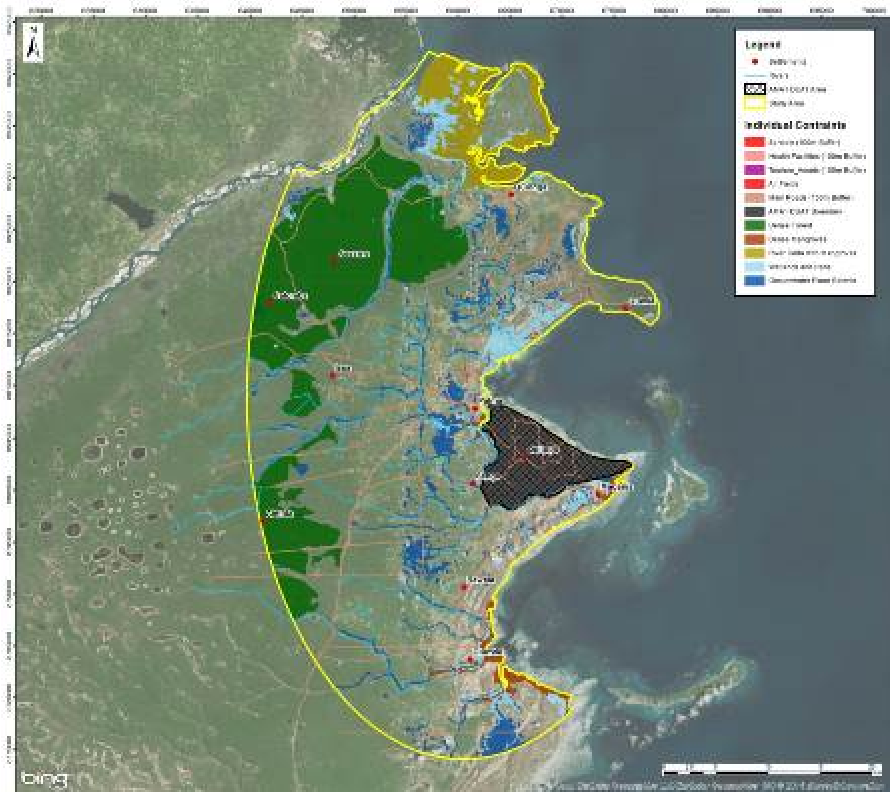


Figure D-10 *Constraint mapping*: *Individual Constraints – Village(s) Infrastructure Model*

Similarly, the *Individual Constraints* that apply to the *Livelihood Restoration/Agricultural Model* are represented in different colours in Figure D-11. This representation allows an understanding of the reason why a given area is deemed *unavailable* or *unsuitable* for the establishment of the agricultural plots associated to the *Replacement Village(s)*.

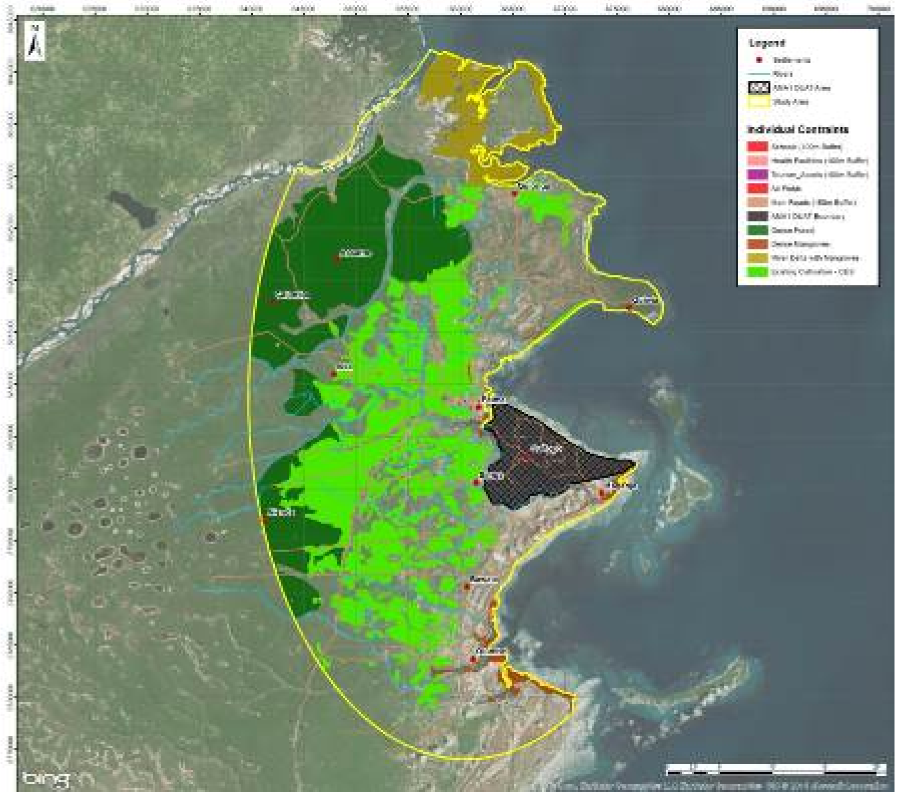


Figure D-11 *Constraint mapping*: *Individual Constraints – Livelihood Restoration/Agricultural Model*

D.4.2.9 Summary – Combined Constraints

The total areas that, for some reason (one or more constraints apply), are deemed *unavailable* or *unsuitable* for either the construction of the *Replacement Village(s)* or the establishment of the agricultural plots have been combined and are represented in grey in Figure D-12 and Figure D-13 respectively. These grey areas represent *Combined Constraints* for each model.

By excluding the *Combined Constraints* that apply to the *Village(s) Infrastructure Model*, it is possible to identify the *Potentially Suitable Areas for this model.*

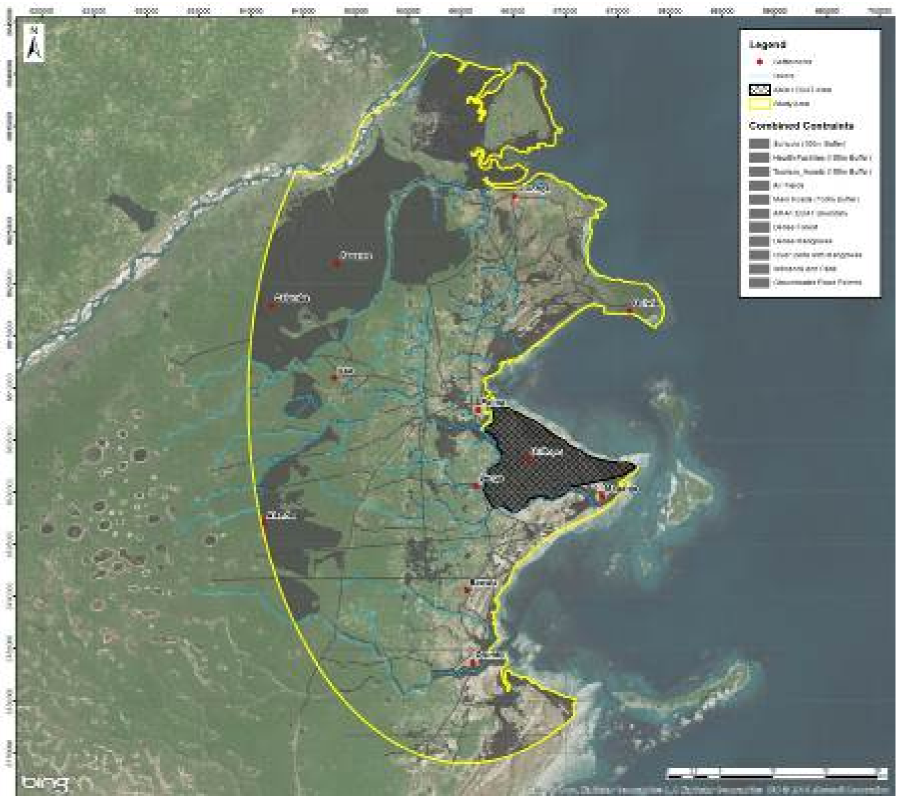


Figure D-12 *Combined Constraints* (in grey) and *Potentially Suitable Areas* for the *Village(s) Infrastructure Model*

Similarly, by excluding the *Combined Constraints* that apply to the *Livelihood Restoration/Agricultural Model*, it is possible to identify the *Potentially Suitable Areas for this model.*

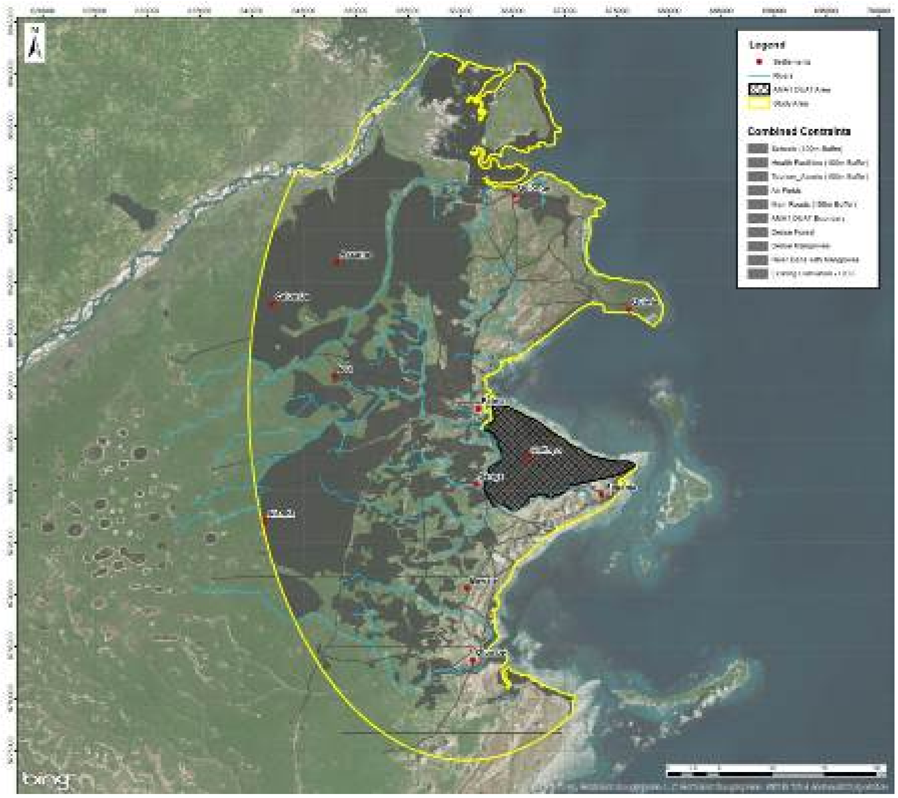


Figure D-13 *Combined Constraints* (in grey) and *Potentially Suitable Areas* for the *Livelihood Restoration/Agricultural Model*

D.4.3 Phase 3: Suitability Models – Multi-Criteria assessment and ranking of Potentially Suitable Areas according to their Overall Suitability

For each model, several parameters were identified to be used as *Criteria* for comparing the *Potentially Suitable Areas* that resulted from Phase 2. It is worth stressing that, in order to qualify as *Comparison Criteria*, the parameter must allow a differentiation of the areas in terms of its suitability with regards to a particular aspect.

For each *Comparison Criterion*, a *Classification System* was developed in order to allow an objective classification of the *Potentially Suitable Areas*. In general, five classes were defined, ranging between (**5**), classification attributed to the *most suitable areas*, and (**1**), attributed to the *least suitable areas*. For each model, the *Potentially Suitable Areas* were then classified for all applicable *Criteria*, using the respective *Classification System*.

For each of the two *Suitability Models* to be developed, a *Relative Weight* was assigned to each *criterion* (on a percentage scale) in order to reflect the relative importance each represents within the respective model: aspects considered more "*relevant*" for the purpose of each model have received a higher *Relative Weight*.
Table D-2 indicates the parameters considered as *Comparison Criteria* for each of the two models. It also summarizes the *Classification Systems* developed for each *criterion* and the *weights* assigned to each, for both models.

Ahead in this section, further detail is presented with regards to *Classification Systems* developed to classify the *Potentially Suitable Areas* for each of the *Comparison Criteria*. Using the spatial information available, the *Potential Suitable Areas* have actually been classified, and the results of this classification are presented ahead in the form of *maps*. For each *Comparison Criteria*, a map is presented representing the Potential Suitable Areas classified in different colours, corresponding to the different classes according to the respective *Classification System*. As mentioned in the Site Selection *Methodology*, the different classes are represented using different colours, varying between green representing the "best" class and red representing the "worst". In other words, all areas are "graded" by degree of suitability, based on each *criterion*.

Table D-2 *Comparison Criteria*, Classification System and weights used for the two models: village(s) infrastructure and livelihood restoration / agriculture

PARAMETER	***CRITERION***	**CLASSIFICATION SYSTEM**		**WEIGHT (%)**	
				VILLAGE(S) INFRASTRUCTURE	**LIVELIHOOD RESTORATION - AGRICULTURE**
Accessibilities (access to main access roads)	Proximity to the closest main access road	Classes of distance to the closest main access road	5 = 0 - 600 m 4 = 600 - 1200 m 3 = 1200 - 1800 m 2 = 1800 - 2400 m 1 = > 2400 m	10	10
Access to the sea	Proximity to the coast	Classes of distance to the coast	5 = 0 - 2 km 4 = 2 - 4 km 3 = 4 - 6 km 2 = 6 - 8 km 1 = > 8 km	20	10
Access to and availability of services and markets / trade	Proximity to a neighbouring town that can serve as hub for services and markets / trade	Classes of distance to a neighbouring town that can serve as hub for services and markets / trade	Five classes of "Distance to Palma" (every 7 km) 5 = 0 - 7 km 4 = 7 - 14 km 3 = 4 - 21 km 2 = 22 - 28 km 1 = - > 28 km **merged with:** Five classes of "Distance to Olumbe" (every 4 km) 5 = 0 - 4 km 4 = 4 - 8 km 3 = 8 - 12 km 2 =12 - 16 km 1 = > 16 km	15	25
Access to suitable agricultural land	Agricultural Potential of the Soils	Classes of Soil Suitability for Agriculture	5 - Very high suitability 4 - high suitability 3 - moderate suitability 2 - generally unsuitable 1 - totally unsuitable	10	40
Access to Water (Quantity and Quality)	Groundwater Quality	Classes of groundwater quality	5 - Very Good Quality 4 - Good Quality 3 - Fairly good Quality 2 - Poor Quality 1 - Bad Quality	5	5
Accessibility to the DUAT Area	Proximity to the DUAT Area	Classes of distance to the main gate (access to the DUAT Area)	5 = 0 - 5 km 4 = 5 - 10 km 3 = 10 - 15 km 2 = 15 - 20 km 1 = > 20 km	10	0
Ecological Sensitivity	Ecological Sensitivity	Classes of Ecological Sensitivity	5 - Very Low Sensitivity 4 - Low Sensitivity 3 - Moderate Sensitivity 2 - High Sensitivity 1 - Very High Sensitivity	10	10
Access to suitable fishing grounds (qualitative criterion)	Suitability of the fishing grounds (qualitative criterion)	Classes of suitability of the fishing grounds	5 - High: > 1.15 4 - Moderate / High: > 1.00 and < 1.15 3 - Moderate: > 0.75 and < 1.00 2 - Low / Moderate: < 0.75 1 - *No Go*	Qualitative Assessment	

D.4.3.1 Accessibilities (access to main access roads)

It was assumed that the communities to be resettled value living close to a main access road so that they can easily access the coast, their agricultural land, other towns, markets, etc. For this reason, the *Replacement Village(s)* and the agricultural plots should desirably be located "close" to an existing access road, so that the communities can benefit from easier/faster accessibilities. Therefore, areas located closer to a main access road were considered to be more favourable than areas located further away.

It was therefore considered that the *criterion* "*Proximity to the closest main access road*" would allow a differentiation between the *Potentially Suitable Areas* for the location of the *Replacement Village(s)* and of the agricultural plots.

Five classes of "*Distance to the closest main access road*" (*Classification System*) were defined to classify and compare the *Potentially Suitable Areas* in terms of it "*Proximity to the closest access road*": areas which distance to the "*closest main access road*" (measured in *meters* in a straight line) is up to 600, 1200, 1800, 2400 m or greater than 2400 m (the closer to the road, the higher the classification should be). The classification of (5) was therefore attributed to the areas located at a distance of up to 600m from the "*closest main access road*" (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas located at a distance of over 2400m from the "*closest main access road*" (the least suitable according to this *criterion*).

Figure D-14 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Proximity to the closest main access road*", using the five classes of "*Distance to the closest main access road*".

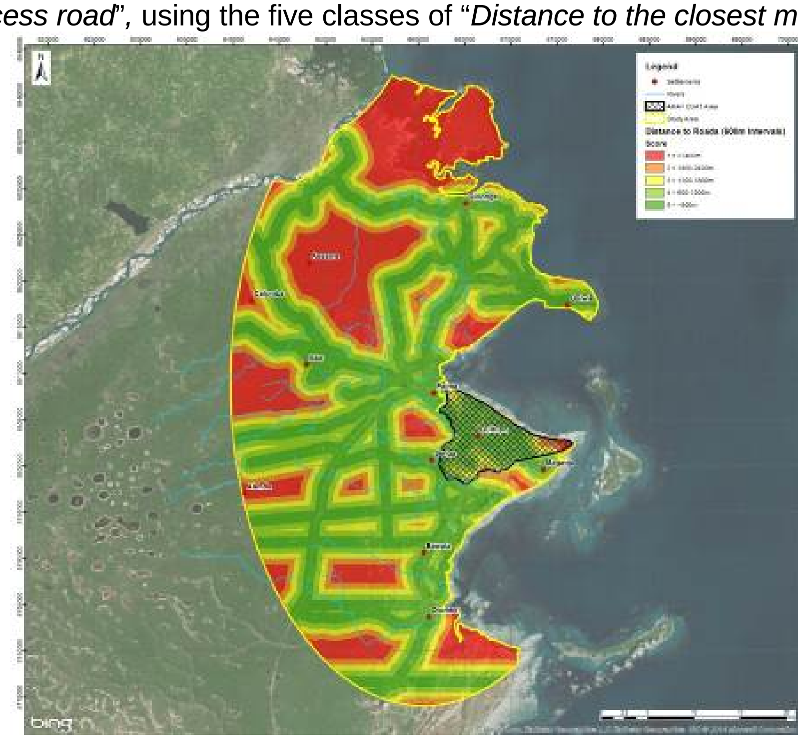


Figure D-14 Classification of the *Potentially Suitable Areas* according to its "*Accessibility (access to main access roads)*"

D.4.3.2 Access to the sea

It was assumed that all communities, although to different extents, depend on both agriculture and fishing. For this reason, the *Replacement Village(s)* should desirably be located "close" to the coast to provide the communities an easier/faster access to the sea for fishing and intertidal collection activities. Therefore, areas located closer to the coast were considered to be more favourable for the location of the *Replacement Village(s)* than areas located further away.

It was therefore considered that the *criterion* "*Proximity to the coast*" would allow a differentiation between the *Potentially Suitable Areas* for the location of the *Replacement Village(s)*. As the fishing communities usually also depend on agriculture, it was considered that this criterion would also allow some differentiation between the *Potentially Suitable Areas* for the location of the agricultural plots. This *criterion* was then considered for the Agriculture Model as well, although with a lower weight, in an attempt to "push" the location of the agricultural plots close to the *Village(s)*, and also to the coast.

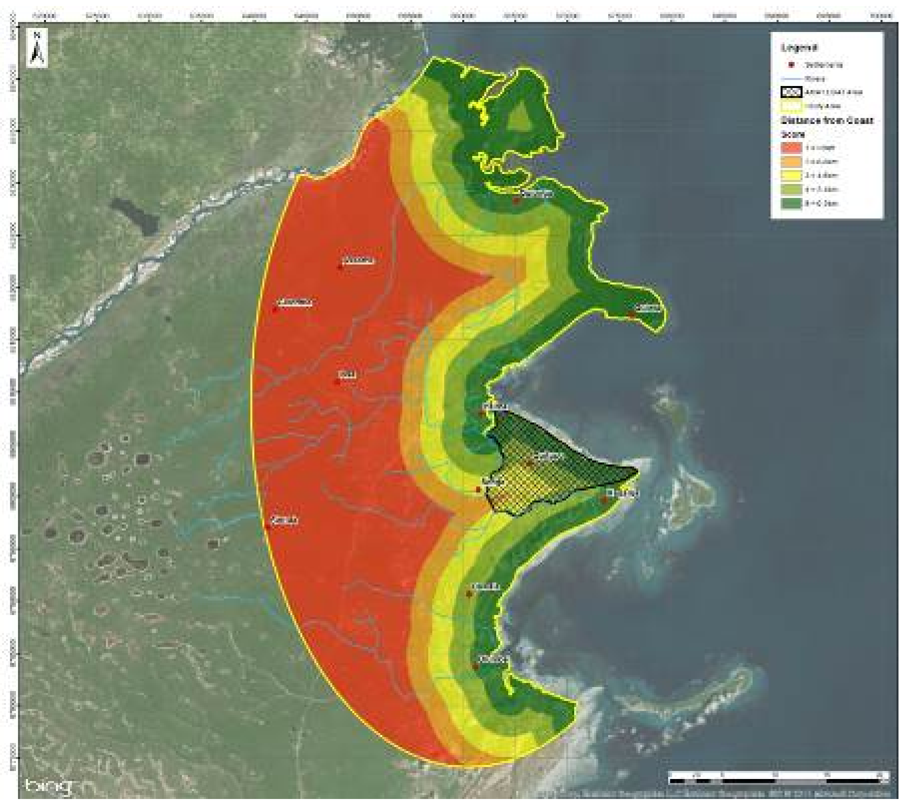


Figure D-15 Classification of the *Potentially Suitable Areas* according to its *"Access to the sea"*

Five classes of "*Distance to the coast*" (*Classification System*) were defined to classify and compare the *Potentially Suitable Areas* in terms of it "*Proximity to the coast*": areas which distance to the coastline (measured in km a straight line) is up to 2, 4, 6 and 8 km or greater than 8 km or greater than 8 km: the closer to the coast, the higher the classification should be.

The classification of (5) was therefore attributed to the areas located at a distance of up to 2 km from the coast (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas located at a distance of over 8 km from the coast (the least suitable according to this *criterion*).

Figure 4-15 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Proximity to the coast*", using five classes of "*Distance to the coast*".

D.4.3.3 Access to and availability of services and markets / trade

It was assumed that the communities to be resettled would value having access to a larger town that would offer a number of services as well as access to markets and trade opportunities. In the *Study Area*, Palma town and Olumbe were considered as being the main towns that can offer these opportunities.
For this reason, the *Replacement Village(s)* should desirably be located "close" to these towns, so that the communities can benefit from an easier/faster access to the services provided there, as well as to markets and trade opportunities. The areas located closer to Palma town and Olumbe were therefore considered to be more favourable for the location of the *Replacement Village(s)* than areas located further away.

It was therefore considered that the *criterion* "*Proximity to a neighbouring town that can serve as hub for services and markets / trade*" would allow a differentiation between the *Potentially Suitable Areas*. This *criterion* was considered relevant for both the location of the *Replacement Village(s)* and associated infrastructure (for ease of access to services and markets / trade, in general) and for the location of the associated agricultural plots (for ease of access to markets where to trade / sell the agricultural produce).

Five classes of "*Distance to a neighbouring town that can serve as hub for services and markets / trade*" (*Classification System*) were defined to classify and compare the *Potentially Suitable Areas* in terms of its "*ease of access*" to services and markets / trade. Although it was considered that both Palma town and Olumbe could play this role, it is believed that this would happen with different intensity (the two towns would have different influence) due to the different dimension and characteristics of these two towns.

The classes were therefore defined drawing circles around Palma town, 7, 14, 21 and 28 km radius and circles around Olumbe 4, 8, 12 and 16 km radius (measured in a straight line). The reasoning behind considering different radius around the two towns is related to the different areas of influence associated to each in terms of the potential to serve as hub for services and markets / trade. This takes into consideration the fact that Palma is the most important town in the District, but that Olumbe has also some potential to play this role, to a certain (lower) extent, that is, for areas closer to this town.

These circles were used to define areas (buffers) that were then classified as follows. The classification of (5) was therefore attributed to the areas within the closest circle around the two towns (the most suitable according to this *criterion*), …, and the classification of (1) attributed to areas outside the last circle defined (more than 28 km away from Palma town and 16 km away from Olumbe (the least suitable according to this *criterion*).

Figure 4-16 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Proximity to a neighbouring town that can serve as hub for services and markets / trade*", using five classes of "*Distance to a neighbouring town that can serve as hub for services and markets / trade*". It is possible to observe that some classes end up merging, meaning that some areas are under the influence, to different extents, of both towns.

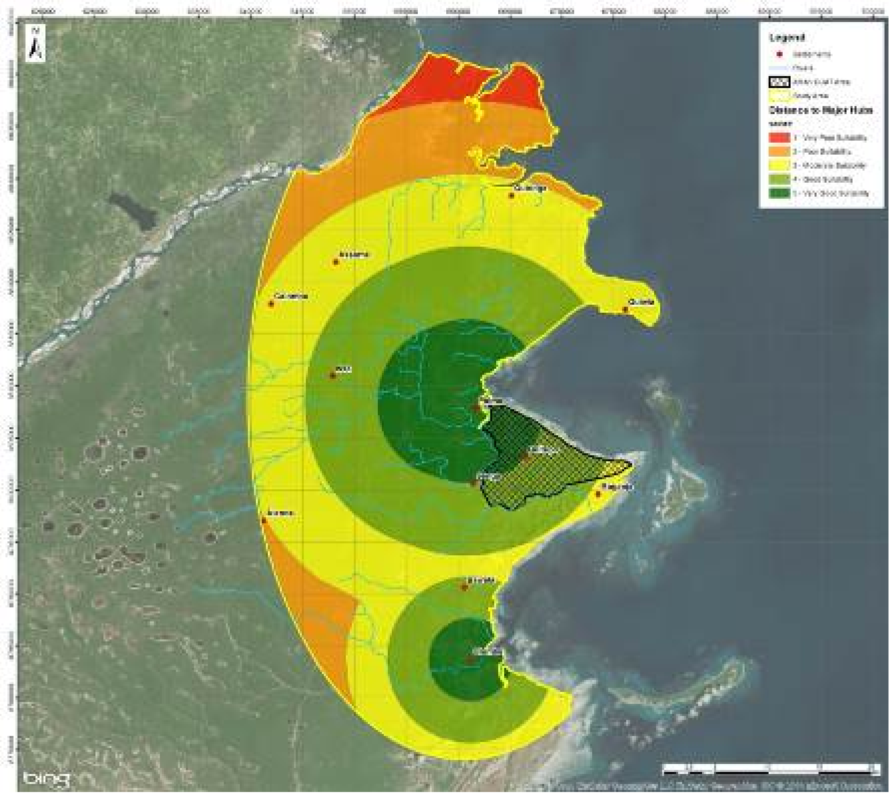


Figure D-16 Classification of the *Potentially Suitable Areas* according its *"Access to and availability of services and markets / trade"*

D.4.3.4 Access to Suitable Agricultural Land

As mentioned, the livelihoods of the communities to be resettled are closely related with agriculture. In order to minimize changes to the livelihood of agricultural communities, it was considered that the communities to be resettled would need to have access to suitable agricultural land. For this reason, the *Replacement Village(s)* should desirably be located in and/or close to areas with soils with a relatively good (to the extent possible, considering the area) suitability for agriculture. The establishment of the agricultural plots in these areas would allow resettled communities to re-establish their *machambas* and to continue practicing their subsistence agriculture, or even increase their agricultural production, allowing them to trade and/or sell the surplus.

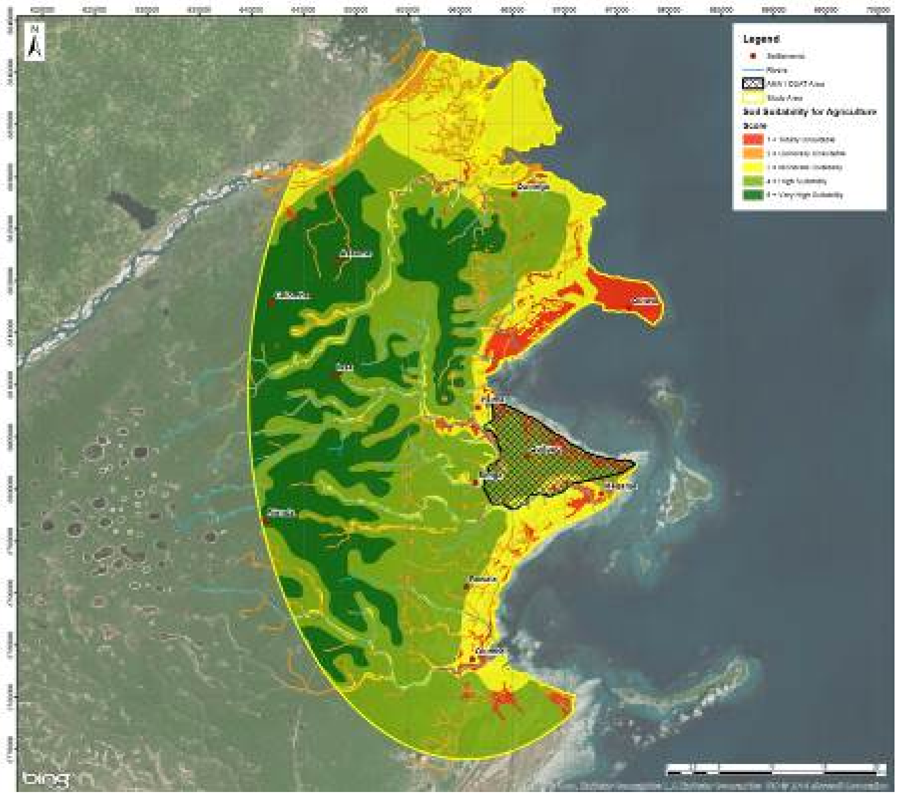


Figure D-17 Classification of the *Potentially Suitable Areas* according to *"Access to suitable agricultural land"*

It was therefore considered that the *criterion* "*Soil suitability for agriculture*" would allow a differentiation between the *Potentially Suitable Areas*.

This *criterion* was considered relevant for both the location of the *Replacement Village(s)* and associated infrastructure, and the location of the agricultural plots, although far more relevant for the latter, as these areas would be exclusively dedicated to agricultural production.

It was then necessary to investigate the characteristics of the soils within the *Study Area*, as well as the respective suitability for agricultural activities, in order to define a *Classification System* that would allow the classification and comparison of the *Potentially Suitable* Areas. This investigation was carried out by CES and presented in the "*Rapid Assessment Field Study Report*" (Appendix C). A correspondence was established between the different soils types present in the *Study Area* and the respective "*agricultural potential*". Based on this correspondence, five classes of "*Soil suitability for agriculture*" were defined and used as the *Classification System*. The higher the "*agricultural potential of the soils*", the more *suitable* the corresponding area is for the location of the *Replacement Village(s)* and in particular of the associated agricultural plots for reestablishment of the *machambas*:

The source of the data/information used in order to map the *Soil Suitability for Agriculture* was:

- Figure 4.33: Agricultural Potential of the Soils, Coral Rock Area and Water Bodies of the Study Area – "*Rapid Assessment Field Study Report*"; Coastal & Environmental Services (CES); September 2013 (presented in Appendix C).

As usual, the higher classification (5) was attributed to the areas with soils with the higher *agricultural potential* (the most suitable according to this *criterion: "very high suitability"*), …, and the classification of (1) attributed to the areas with soils with the lower *agricultural potential* (the least suitable according to this *criterion: "totally unsuitable*").

Figure 4-17 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Suitability for agriculture*", *using five classes of* "*Soil Suitability for Agriculture*".

D.4.3.5 Access to Water (Quality)

It was assumed that the communities to be resettled need to have access to sufficient quantities of groundwater of the best possible quality for both their day-to-day use / consumption and for agriculture. Therefore, providing access to enough and good quality water is essential to grant good living conditions to the resettled communities, as well as to allow them to continue practicing their subsistence agriculture, or even to increase their agricultural production, aiming at trading and/or selling the surplus.

For these reasons, the *Replacement Village(s)* and the associated agricultural plots should desirably be located in areas where groundwater is available / accessible, in quantity enough to satisfy the demand and with a level of quality adequate for the expected uses. These areas are preferable because they provide an easier access to higher quantity / quality of this fundamental resource, comparing with locations where groundwater is inaccessible or harder to reach (very deep water table levels), or where it is available, but in little quantity and/or poor quality.

It was then considered that the *criterion* "*Groundwater quality*" allows for a differentiation between the *Potentially Suitable Areas*. This *criterion* was considered relevant for both the location of the *Replacement Village(s)* (for day-to-day use) and the location of the associated agricultural plots (for water use in agriculture).

It was therefore necessary to investigate the areas within the *Study Area* where the aquifers are expected to be accessible, more productive and the water has the highest possible quality. Studies have been conducted in order to obtain the necessary information to define a *Classification System* that would allow the comparison of the *Potentially Suitable Areas* in terms of "*Groundwater quality*".

The geology and hydrogeology of the *Study Area* were determined from literature and field data, and this has informed the likely availability and quality of water supply across the Cabo Delgado Province.

Saline intrusion, formation water, mineralisation and sanitary pollution have been identified as the contributors to areas of lower water quality. Agricultural practices may also influence the quality of water. Aquifers with sufficient productivity to support resettled people appear to be present across the *Study Area*.

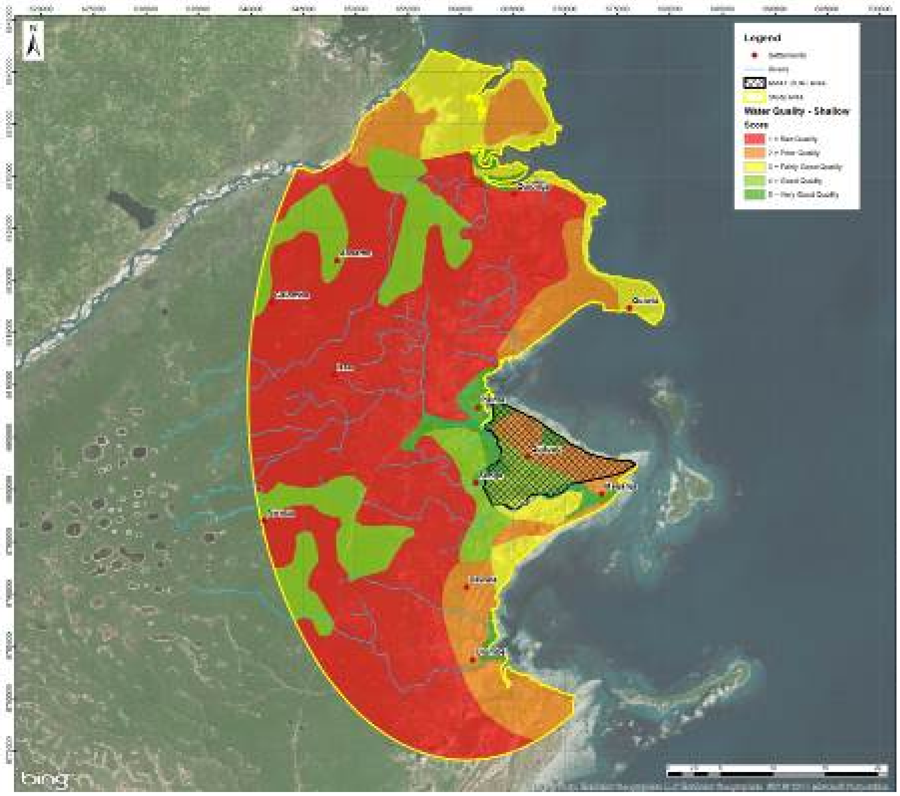


Figure D-18 Classification of the *Potentially Suitable Areas* according its *"Access to Water (Quality)"* – shallow aquifer

The groundwater discharges along the coastal margin forming wetlands, the extents of which are highly seasonal. Areas of "groundwater flooding" have been established from numerical modelling to inform location planning. The effects of climate change may alter the productiveness, particularly in the shallow rapidly responding coastal dune aquifers, and extents of groundwater flooding. The development of the LNG facility will also locally impact on quality and productiveness, through construction activities, change of land use and the installation of a well field to supply the Project. These potential impacts have been assessed and considered in the analysis.

Based on the information provided by these studies, the *Classification System* defined consisted in the definition of five classes of "*Groundwater quality*". These have been defined taking into consideration aspects related with both the aquifers productivity (quantity) and water quality, regarding both the deep and shallow aquifers. The better the areas are in terms of both groundwater availability and quality (of both the deep and shallow aquifers), the higher the classification of the areas according to this *criterion*.

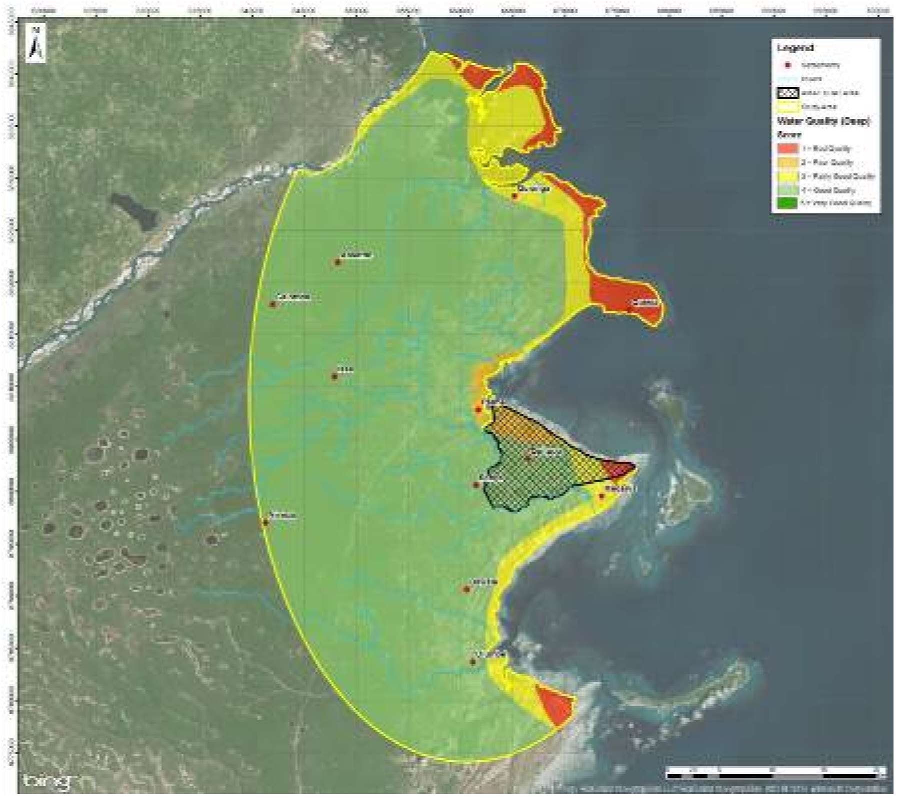


Figure D-19 Classification of the *Potentially Suitable Areas* according its "*Access to Water (Quality)*" – deep aquifer

The classification of (5) was attributed to the "Very Good" areas (the most suitable according to this *criterion*), …, and the classification of (1) attributed to the "Bad" areas (the least suitable according to this *criterion*).

Figure D-18 and Figure D-19 illustrate the classification of the *Potentially Suitable Areas* according to the *criterion* "groundwater quality", *using* "*Classes of groundwater quality*" as *Classification System*, regarding the shallow and deep aquifers respectively.

D.4.3.5 Accessibility to the DUAT Area

It was assumed that the communities to be resettled would value having an easy access to the LNG Project Area, as the Project is seen as a potential source of direct and indirect employment, during both the construction and operation phases.

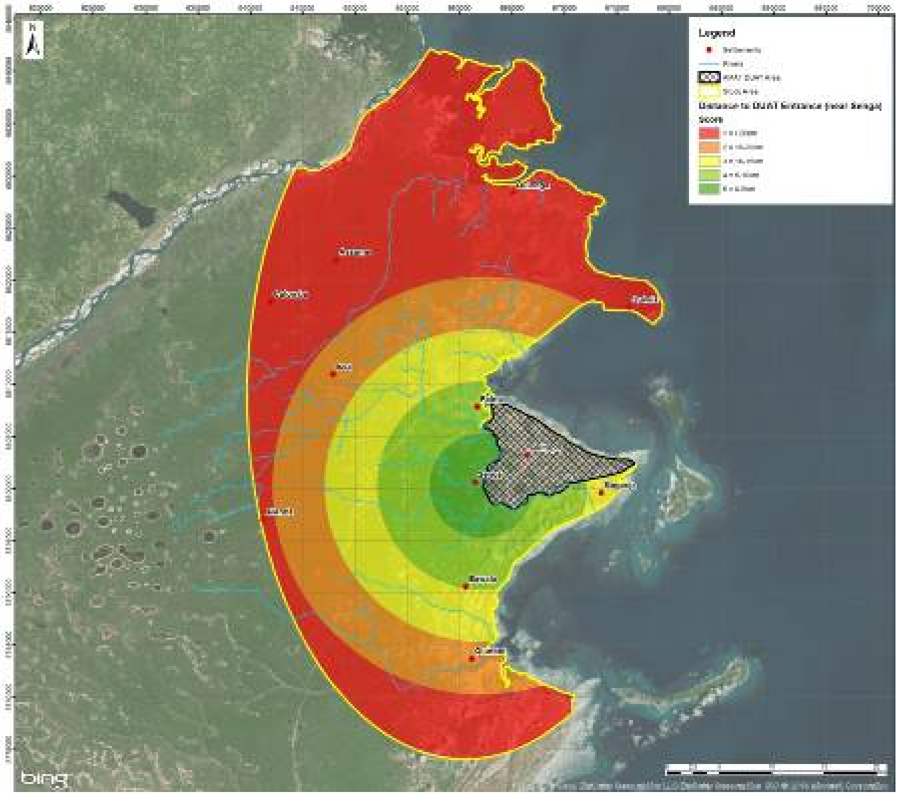


Figure D-20 Classification of the *Potentially Suitable Areas* according to its *"Accessibility to the DUAT Area"*

For this reason, the *Replacement Village(s)* should desirably be located "close" to the DUAT Area, so that the communities can better benefit from these employment opportunities. The areas located closer to the Project's "main gate" (which location was assumed as to provide access to the DUAT Area, also assuming that this area will be fenced and therefore access will be limited to controlled access points) were therefore considered to be more favourable for the location of the *Replacement Village(s)* than areas located further away.

It was therefore considered that the *criterion* "*Proximity to the DUAT Area*" would allow a differentiation between the *Potentially Suitable Areas* for the location of the *Replacement Village(s)* and associated infrastructure (for ease of access to the area where potential employment opportunities are more likely to occur).

Five classes of "*Distance to the main gate – access to the DUAT Area*" were defined in order to classify and compare the *Potentially Suitable Areas* in terms of its "*ease of access*" to the DUAT Area: circles around the "*main gate*" 5, 10, 15 and 20 km radius (measured in a straight line), were used to define areas (buffers) which *distance to the "main gate"* is up to 5, 10, 15, 20 km or greater than 20 km: the closer to the "main gate", the higher the classification should be.

The classification of (5) was therefore attributed to the areas located at a distance of up to 5 km from the "*main gate*" (areas within the 5 km radius circle, closest to "*main gate*": the most suitable according to this *criterion*), …, and the classification of (1) attributed to the areas located at a distance of over 20 km (areas outside the 20 km radius circle, furthest away from the "*main gate*": the least suitable according to this *criterion*).

Figure D-20 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*Accessibility to the DUAT* Area", using five classes of "*Distance to the main gate - access to the DUAT Area*".

D.4.3.6 Ecological Sensitivity

As mentioned, it was assumed that ecologically sensitive areas play a very important role in society as they provide important economic, social and cultural benefits, both directly and indirectly, apart from its intrinsic ecological value. Once the areas of higher ***ecological sensitivity*** are in general strongly related with natural products/services that are directly associated with the livelihood of the communities to be resettled, they should be avoided and preserved.

Ecological Sensitivity would therefore allow a differentiation between the areas, and should be used as a *criterion*, for both the location of the *Replacement Village(s)* and of the associated agricultural plots. These should desirably be located in the areas of lower ***ecological sensitivity***.

It was therefore necessary to study the ecology of the *Study Area* in order to define a *Classification System* that would allow the classification and comparison of the *Potentially Suitable* Areas.
This study was carried out by CES and presented in the "*Rapid Assessment Field Study Report*" (Appendix C), and resulted in the production of a ***global map*** summarizing the *vegetation sensitivity* of the *Study Area* (then used to assess overall ***ecological sensitivity***) and representing the areas classified by *degree of sensitivity*.

Areas with lower ***ecological sensitivity*** would be preferable for both the location of the *Replacement Village(s)* and of the associated agricultural plots, for what the ***global map*** was used to provide input to the *Site Selection Process*, through the definition of a *criterion* that avoids the areas of higher ***ecological sensitivity*** for both these purposes, aiming at accounting for the impacts, on ecology, of the *Replacement Village* Project.

The five "*Classes of ecological sensitivity*" defined in the ***global map*** were used as the *Classification System* for this *criterion,* in order to compare the *Potentially Suitable Areas* for both the location of the *Replacement Village(s)* Infrastructure and the location of the associated agricultural plots, in terms of the "ecological sensitivity".

The source of the data/information used in order to map the *ecological sensitivity* was:

- Figure 4.35: Vegetation Sensitivity map of the Palma Study Area – "*Rapid Assessment Field Study Report*"; Coastal & Environmental Services (CES); September 2013 (presented in Appendix C).

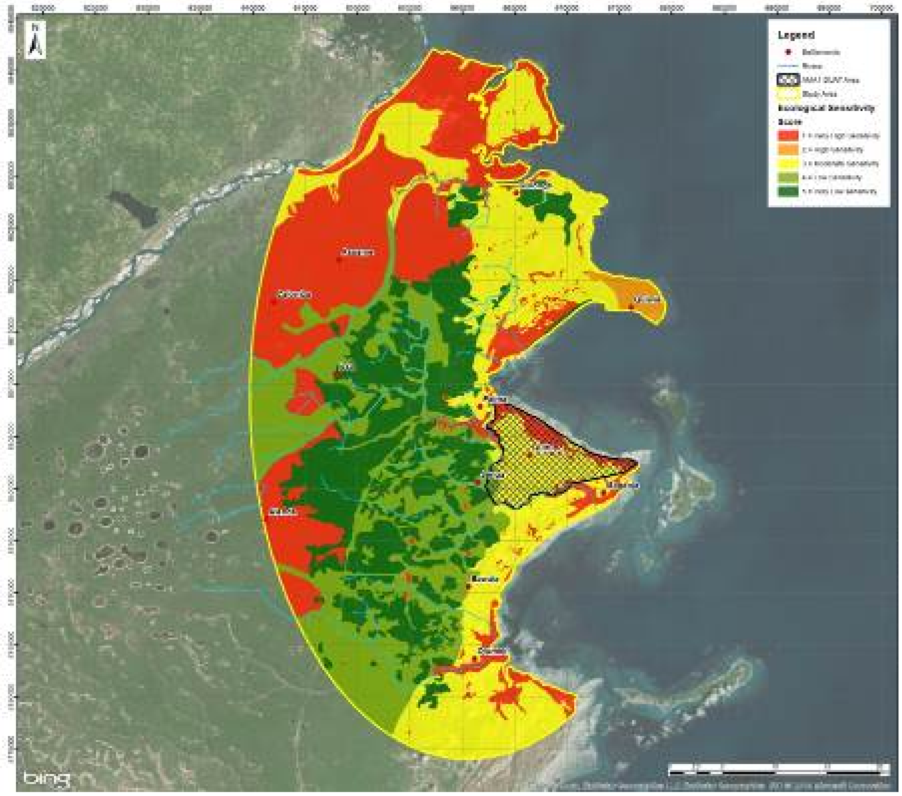


Figure D-21 Classification of the *Potentially Suitable Areas* according to its "*Ecological Sensitivity*"

The higher the "*ecological sensitivity*", the less *suitable* the corresponding area is for the location of the *Replacement Village(s)* and the associated agricultural plots. The classification of (1) was therefore attributed to the areas with "very high" ***ecological sensitivity*** (the least suitable according to this *criterion*), …, and the classification of (5) attributed to the areas with "very low" ***ecological sensitivity*** (the most suitable according to this *criterion*).

Figure 4-22 illustrates the classification of the *Potentially Suitable Areas* according to the *criterion* "*ecological sensitivity*", using five classes of ***ecological sensitivity***.

D.4.3.7 Fishing Accessibility

As mentioned, it was assumed that the communities to be resettled depend on fishing and intertidal collection activities. Therefore, although it is important to be close to the sea (reason why "proximity to the sea" is important and has been captured in another *criterion*) there are other aspects related with fishing and the characteristics of the coastline that are important to consider when assessing a location in terms of its suitability for fisheries. The coastline is not homogeneous and these aspects vary along the coastline, making some areas more attractive to the fisherman than others.

For this reason it is important to define a *criterion* ("*Suitability of the Fishing Grounds*") that captures these differences and allows a differentiation between the *Potentially Suitable Areas* for the construction of the *Replacement Village(s)*. The consideration of such *criterion* aims at pushing the location of the

Replacement Village(s) towards the coastal areas that maximize the aspects that bring fishing advantages, thus minimizing the changes to the livelihood of the fishing communities.
The aspects taken into account were:

- Protection from south and east waves;
- Immediate coastal access;
- Intertidal plane;
- Proximity of sea grass;
- Distance to Reef;
- Potential for mitigation measures; and
- Existing fishing pressure.

The coastline inside the *Study Area* was split into sections and each section was classified for each of the parameters mentioned above as “poor”, “fair” or “good”. In order to determine a *Global Classification* for each section, the qualitative classification was converted to a quantitative one (0, 1 and 2 respectively), and an average classification was then determined. All this information is detailed in Table D-3.

A *Classification System* was then defined, considering the range of classifications achieved in the analysis, and five classes of “*Suitability of the Fishing Grounds*” were defined in order to classify and compare the “*Suitability of the Fishing Grounds*” of the coastline inside the *Study Area* (presented in Table D-2).

The fact that the *coastline*, rather than the *Potentially Suitable Areas* themselves, were classified according to this *criterion*, did not allow the integration of this classification in the model. In other words, the Final *Suitability Models* will not be able to automatically integrate this *criterion*, for what it will have to be accounted for in a qualitative way. The way this will be done will be better explained ahead, when presenting and discussing the results of the models and the identification of the *Potential Sites*.

For this reason, there was no need to convert the *Global Classification* to the scale from 1 to 5, and it remained a qualitative classification.

Table D-3 Classification of Sections along the coast according to the *Suitability of the Fishing Grounds* (parameters, classification and Global Classification)

Section From / To / PARAMETER		R Rovuma – Quionga Estuary	Quionga Estuary	Quionga Estuary – Cabo Delgado	Cabo Delgado	Cabo Delgado	Cabo Delgado – Macongo	Macongo – Bagala	Bagala – Palma	Palma – Nsemo	Nsemo – Maganja	Maganja – Mondlane	Mondlane – Olumbe	Olumbe	Olumbe – Peninsula
Protection from south waves		1	2	1	2	0	0	1	2	2	2	1	1	2	2
Protection from east waves		0	0	0	0	1	1	0	1	2	1	2	0	0	0
Immediate coastal access		0	0	2	0	2	1	1	2	2	1	1	1	2	1
Intertidal plane		0	0	1	1	1	2	2	1	2	2	2	2	1	2
Proximity of Sea grass		1	1	1	0	0	1	1	0	2	2	2	2	1	1
Distance to Reef		1	2	2	2	2	1	1	1	1	2	1	1	1	2
Market Access		1	1	1	1	1	1	2	2	2	1	1	1	2	1
Potential for mitigation measures (infrastructure)		0	1	1	0	0	1	2	2	2	1	1	1	2	1
Potential for mitigation measures (reef)		0	0	1	1	2	1	0	0	1	1	2	2	1	1
Potential for mitigation measures (fad)		2	0	2	2	0	0	0	0	0	2	1	0	0	1
Resource status															
Existing fishing pressure		2	1	2	2	1	0	0	0	0	0	1	1	0	1
Global Classification (Suitability of the Fishing grounds)	TOTAL	8	8	14	11	10	9	10	11	AMA1 DUAT AREA	15	15	12	12	13
	AVERAGE Classification	0.67	0.67	1.17	0.92	0.83	0.75	0.83	0.92		1.25	1.25	1.00	1.00	1.08

0 – Poor; 1 – Fair; 2 - Good

The areas closer to the best classified sections (classified as having "high" suitability) are preferable because they provide a better access to suitable fishing grounds and to better areas for intertidal collection activities, comparing with the areas further away from these sections and/or closer to sections poorly classified (namely those classified as "low" suitability).

This *criterion* complements the other *criterion* considered: "*Proximity to the coast*". Together, they push the location of the *Replacement Village(s)* towards the areas as close as possible to the sea, in the sections of the coastline that offer the most suitable fishing grounds. This is particularly important considering the importance of fishing as a major subsistence activity for the communities to be resettled.

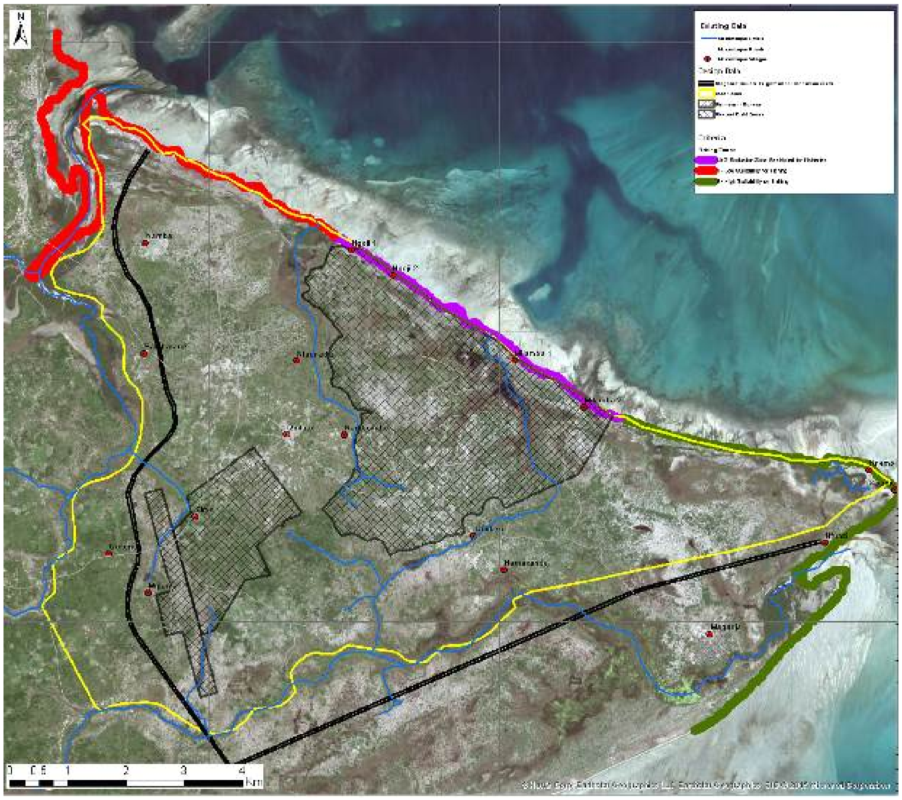


Figure 4-23 illustrates the classification of the coastline inside the *Study Area* according to the *criterion* "*Suitability of the Fishing Grounds*", *using five classes of* "*Suitability of the fishing grounds*". A similar correspondence was established between the several classes established under the *Classification System* for this *criterion* and the code of colours generally used to represent the *suitability*.

The *Suitability of the Fishing Grounds* was therefore represented as lines along the coast which colour represents the *Global Suitability* of the respective section (green lines corresponding to "High" *Suitability* and red lines "Low" *Suitability of the Fishing Grounds*).

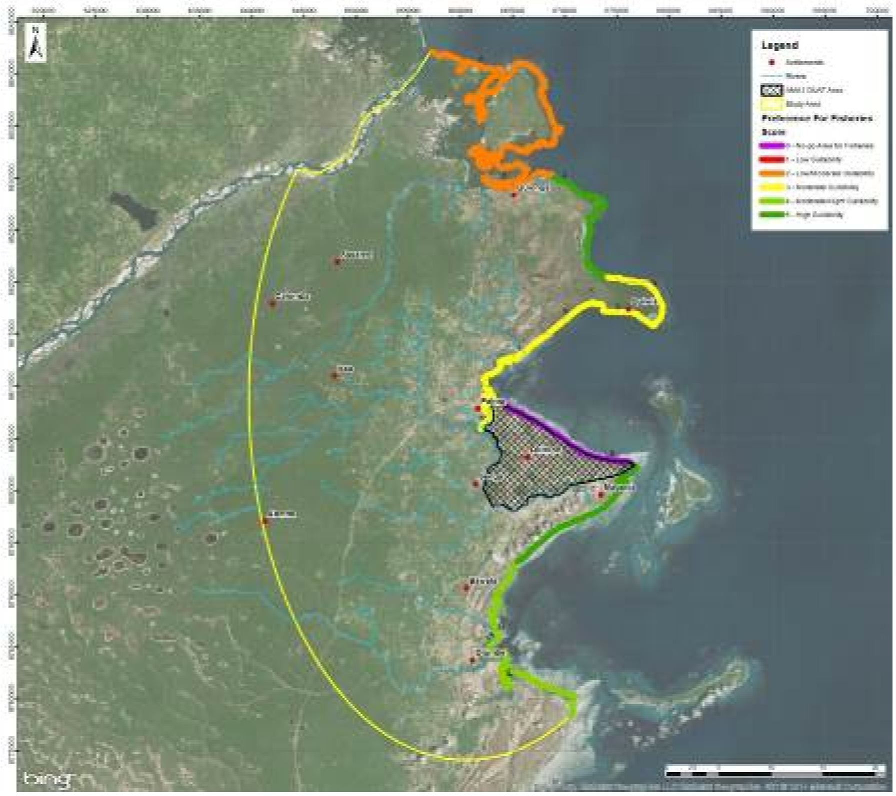


Figure D-22 Classification of the of the coastline according its "*Access to suitable fishing grounds*"

D.4.3.8 Suitability Models – Overall Suitability

After classifying the *Potentially Suitable Areas* for all the *Comparison Criteria*, the GIS software, considering the *weights* assigned to each *criterion*, calculates – for each area in the map – the *weighted average* of the classifications for all the *Comparison Criteria*. This *weighted average classification* represents the *Overall Suitability* of that *area*. This is done separately for each of the two models developed (*Village(s) Infrastructure Model* and the *Livelihood Restoration / Agricultural Model*), once the *Comparison Criteria* and respective *weights* differ on the two models, as per indicated on Table D-2.

The *Potentially Suitable Areas* can then be represented *ranked* according to their *Overall Suitability*, using a gradation of colours, ranging from dark green (corresponding to the areas of higher *Overall Suitability*), through to light green, yellow, orange and finally red (corresponding to the areas of lower *Overall Suitability*).

The results of the two *Suitability Models* developed are presented below: *Village(s) Infrastructure Model* (Figure D-23) and *Livelihood Restoration / Agricultural Model* (Figure D-24).

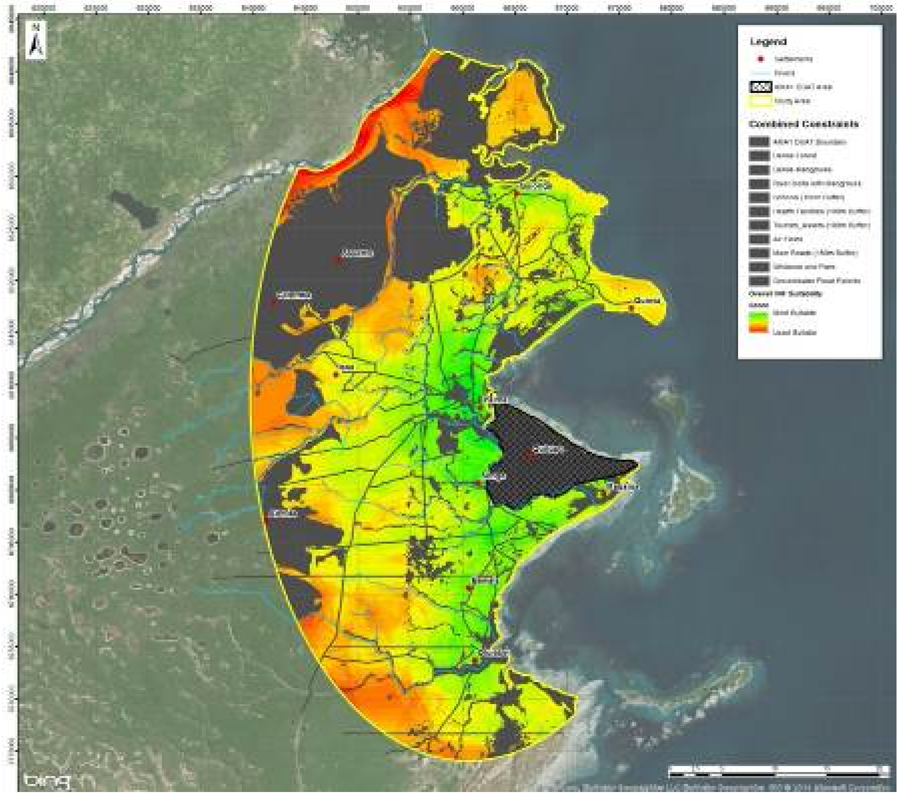


Figure D-23 *Overall Suitability*: *Village(s) Infrastructure Model*

The qualitative analysis to be carried out with regards to the fisheries aspects takes into account the representation of the *Suitability of the Fishing Grounds* of the several sections of the coast line, as per presented in the *Livelihood Restoration / Agricultural Model*.

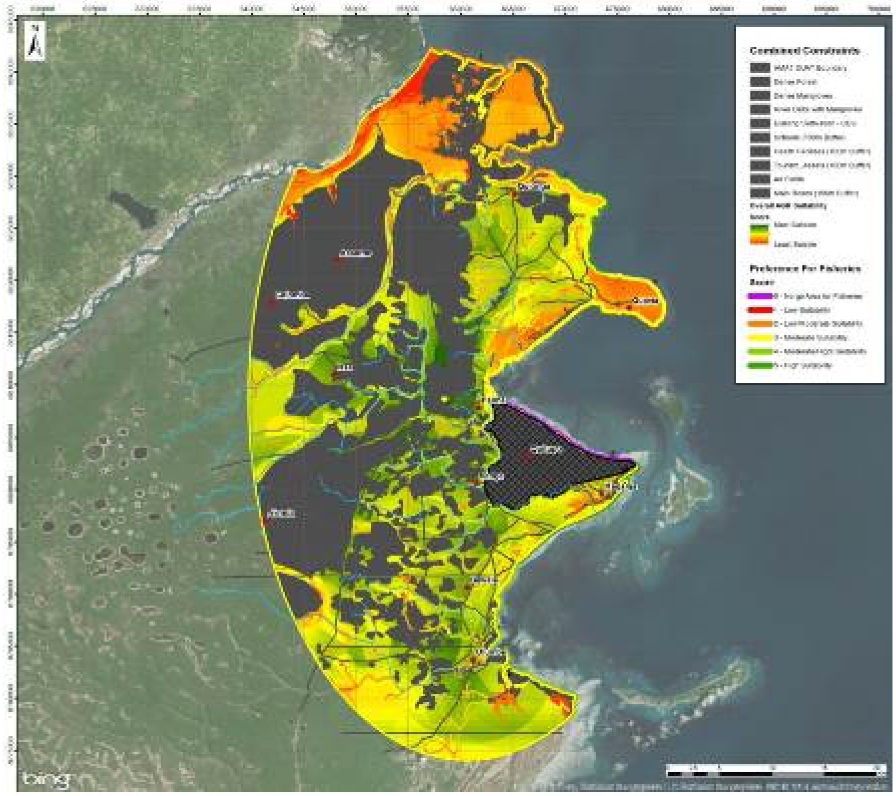


Figure D-24 *Overall Suitability*: *Livelihood Restoration / Agricultural Model*

As mentioned, these *Site Selection Models* (post *Rapid Assessment Field Study*) were intended to be presented and discussed with the Government of Mozambique, previously to community engagement, and were presented to and discussed with the Project on the 6th of September, at the Centurion Workshop.

D.4.4 Phase 4 – Identification of the Most Suitable Areas and of Potential Replacement Site(s)

The *Suitability Models* developed can now be used to support the identification of a number of suitable *Potential Replacement Sites* where to build the *Replacement Village(s)* and associated infrastructure.

The identification (short-listing) of the *Potential Replacement Sites* took into account:

- The output of the *Village(s) Infrastructure Model:* this model was used to support the identification of the best areas for the location of the *Replacement Village(s)* and associated infrastructures: the *greener* areas correspond to the *most suitable areas* for this purpose. The size of the *Sites* must allow the construction of the *Village(s)* and associated infrastructure, considering the number of families to be resettled;
- Proximity to the best *Agricultural Areas:* the output of the *Livelihood Restoration / Agricultural Model* was used to support the identification of the best agricultural areas: the *greener* areas correspond to the *most suitable areas* for agriculture. The agricultural plots should therefore be located amongst these areas. The total areas to assign to this purpose should be large enough to allow the restoration

of the livelihood related to agriculture for the families to be resettled, **and be as close as possible** to the *Replacement Village(s)*;

- Proximity to the best fishing grounds: the output of the analysis carried out on the *Suitability of the Fishing Grounds* was used to support the identification of the best sections of the coast line in terms of fishing: the green lines along the coast correspond to the *most suitable* sections of the coast line for fishing and related subsistence activities, such as intertidal collection (the *most suitable fishing grounds*).

Considering the above, three *Potential Replacement Sites* were identified as *Potential Replacement Sites*:

- *Potential Village* – Option 1 (to the South of Quionga);
- *Potential Village* – Option 2 (around Bawala);
- *Potential Village* – Option 3 (to the South of Olumbe).

The location of these *Potential Sites* is shown in Figure D-25 (representing them over the *Village(s) Infrastructure Model)* and Figure D-26 (representing them over the *Livelihood Restoration / Agricultural Model).*

The fact that these *Potential Sites* have been selected within the areas of *higher Overall Suitability* (according to the *Village(s) Infrastructure Model*) and close to the areas of *higher Overall Suitability* (according to the *Livelihood Restoration / Agricultural Model*) ensures that the *Overall Suitability* of the short-listed *Sites* is maximized.

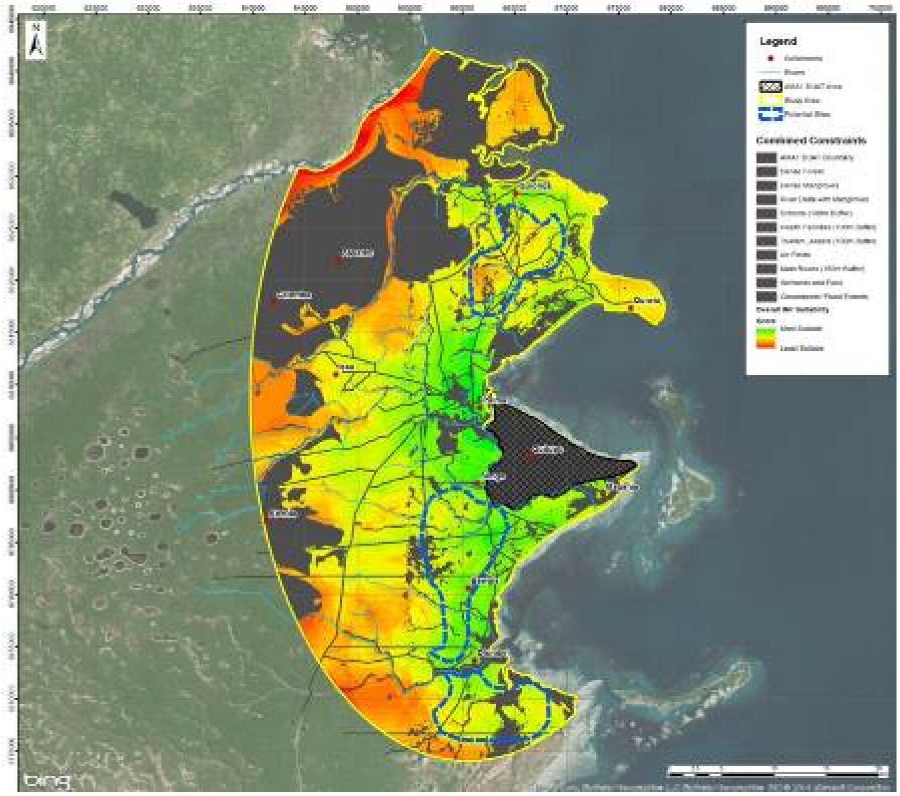


Figure D-25 *Overall Suitability*: *Village(s) Infrastructure Model – Potential Sites*

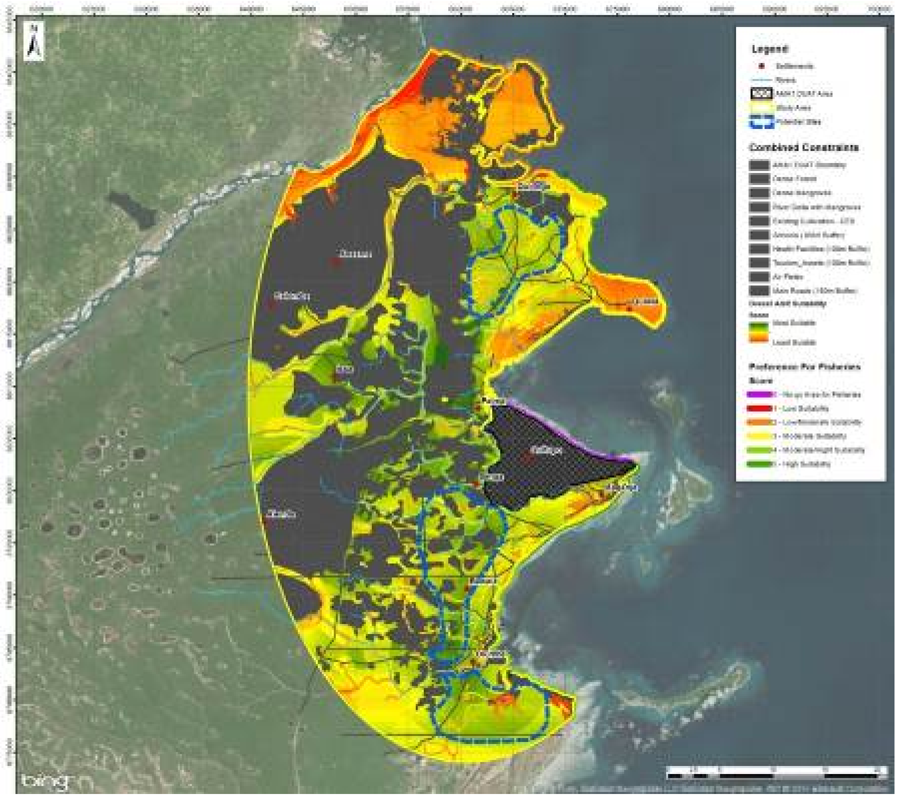


Figure D-26 *Overall Suitability*: *Livelihood Restoration / Agricultural Model – Potential Sites*

D.4.5 Potential Institutional Constraints

A number of *Potential Institutional Constraints* was identified within the *Study Area* that, for different reasons, ended up not being considered as *no-go areas* and therefore have not been included in the *Combined Constraints*. These are:

- Mining Concessions (as far as it was possible to clarify, a Rio Tinto Concession Area had existed inside the Study Area, but expired);
- Forest Concessions (two Forest Concessions seem to exist in the Palma District, one located in the Administrative Post of Pundanhar (outside the Study Area) and one in the Administrative Post of Olumbe; nevertheless, it was not possible to confirm the exact location of this last concession area);
- Other DUAT's (not enough and reliable information was possible to obtain with regards to other DUAT's issued inside the Study Area);
- *Industrial Zone.*

Two different versions of an "Industrial Zone" have been provided. It needs to be established which of these areas, if any, is going to be declared an *Industrial Zone* by the Government of Mozambique.

If either of the two potential Industrial Zones is declared as such, a significant area within the *Study Area* will no longer be available for the location of the *Replacement Village(s)*, for what those areas need to be deemed *unavailable* in the assessment.

For information purposes, these areas are represented in Figure D-27 and Figure D-28, together with the Combined Constraints that apply to each of the two *Suitability Models* developed, and the location of the *Potential Sites* identified.

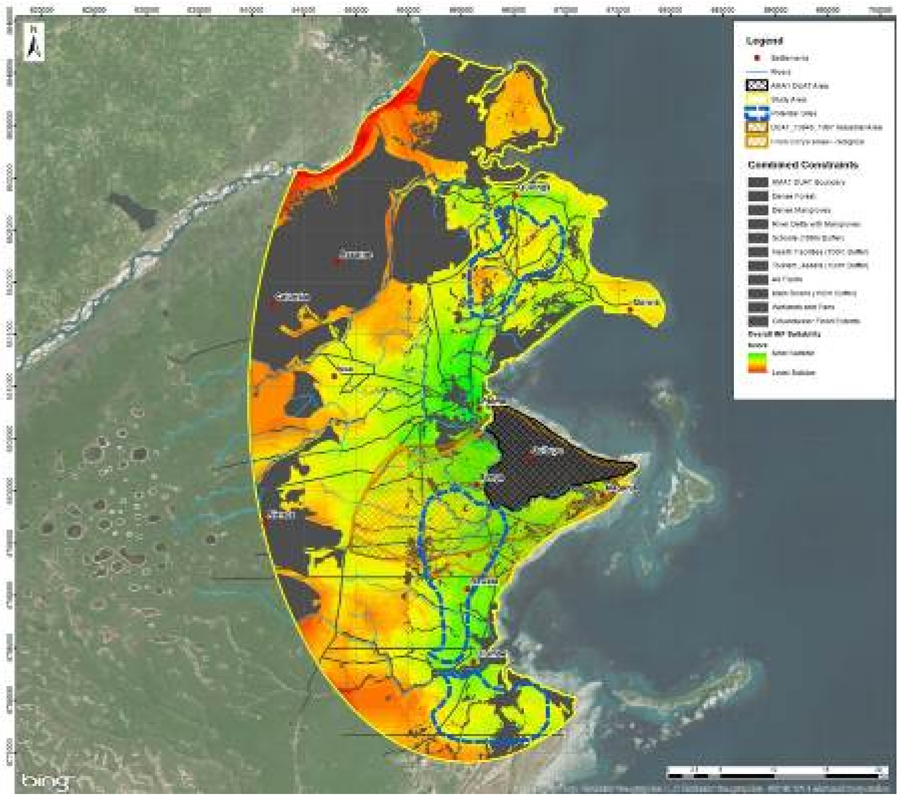


Figure D-27 *Potential Sites and the Industrial Zone – Village(s) Infrastructure Model*

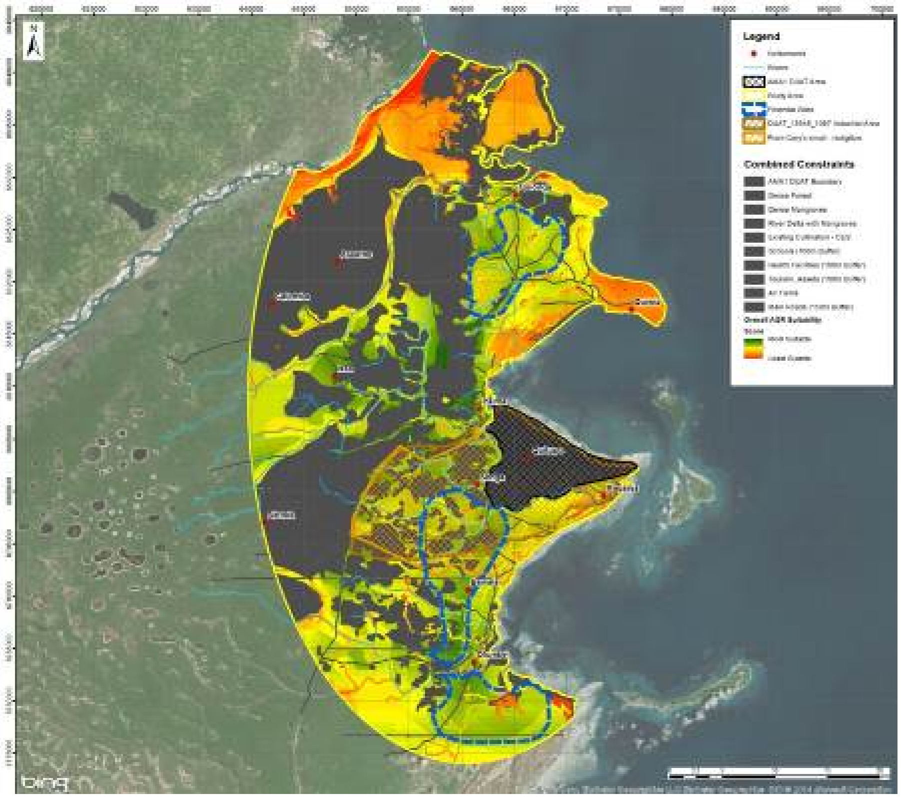


Figure D-28 *Potential Sites and the Industrial Zone – Livelihood Restoration / Agricultural Model*

APPENDIX E – PAPER: "RESETTLEMENT REPLACEMENT VILLAGE – RESETTLEMENT INSIDE THE DUAT AREA"

Replacement Village - Resettlement Inside DUAT Area

MOZAMBIQUE GAS DEVELOPMENT

TABLE OF CONTENTS

FIGURES

TABLES

DECISIONS MADE BY THE PROJECT

Following the presentation of this report, describing the process followed in identifying *Potential Sites* within the provisional DUAT Area for resettlement and identifying a number of key decisions to be made by the Project in order to proceed with the process, AMA1 and EEA have made the following decisions:

a. Resettlement within the DUAT Area has been accepted as the option to be canvassed with the Government and Communities to be resettled;

b. There are four alternative *Potential Sites* for the main village and one *Potential Site* for a Fishing Village (to be built with similar structures as exist in the present Fishing Villages to be resettled);

c. *Permanent housing* will be built inside the DUAT Area, occupying an area of around 40ha;

d. Final location for the *permanent housing* to be determined;

e. Permanent airport will be located outside the DUAT Area;

f. LNG Project looking at having *Permanent Construction Camp* closer to the LNG Plant site;

g. LNG Project will look at ways to reduce *noise footprint* (noise reduction in the source, noise mitigation measures);

h. The Project will prepare a Land Use Plan for the DUAT Area;

i. Areas within the 45dB(A) noise contour will be accessible for livelihood activities (agricultural, intertidal collection) but will not be used for habitation (these areas will be fenced with cattle fence to indicate demarcation);

j. Revised Build Zone consists of the “New Build Zone” and the “Extended New Build Zone”, which will be linked in a way that allows an easy (fenced) access through an under/overpass, to allow the communities to cross this area.

EXECUTIVE SUMMARY

INTRODUCTION

Anadarko Mozambique Area 1 Limitada (AMA1) and Eni East Africa (EEA) have found significant gas reserves off the northern coast of Mozambique, in the Rovuma basin areas 1 and 4, respectively . AMA1 and EEA have established the *Mozambique LNG Development Project* (the Project) to bring the gas onshore, process it (to a liquefied form, LNG) and export the gas to international markets. A significant requirement for the Project is the establishment of a Liquefied Natural Gas (LNG) processing facility to process the gas and attendant on and offshore infrastructure.

BACKGROUND

An area (referred to as the DUAT) of approximately 7,000 hectares on the Afungi Peninsular has been provisionally granted by the Government of Mozambique to the Project for the development and operation of the LNG facility. In the initial planning phase of the Project, it was proposed that the DUAT would need to be for the exclusive use of the Project and any existing communities (an estimated 750 households within the DUAT) would need to be resettled into replacement accommodation at an alternative site or sites. Subsequent design and planning of the LNG facility has resulted in a revised building footprint that is much smaller than originally envisaged and importantly requiring fewer households to be resettled.

BENEFITS OF RESETTLEMENT WITHIN THE AMA1 DUAT AREA

Important benefits to resettlement within the DUAT Area would be:

- Reduction in the number of households needing to be resettled;
- Potentially reduced host community negotiation;
- Limiting areas of agricultural livelihood development activities required (implementation of a livelihood development zone outside the constraints for agricultural livelihood development).

PURPOSE OF THE REPORT

The purpose of this report is to describe the process followed in identifying *Potential Sites* within the DUAT Area for resettlement and, in doing so, achieve a number of key decisions, namely:

- Agreement that resettlement within the provisional DUAT should be advanced as one of the replacement site options to be canvassed with the Government and communities to be resettled **(agreed by the Project).**
- Agreement on revised build zone **(agreed by the Project that the Revised Build Zone** consists **of the “New Build Zone” and the “Extended New Build**

Zone", which will be linked in a way that allows an easy (fenced) access through an under/overpass, to allow the communities to cross this area).

- Agreement on what other activities are planned outside the revised build zone:
  - o Access roads and pedestrian access to Palma;
  - o Permanent Housing **(agreed by the Project that Permanent Housing will be built inside the DUAT Area, occupying an area of around 40ha; final location yet to be determined);**
  - o Borrow pits;
  - o Water well field.

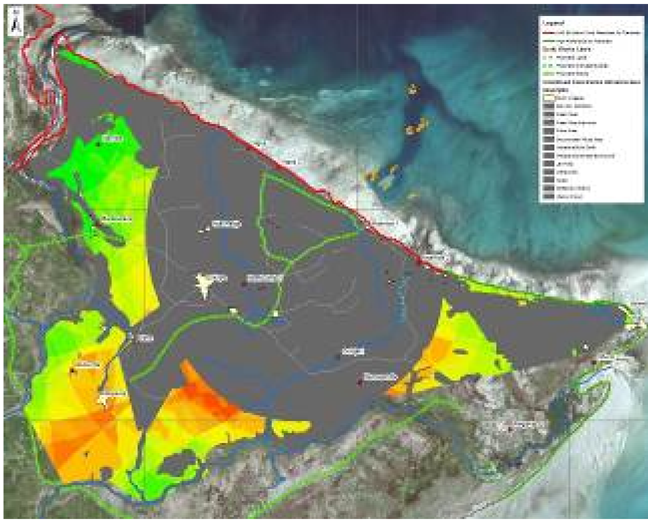
- Agreement on full Resettlement Action Plan (RAP), with slower build for replacement village (staged resettlement).

- Agreement to move forward with selected village and fishing village sites as an option that can be canvassed with Government and communities to be resettled **(agreed by the Project).**

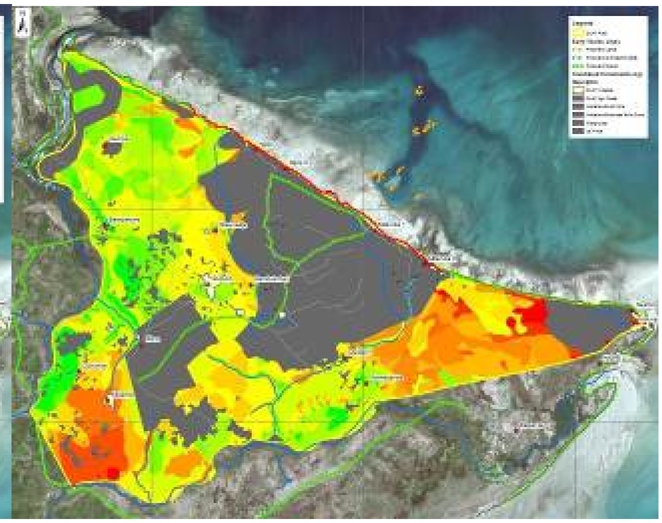
- Agreement on obtaining security of tenure for resettled communities.

- General Methodology

A multi-criteria assessment and site selection methodology has been developed that consists of a three-phased GIS-supported approach. Phase 1 consisted of defining the Study Area. Phase 2 consisted of identifying any serious constraints to resettlement (constraint mapping), ie, applying identified constraints to the Study Area to reveal *Potentially Suitable Areas*. Phase 3 applied several *Comparison Criteria* to the *Potentially Suitable Areas* (each classified from 1 – 'least suitable' to 5 – 'most suitable'). Weights were then assigned to each *criterion* to determine a ranked 'overall suitability' of the *Potentially Suitable Areas*. *Potential Sites* were identified within the areas of higher 'overall suitability'.



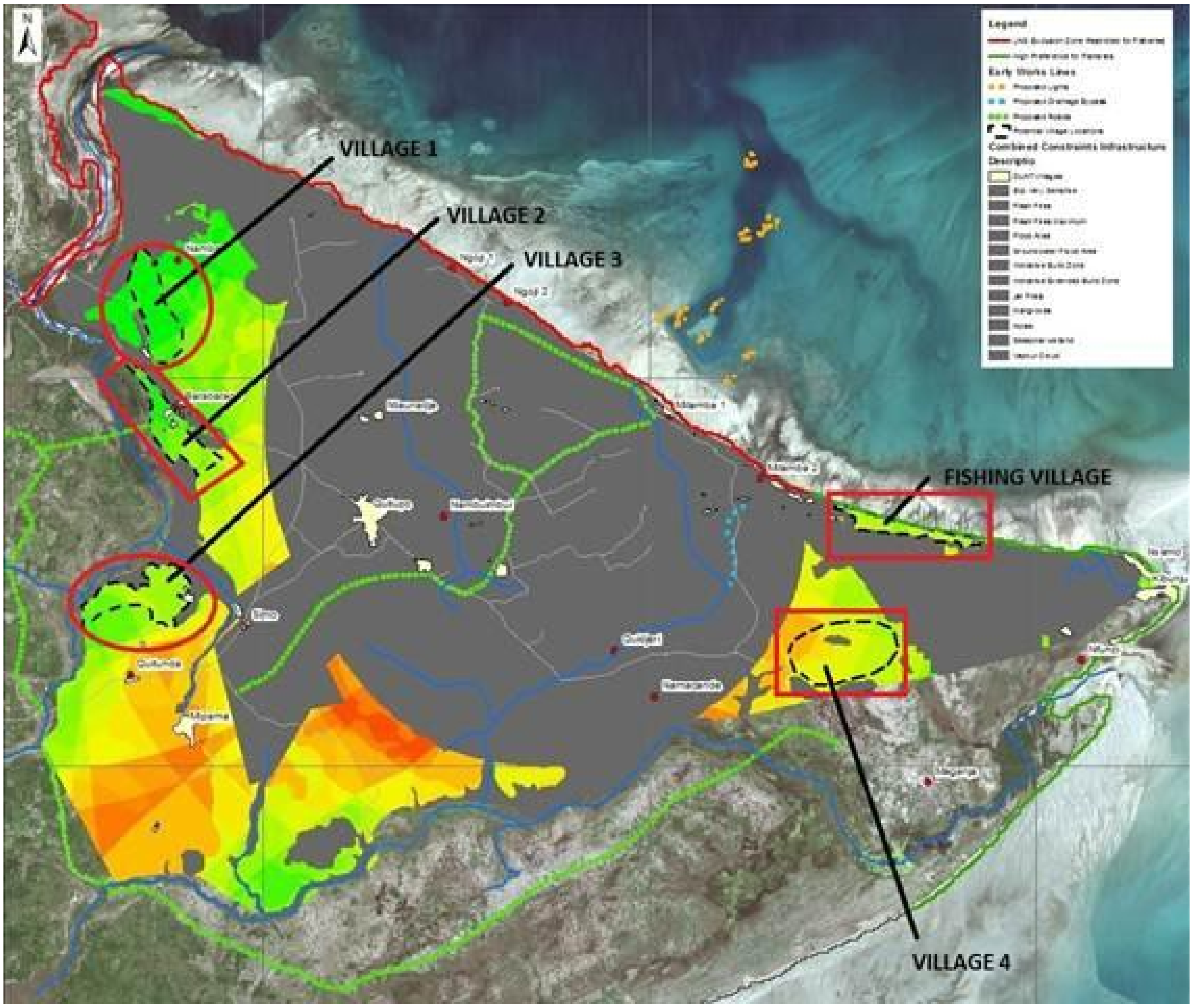
Overall Suitability: Village(s) Infrastructure Model



Overall Suitability: Livelihood Restoration / Agricultural Model

RESULTS – IDENTIFICATION OF MOST SUITABLE AREAS, POTENTIAL REPLACEMENT SITE

Overall suitability of areas is shown in gradation of colours from dark green (most suitable) through to red (least suitable), as per the Figure below.



Potential Sites **for the Fishing Village and Villages 1, 2, 3 and 4**

LEGAL REVIEW – DUAT OPTIONS AND TENURE

This report also includes, in appendix A, a summary of tenure and land use agreements currently in use in rural Mozambique and makes some suggestions as to what might be an acceptable (to communities and government) form of tenure for housing plots and the access and use of agriculture land.

RECOMMENDATIONS

From the research and analysis to date, it appears both feasible and desirable to progress the option of resettlement within the DUAT. This option includes a number of recommendations.

The project agrees to progress resettlement within the DUAT that takes account of the following:

- The four potential main village locations and one potential fishing village location to be presented to the Government and communities, in order to agree on the final locations **– agreed by the Project.**
- Review tribal affiliations, land ownership, preferences for where to be resettled etc.
- Staged resettlement of affected households:
  - First stage would be to provide access to the area for the commencement of the construction of the LNG facility;
  - The following stages would be to relocate Quitupo and other affected communities in stages, as housing and community facilities are completed.
- Construction and operations security and safety measures to be developed and implemented to ensure safeguard of local residents.
- Fishing Villages recreated (where fishing shelters are a secondary house, this will be replaced with a similar structure constructed from the same materials as the current structures) – **agreed by the Project.**
- Current agricultural land should be avoided when planning / sitting new facilities outside revised build zone.
- Agreement obtained from the Government for this option (ENH, DNAPOT, Provincial Government).
- Security of tenure for the resettled households to be agreed with the Government (DUAT's).
- Environmental licencing process for the Replacement Village(s) to be agreed with MICOA.
- Final Sites agreed with Government and communities.
- Agreement with communities on any land re-distribution.

1 INTRODUCTION

Anadarko Mozambique Area 1 Limitada (AMA1) and Eni East Africa (EEA) have found significant gas reserves off the northern coast of Mozambique, in the Rovuma basin areas 1 and 4, respectively. AMA1 and EEA have established the *Mozambique LNG Development Project* (the Project) to bring the gas onshore, process it (to a liquefied form) and export the gas to international markets. A significant requirement for the Project is the establishment of a Liquefied Natural Gas (LNG) processing facility to process the gas and attendant on and offshore infrastructure.

An area (referred to as the DUAT Area) of approximately 7,000 hectares on the Afungi Peninsular (situated in the Palma District, Cabo Delgado Province, in northern Mozambique) has been provisionally granted by the Government of Mozambique to the Project for the development and operation of the LNG facility.

In the initial planning phase of the Project, it was proposed that the DUAT Area would need to be for the exclusive use of the Project and any existing communities (an estimated 750 households within the DUAT Area) would need to be resettled into replacement accommodation at an alternative site or sites. Subsequent design and planning of the LNG facility has resulted in a revised building footprint (*revised build zone*) that is much smaller than originally envisaged and importantly requiring fewer households to be resettled.

However, the people situated inside the Project's *revised build zone* and those located in the surrounding areas that are found to be significantly affected by the Project will still require physical and/or economic displacement. The physically displaced households will need to be relocated to one or more Replacement Village(s).

WorleyParsons (WP) has developed a GIS-supported *Multi-Criteria Assessment and Site Selection Methodology* in order to identify *Potential Sites* for the Replacement Village(s). The methodology clearly and transparently communicates how these *Potential Sites* have been pre-selected based on the availability and suitability of land in a defined Study Area, by identifying *no-go* areas and ranking the *Potentially Suitable Areas* in terms of its *Overall Suitability*, taking into consideration the *Purpose of the Resettlement*, stated in Art. 5 of the Resettlement Decree (Decree no. 31/2012).

This report presents the results of the implementation of the methodology developed in order to identify the best areas within the DUAT Area in which to short list a number of *Potential Sites* where to resettle and restore the livelihoods of the households that will be displaced. It is not intended to compare the characteristics/suitability of these *Potential Sites* with those previously identified outside the DUAT Area.

The resettlement inside the DUAT Area would be in line with the Resettlement Decree, by *considering the areas closer to the Project Area*, and the resettlement preferences stated during a survey conducted for the LNG Project EIA. According to this survey, over 60% of the total households surveyed in the Afungi Project Site and surrounds stated that they would prefer to be resettled to a "nearby" location, with regards to the location where they currently reside. According to the same survey, more than 75% of the total households surveyed stated they would prefer to live in a "concentrated village" and over 70% in a "formally organized settlement". Important benefits to the resettlement within the DUAT Area would be:

- Reduction in the number of households needing to be resettled;
- Potentially reduced host community negotiation;
- Limiting areas of agricultural livelihood development activities required (implementation of a livelihood development zone outside the constraints for agricultural livelihood development).

A summary on legal consideration for tenure security is also presented in this report (in appendix A), based on the assumption that AMA1 and EEA have the right to develop the DUAT Area in accordance with a government approved exploitation plan to develop a LNG Plant.

2 MULTI-CRITERIA ASSESSMENT & SITE SELECTION METHODOLOGY FOR REPLACEMENT VILLAGES INSIDE THE DUAT AREA

2.1 GENERAL METHODOLOGY

The *Multi-Criteria Assessment & Site Selection Methodology* developed consists of a three-phased GIS-supported approach. After defining (and mapping) the Study Area (Phase 1), all known parameters that may pose serious constraints to the use of the land for resettlement purposes (for the construction of the villages and/or livelihood development activities for agriculture) have to be identified, mapped, and *blocked out* (Phase 2 – Constraints Mapping). These *no-go* areas (*Constraints*) are therefore excluded from the subsequent analysis, as they are deemed unavailable and/or unsuitable for resettlement.

The remaining areas are considered *Potentially Suitable* and it is now necessary to identify, amongst these areas, which are the most suitable for resettlement, and to short-list a number of *Possible Sites* within the *most suitable areas*. This is done through a GIS-supported "comparison exercise" of the *Potentially Suitable* Areas. A number of *criteria* that allow a comparison between the *Potentially Suitable Areas* (*Comparison Criteria*) must be identified, ultimately allowing the ranking of these areas according to their *Overall Suitability* (Phase 3).

This ranking takes into account all the *Comparison Criteria* defined, each classified according to a pre- defined *Classification System* (on a scale from 1 – *least suitable* to 5 – *most suitable*) and also considering the relative importance of each *Comparison Criterion* in the overall assessment (weights assigned to each *Criterion*, on a percentage scale).

The parameters that are relevant to consider as *Constraints* and *Comparison Criteria* for identifying the *most suitable areas* for the construction of the infrastructure associated with the villages are different (and/or have different weights) to those that will lead to the identification of the *most suitable areas* for agriculture. Therefore, two models have been developed, one for *Village(s) Infrastructure* and one for *Livelihood Restoration / Agriculture model*.

In order to short-list a number of *Possible Sites*, it was necessary to identify sites within the *most suitable areas* for the construction of the villages / infrastructure that were close to *suitable areas* for agriculture, based on the outputs of the two models.

The parameters considered in this analysis take into consideration that "*the resettlement aims at stimulating the socio-economic development of the country and guaranteeing a better quality of life of the affected population and social equity, taking into account the sustainability of the physical, environmental, social and economic aspects*." (Decree no. 31/2012, Art 5).

2.2 ASSUMPTIONS

The following assumptions were considered in the assessment:

- The *revised build zone* (as indicated in Figure 2-1) is the reduced area considered to be what is required for the construction of the LNG facility and associated services. This will minimise the amount of resettlement required by the Project. **It has been agreed by the Project that the *revised build zone* consists of the "New Build Zone" and the "Extended New Build Zone", which will be linked in a way that allows an easy (fenced) access through an under/overpass, to allow the communities to cross this area;**

- There is no legal impediment to resettlement within the current provisional DUAT Area;

- Land use rights for the resettled and remaining population to be ascertained.

- It is assumed that there will be sufficient land available inside the DUAT Area for re-distribution amongst the households that are needing to be resettled, taking into account:
    - the actual loss of land within the *revised build zone* (many of the households that will be resettled own/use land outside the *revised build zone*, that they will still be able to use);
    - that people who own/use land within the DUAT Area but do not live there may receive economical compensation and/or replacement land outside the DUAT Area.

- Milamba and Ngoji are to be relocated along the coast, outside *revised build zone*:
    - Recreate existing fishing villages using traditional building materials;
    - Permanent dwellings are provided within the new replacement village.

- Construction of public roads within the DUAT to connect up new and existing villages.

- Livelihood development activities (agriculture and fishing) to be implemented outside the *revised build zone,* only constrained by the following criteria:
    - 5kw radiation contours;
    - Marine exclusion zone.

Agreed by the Project that these areas will be fenced with cattle fence to indicate demarcation – no construction (habitation) shall occur within the fenced areas.

- Pedestrian access through the DUAT area to be provided. **It has been agreed by the Project that an under/overpass will be provided in order to grant communities a way to cross the *revised build zone* (between the "New Build Zone" and the "Extended New Build Zone");**

- Permanent housing location to be determined once government and community input to the Site Selection process has been received (possibly as currently located or alternatively to the south- east). **It has been decided by the Project that *Permanent housing* will be built inside the DUAT Area (occupying an area of around 40ha), although its final location is yet to be decided;**

- Tribal, traditional and community ownership is not a barrier to village relocation areas.

- Political affiliations, religious and similar factors are not considered a barrier to village relocation areas.

2.3 LIMITATIONS

The following limitations were considered in the assessment:

- The data and information used to implement the Multi-Criteria Assessment and Site Selection Methodology to the DUAT Area, with regards to the parameters considered as *Constraints* and *Comparison Criteria* was derived from the LNG Project EIA.

- Wherever possible the information from the LNG Project EIA was supplemented by additional data and information produced by WP specifically for this exercise.

- Data regarding "cultivated areas" (used as a constraint), as corresponding to areas currently in use for agriculture, have been determined based on interpretation of satellite imagery of the DUAT Area; it is likely that more areas are in use for agriculture and were not detected by the methodology used, either because small areas may not be identified at the scale of the analysis, or due to shifting agriculture practice (fallow land, at the date of the data capture).

- The *Constraints* and *Comparison Criteria* considered in the models, as well as the weights assigned to each *Criterion* require validation by the Project, Government of Mozambique and the Communities.

- There has been no consultation with the Government of Mozambique and the Local Communities with regard to Community socio-economic parameters that reflect community aspirations and resettlement / compensation preferences.

- No assessment of the environmental and social impacts for resettlement within the DUAT has been considered in the LNG project EIA.

- A planning report has been released recently for the 18,000ha Industrial Zone for public comment. The planned resettlement will need to be integrated into the planning.

2.4 IMPLEMENTATION OF THE METHODOLOGY TO THE DUAT AREA

2.4.1 Phase 1 – Definition of the Study Area

The Study Area has been defined as the DUAT Area, with the exception of the *revised build zone* (see Figure 2-1).

Figure 2-1 Study Area and Indication of the *Revised Build Zone*

2.4.2 Phase 2 – Constraint Mapping

The Study Area was assessed in terms of its availability and suitability for the construction of the Replacement Village(s) infrastructure and for the establishment of the associated agricultural plots. The parameters that may pose serious constraints to the use of the land for either of these purposes have been identified and mapped.

As the *Constraints* that apply to the identification of the most suitable sites for the construction of the villages are different to those that apply to the identification of the most suitable areas for agriculture, these two analyses were conducted separately for the two models (Village(s) infrastructure and Livelihood restoration / agriculture).
Table 2-1 presents the parameters considered as *Constraints* for each model, together with some notes regarding the sources of the information used.

Table 2-1 Relevance of *Constraints (no-go areas) Considered* for the Two Models

PARAMETER	CONSTRAINT (NO GO)	NOTES / SOURCE OF INFORMATION	RELEVANT CONSTRAINTS	
			VILLAGES / INFRASTRUCTURE	LIVELIHOOD RESTORATION - AGRICULTURE
Floodable areas	Inside floodable Areas	Results of Surface Water Modelling (LNG Project EIA) "1 in a 100 year Floodline" and "Groundwater Flood Extents" (WP Groundwater modelling)	✓	
Pool fires / Jet fires / Fireballs	Inside risk areas in terms of thermal radiation loads associated with pool and jet fires - Preliminary Worst Credible Case	Based on 5kW/m3 unobstructed heat flux (according to the Technical Note - 1 Revision 0: Consequence Modelling for Resettlement Planning; MMI, Oct 2013)	✓	✓
Flash fires	Inside risk areas in terms of flash fire burns and fatality impacts to personnel exposed (Lower Flammable Limit - Preliminary Worst Credible Case)	(according to the Technical Note - 1 Revision 0: Consequence Modelling for Resettlement Planning; MMI, Oct 2013)	✓	
Vapour Cloud Explosion	Inside risk areas in terms of *personal vulnerability* - areas where the threshold limit of 0.069 bar (6.9 kPa) Overpressure Vapour Cloud Explosion is exceeded (Preliminary Worst Credible Case)	Personal vulnerability, meaning *injury or fatality arising from contact with debries i.e. broken glass, corrugated metal, building panels, etc. (according to the Technical Note - 1 Revision 0: Consequence Modelling for Resettlement Planning; MMI, Oct 2013)*	✓	
Cultivated areas - existing agriculture	Inside cultivated areas (existing agriculture)	Developed by CES, based on interpretation of satellite imagery of the DUAT Area, based on the knowledge and experience gained on-site during the Rapid Site Assessment (outside the DUAT Area)		✓
Household and/or community infrastructure	Inside existing infrastructured areas (househole and/or community infrastructure)	Developed by CES, based on interpretation of satellite imagery of the DUAT Area	✓	✓
Mangroves	Inside mangrove stands	Data from the LNG Project EIA	✓	✓
Wetlands	Inside wetlands	Data from the LNG Project EIA	✓	
Noise levels	Inside areas with estimated noise levels at the receptors higher than 45 dB(A) – worst case scenario (LNG flare processing and shipping scenario)	Data from "Supplementary Noise Assessment" Report - Figure A.4a - Predicted Noise Levels Scenario 4 (14 LNG Train Units) - ERM	✓	

Air Quality	Inside areas where the NO2 annual average concentration exceeds the Mozambican Guideline Value	The Mozambican Guideline Value for the NO2 annual average concentration is 10 ug NO2/m3 (Decree no. 67/2010) Data from ERM Revised Air Quality Report - Figure 4.1: Annual NO2 impact (Scenario 1: 14 Trains operational, no flaring)	✓	
Ecological sensitivity	Inside areas classified as "Very High Sensitivity" for vegetation and herpetofauna	Data from the LNG Project EIA	✓	

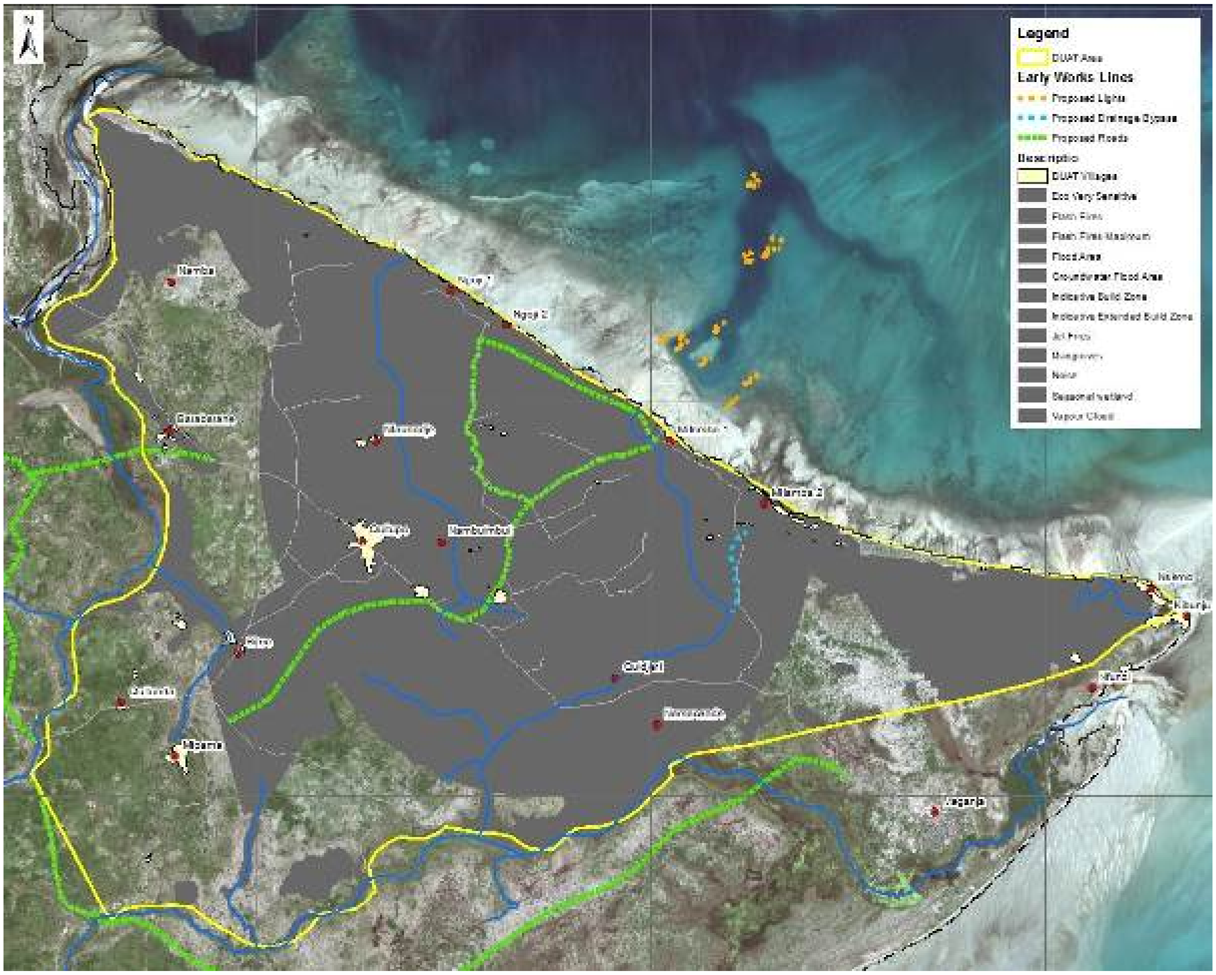


Figure 2-2 Constraint Mapping and Potentially Suitable Areas for the Village(s) Infrastructure Model

Figure 2-3 Constraint Mapping and Potentially Suitable Areas for the Livelihood Restoration Model

The systematic exclusion of the areas deemed unavailable and/or unsuitable for each of the two distinct purposes (represented in grey in Figure 2-2 and Figure 2-3) led to the identification of the *Potentially Suitable Areas*, within the Study Area, for each model (remainder areas). The *no-go* areas (*Constraints*) are therefore excluded from the subsequent analysis.

2.4.3 Phase 3 – Multi-Criteria Assessment and ranking of Potentially Suitable Areas

For each model, several parameters were identified to be used as *criteria* for comparing the *Potentially Suitable Areas* that resulted from Phase 2. It is important to note that in order to *qualify* as *Comparison Criteria*, the respective parameter must allow a differentiation of the areas, in terms of its suitability with regards to a particular aspect.

Table 2-2 indicates the parameters considered as *Comparison Criteria* for each of the two models. It also summarises the *Classification Systems* developed for each *criterion* and the *weights* assigned to each, for both models.

Table 2-2 *Comparison Criteria*, *Classification System* and *Weights* used for the Two Models

[illegible]	[illegible]	[illegible]		NOTES / SOURCE OF INFORMATION	WEIGHT (%)	
					VILLAGE(S) INFRASTRUCTURE	LIVELIHOOD RESTORATION-AGRICULTURE
Access to the sea	"Proximity to the coast"	Classes of "Distance to the coast"	5 = 0 - 1.5 km 4 = 1.5 - 3.0 km 3 = 3.0 - 4.5 km 2 = 4.5 - 6 km 1 = > 6 km	Buffers were considered and classes defined according to the Classification System	25	0
Access to and availability of services and markets / trade	"Proximity to Palma", considered to be the neighbouring town that can serve as hub for services and markets / trade	Classes of "Distance to Palma"	5 = 0 - 3 km 4 = 3 - 6 km 3 = 6 - 9 km 2 = 9 - 12 km 1 = > 12 km	Buffers were considered and classes defined according to the Classification System	15	15
Access to suitable agricultural land	Agricultural potential of the soils	Classes of "agricultural potential" of the soils	5 - High (Map Unit 3) 4 - Moderate (Map Unit 2) 3 - Moderate to low (Map Unit 1) 2 - Low (Map Unit 5) 1 - Very low (Map Unit 4)	Revised soils map provided by RSZ; classes defined based on the "Agricultural Reconnaissance Soil Survey (14-24 May 2013) and respective addendum considering the "map units" defined	5	40
Access to Water (in quantity and quality)	Ground Water Availability (Quantity and Quality of the deep and shallow aquifers)	Classes of groundwater quality and availability	5 - Very Good 4 - Good 3 - Fairly good 2 - Poor 1 - Bad	Classes defined based on WP model of Ground Water Availability (of the deep and shallow aquifers)	15	25
Access to a quiet environment (in terms of noise)	Noise levels – worst case scenario (LNG flare process sing and shipping scenario)	Classes of Estimated "noise levels" at the receptors	5 = < 37 dB(A) 4 = 37 dB(A) <= X < 39 dB(A) 3 = 39 dB(A) <= X < 41 dB(A) 2 = 41 dB(A) <= X < 43 dB(A) 1 = 43 dB(A) <= X < 45 dB(A)	Data from "Supplementary Noise Assessment" Report - Figure A4b - Predicted Noise Levels Scenario 4 (14 LNG Train Units)	15	0
Access to an unpolluted environment (in terms of air quality)	NO2 annual average concentration (14 Trains operational, no flaring)	Classes of "NO2 annual average concentration" (in ug NO2/m3)	5 = < 5.0 3 = 5.0 <= X < 7.5 1 = 7.5 <= X < 10.0	Data from revised LNG EIA Air Quality Assessment Report - Figure 4.1: Annual NO2 impact (Scenario 1: 14 Trains operational, no flaring)	5	0
	Short term (1 hour max) NO2 concentration (14 Trains operational, 2 flares in emergency blowdown event)	Classes of "NO2 Short term (1 hour max) concentration" (in ug NO2/m3)	5 = < 95.0 3 = 95.0 <= X < 142.5 1 = 142.5 <= X < 190.0	Data from revised LNG EIA Air Quality Assessment Report - Figure 4.2: Short term (1 hour max) NO2 impact (Scenario 2: 14 Trains operational, 2 flares in emergency blowdown event)	5	0
Ecological Sensitivity	Key onshore environmental sensitivities (combined)	Classes of Ecological Sensitivity	5 - Very Low Sensitivity 4 - Low Sensitivity 3 - Moderate Sensitivity 2 - High Sensitivity 1 - Very High Sensitivity	Data from the LNG EIA	15	20
Access to suitable fishing grounds (qualitative criterion)	Suitability of the fishing grounds (qualitative criterion)	Classes of suitability of the fishing grounds	5 - High 4 - Moderate / High 3 - Moderate 2 - Low / Moderate 1 - Low	As provided by the AVI Fishing Team	Qualitative analysis	-

For each *Comparison Criterion*, a *Classification System* was developed in order to allow an objective classification of the *Potentially Suitable Areas*. Five classes were defined, ranging between (**5**), classification attributed to the *most suitable areas* and (1), attributed to the *least suitable areas*. For each model, the *Potentially Suitable Areas* were then classified for all applicable *Criteria*, using the respective *Classification System*.

For each model, a *relative weight* was then assigned to each *Criterion* (on a percentage scale) in order to reflect the relative importance each represents within the respective model (aspects considered more "relevant" for the purpose of each model should receive a higher relative weight).

2.4.4 Overall Suitability – Models

After classifying the *Potentially Suitable Areas* for all the *Comparison Criteria*, the GIS program, considering the *weights* assigned to each *criterion*, calculates – for each area in the map – the *weighted average* of the classifications for all the *Comparison Criteria*. This *weighted average classification* represents its *Overall Suitability*. The *Potentially Suitable Areas* can then be represented *ranked* according to its *Overall Suitability* (the models).

The results of the two models developed are presented below: Village(s) Infrastructure Model (Figure 2-4) and Livelihood Restoration / Agricultural Model (Figure 2-5).

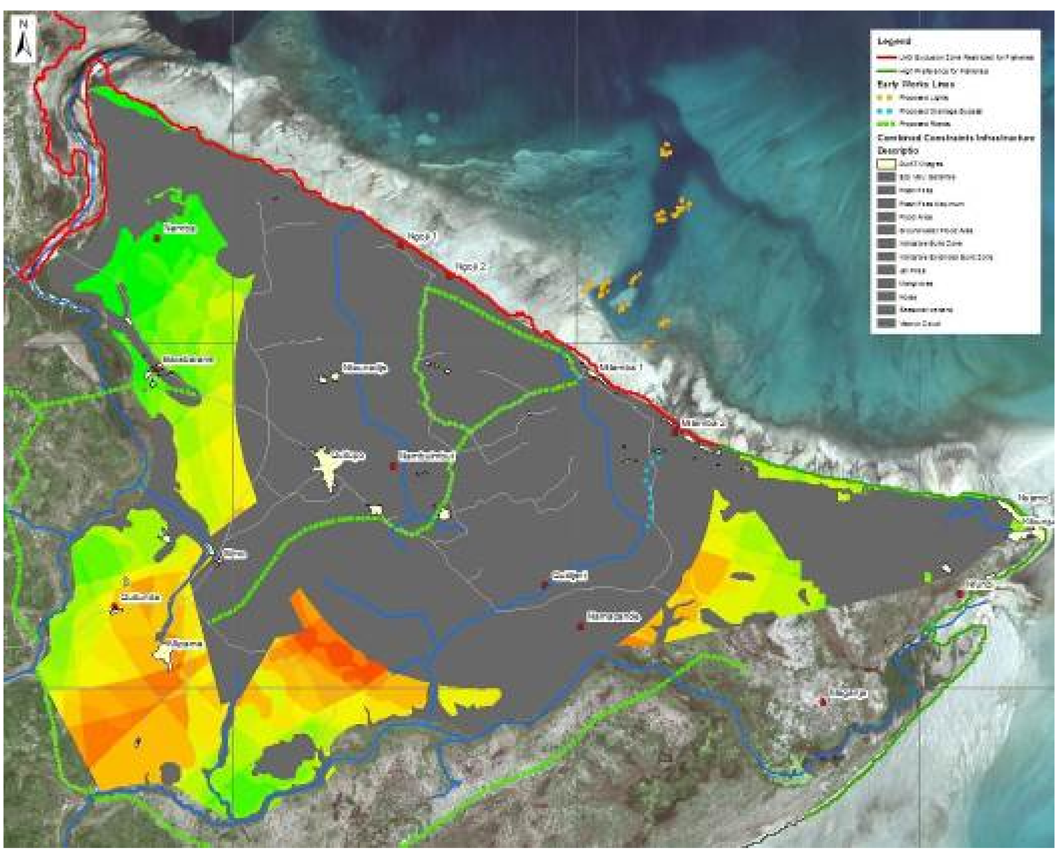


Figure 2-4 ***Overall Suitability*: Village(s) Infrastructure Model**

In these models, the overall suitability of the areas is represented as a gradation of colours ranging from dark green, corresponding to the areas of best overall suitability, through to lighter green, yellow, orange and finally red, corresponding to the areas of worst overall suitability.

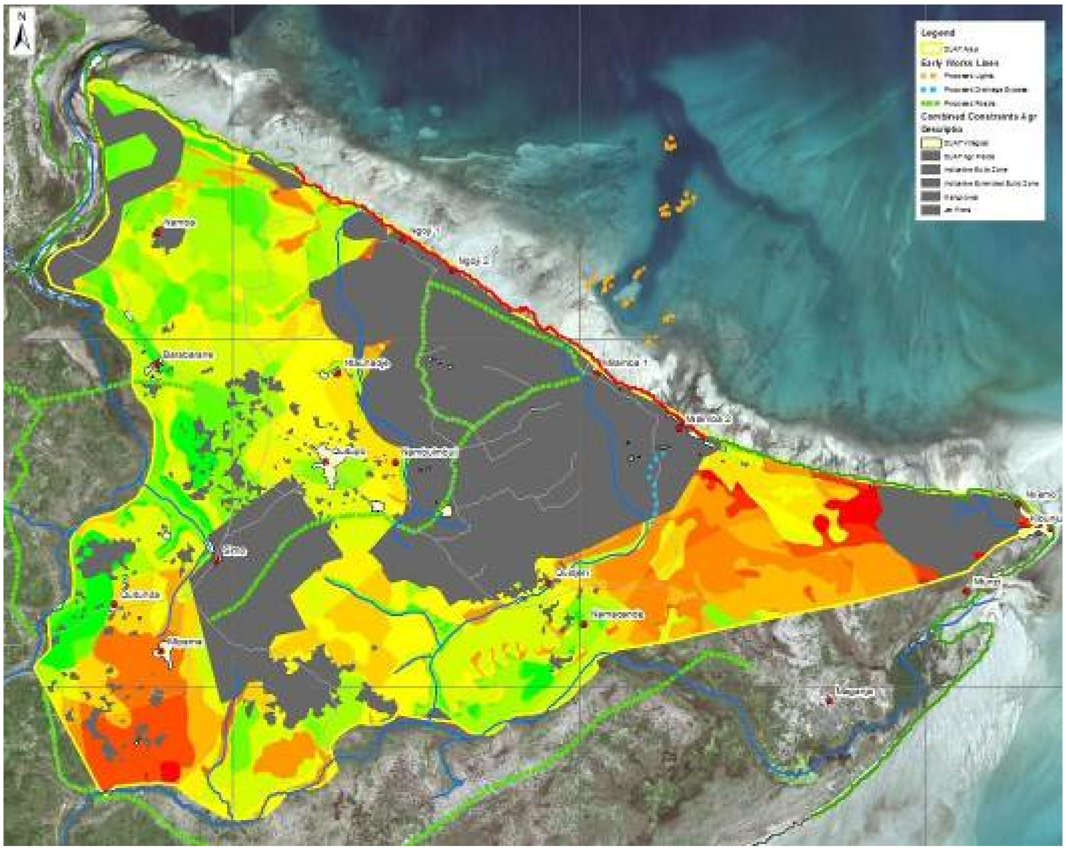


Figure 2-5 *Overall Suitability*: Livelihood Restoration / Agricultural Model

The qualitative analysis to be carried out with regards to fisheries aspects takes into account a similar gradation of colours of lines along the coast presented in the map of the Village's model. The colour of these lines represents the suitability for access to the fishing grounds, as per Table 2-2 (green lines corresponding to the best access to productive fishing grounds).

2.4.5 Identification of the Most Suitable Areas and of Potential Replacement Site(s)

The Livelihood Restoration / Agricultural Model supported the identification of a number of Agricultural *Areas* amongst the *most suitable areas* for the agricultural plots (greener areas in this model), inside the DUAT Area. These areas should be relatively large, in order to allow the restoration of the livelihood related to agriculture for the families to be resettled. The identification (short-listing) of the *Potential Sites* where to build the Replacement Village(s) and associated infrastructure took into account:

- the output of the *Village(s) Infrastructure Model* (identifying the most suitable areas for the villages and physical infrastructure);
- proximity to the *best Agricultural Areas* identified; and
- closer proximity to the *most suitable* fishing grounds (qualitative analysis on fisheries aspects).

3 CONCLUSIONS AND RECOMMENDATIONS

From the analysis done to-date on resettlement within the preliminary DUAT Area it appears feasible that this can be accomplished based on the assumptions and limitations listed in the main body of the report. The process going forward would be as follows:

o The Project agrees to progress resettlement within the preliminary DUAT area:

- The four potential main village locations and one potential fishing village location to be presented to the Government and communities in order to agree on the final locations – **agreed by the Project.**
- Review tribal affiliations, land ownership, preferences for where to be resettled, etc.
- Staged resettlement of affected households:
  - First stage would be to provide access to the area for the commencement of the construction of the LNG facility;
  - The following stages would be to relocate Quitupo and other affected communities in stages, as housing and community facilities are completed.
- Construction and operations security and safety measures to be developed and implemented to ensure safeguard of local residents.
- Access roads to be routed away from Quitupo in the near term.
- Fishing village(s) to be recreated (where fishing shelters are a secondary house, this will be replaced with a similar structure) **– agreed by the Project that the Fishing Village is to be built with similar structures as those that exist in the present Fishing Villages to be resettled.**
- Current agricultural land should be avoided when planning / siting new facilities outside the *revised build zone*.

o Agreement obtained from the Government for this option (ENH, DNAPOT, Provincial Government).

o Security of tenure for the resettled households to be agreed with the Government (DUAT's).

- o Environmental licensing process for the Replacement Village(s) to be agreed with MICOA.
- o Final Sites to be agreed with the Government and communities.

- Agreement with communities on any land re-distribution.

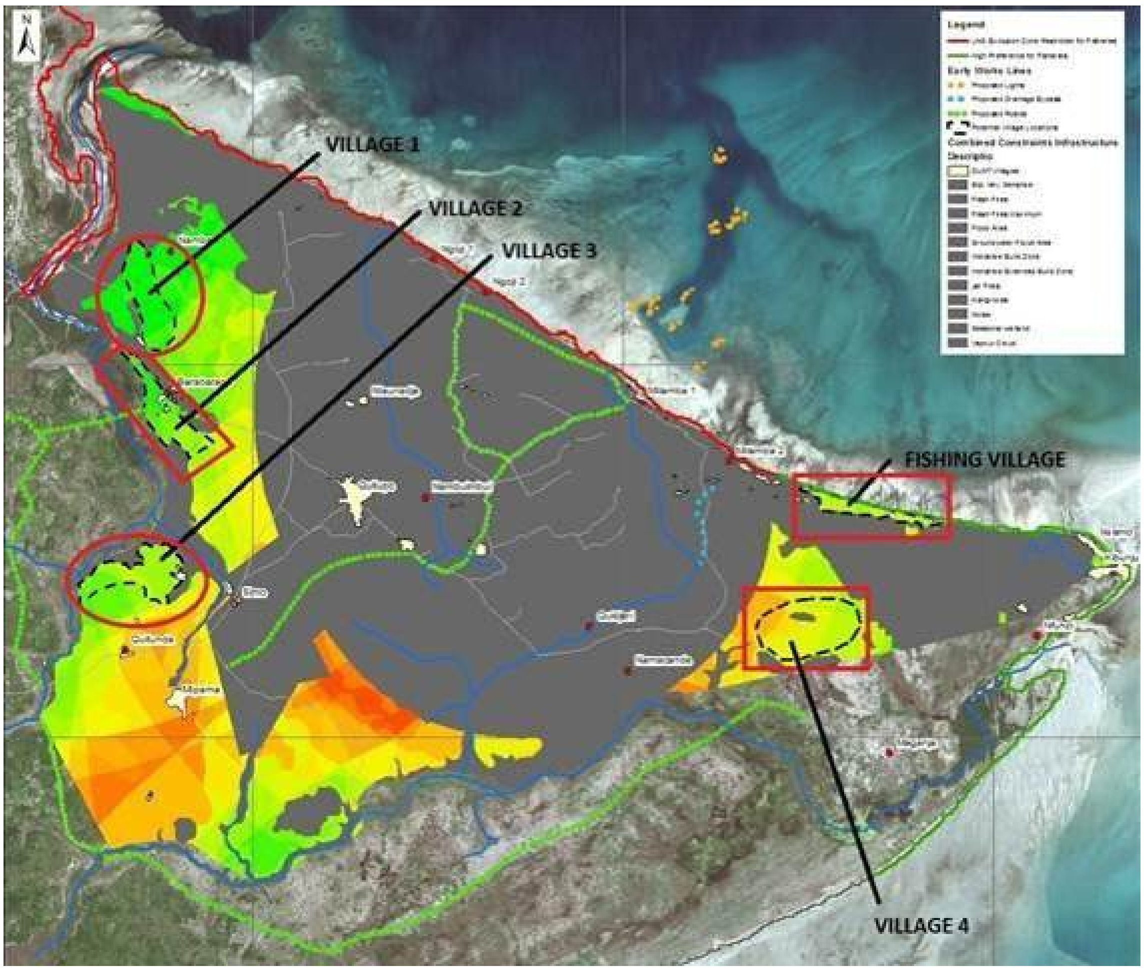


Figure 3-1 ***Potential Sites*** **for the Fishing Village and Villages 1, 2, 3 and 4**

4 RESETTLEMENT WITHIN THE DUAT AREA – KEY DECISIONS REQUIRED

- Agreement that resettlement within the provisional DUAT should be advanced as one of the replacement site options to be canvassed with the Government and communities to be resettled – **agreed by the Project.**

- Agreement on revised build zone – **agreed by the Project that the *revised build zone* will consist of the "New Build Zone" and the "Extended New Build Zone", which will be linked in a way that allows an easy (fenced) access through an under/overpass, to allow the communities to cross this area.**

- Agreement on what other activities are planned outside the revised build zone:

  - Access roads and pedestrian access to Palma;

  - **Permanent Housing (agreed by the Project that Permanent Housing will be built inside the DUAT Area, occupying an area of around 40ha; final location yet to be determined);**

  - Borrow pits;

  - Water well field.

- Agreement on full Resettlement Action Plan (RAP), with slower build for replacement village (staged resettlement).

- Agreement to move forward with selected village and fishing village sites as an option that can be canvassed with Government and communities to be resettled **– agreed by the Project.**

- Agreement on obtaining security of tenure for resettled communities.

APPENDIX A – LEGAL REVIEW: DUAT OPTIONS AND TENURE SECURITY

CAVEAT

This summary on legal consideration for tenure security is based on the assumption that the existing preliminary DUAT on the Afungi peninsula was granted on 12 December 2012 to Rovuma Basin LNG Land, Lda. (RBLL), a company currently owned by AMA1, EEA and ENH (EEA joined RBLL as a quota holder on 19 March 2014). The DUAT was awarded for an area of 7,000 ha. Under the terms of exploitation assignment agreements between RBLL, AMA1 and EEA, and following approval of the Minister of Agriculture, AMA1 and EEA each hold exclusive exploitation rights over a certain portion of land within the Project DUAT, on equal terms. The two parties also hold joint exclusive exploitation rights over the remaining portion of land within the Project DUAT intended as common area. The exploitation assignment agreements give the Project the right to develop the provisional DUAT area on the Afungi peninsula. The Project's EIA covers the provisional 7,000 ha, the size of the DUAT prior to demarcation, in its assessment. If the legal status of the preliminary DUAT is contingent upon other rights, or other rights holders, or if the configurations of the land plot are altered, or the zoning of the area suddenly changes, it may have different legal consequences than which is covered here.

INTRODUCTION

Security of tenure is the confident expectation that one will hold land without interference and be able to profit from one's investment. Ensuring tenure security is not only a very high priority for the project facility, but also for the communities who are being resettled, as well as host communities inside or outside the present DUAT area who might be affected by the relocation. Tenure security ensures a safe and stable operating environment for the project. It also creates a stable and secure environment for resettled communities within which to re-establish their livelihoods and foster development. In resource-rich post- conflict countries in particular, there are very strong linkages between tenure security and equitable access to natural resources and maintaining peaceful co-existence.

International standards regarding tenure security in the resettlement context (most notably IFC Performance Standard 5: Involuntary Resettlement [IFC PS 5] and 2012 UN FAO Voluntary Guidelines on Responsible Governance of Tenure) prescribe various safeguards that will supplement national laws and standards as contained in the Mozambique land legislation and the spatial planning legislation including the Resettlement Decree (no.31 of 2012).

REGULATORY PRESCRIPTIONS FOR RESETTLEMENT VILLAGE

The Resettlement Decree (Art. 16&18) sets out a Resettlement Model, which prescribes the most important features of the resettlement plots:

- Registered housing plot with appropriate infrastructure
- Housing infrastructure must cover a surface area of 70m²
- Housing plot in rural area must comprise of at least 5,000m²

- Housing plot in urban areas must comprise of at least 800m² (DNAPOT have agreed with this as
- being a suitable size for the replacement village)

- Housing plot must conform to the social and cultural features of the resettlement area

- Basic infrastructure such as sanitation, electricity, access roads, school, nursery, market, shops, police station, leisure areas, sports and recreation areas, worship and congregation venues
- In rural areas provision for agriculture, livestock, vegetable farming, poultry breeding and other animals

Other important principles to consider include promoting social cohesion and public participation (Art. 4).

In respect of site selection for resettlement, the District Government has the duty to provide land for relocation of *affected populations* and ensure legal plot registration (Resettlement Decree, Art. 12.5). Several other government departments bear obligations in the process, such as for integrating the settlements with land use planning, surveying and demarcating the area applied for, regulating forestry and wildlife access etc. Recent resettlement projects for the purpose of large investment in other provinces did not display a governance style that support the collaborative approach dictated by law; not only with affected communities who are being resettled, but by implication also with host communities who will be expected to surrender community land.

The Resettlement Decree neglects to include in the definitions of "affected population" or "indirectly affected population" host communities impacted as a result of the resettlement within their community. "Community" being a dynamic concept, referring in this context to a group of people who may share common resources, culture and/or religion etc.; who recognize customarily established land boundaries. Regardless of the selected site, resettlement will likely have a significant impact on host communities: their livelihoods, access to natural resources and social cohesion.

Read against the contexture of all the relevant laws and standards, it is both logical and in keeping with international best practice to extend certain safeguards available to resettled communities also to host communities, in particular consideration for security of tenure. Failing to acknowledge these host communities' tenure rights in the resettlement process will impose undue hardship, which, in turn, will certainly trigger a host of other challenges for the project. This interpretation is also supported by the concept and definition of the "project's area of influence" as contemplated in IFC PS 1.8. and the stakeholder engagement requirements and definition of "affected Communities" in IFC PS1.12 and GN
92.

TENURE OPTIONS FOR RESETTLEMENT VILLAGES AND HOST COMMUNITIES

In terms of the Resettlement Decree and international best practice, individuals and communities who are subject to physical resettlement have the right to obtain secure tenure at their resettlement site. This does not necessarily imply that the only option is to grant singular registered titles to individuals or family units over a specific demarcated tract of land.

As all ownership of land vests in the state, the Government may propose appropriate resettlement sites, inside or outside the present (provisional) project DUAT area. Regardless whether claim to a section of the provisional project DUAT is given up, AMA1 and EEA does not have the authority to authorize resettlement nor to allocate land for resettlement within the existing configuration of the DUAT area, as the project's rights are conditioned upon the approved exploitation plan. The right will not change if the DUAT is held by a different entity. While total transfer of the legal interests represented by a DUAT is possible through contractual cession, the nature of the rights that are susceptible to transfer are not the kind of rights resettlement communities need, nor what AMA1 or EEA can grant to ensure secure tenure.

On the project site, interested parties may request a decrease in the area applied for between the provisional and the final stages of DUAT registration, and government authorities responsible for monitoring and enforcing the terms may order the decrease if it appears that land may not be utilized efficiently, or if there is redundancy in the area applied for, or if there are other compelling factors. By implication, if resettlement is planned inside the present DUAT area, the size of the DUAT will be decreased, and the section that is surrendered will revert back to the State, who may appropriate it for the purpose of resettlement.

Partitioning of a DUAT – transfer of just a portion of a rural tenement - is only allowed when the title is held jointly by a community. Such is the exception in the case of individuation, as mentioned above, whereby an individual, within a community that hold land communally, may elect to obtain an individual title, or to have their portion of land excluded from the communal area or communal title. If the process of delimitation is carried out correctly, and host communities are empowered to have their community titles registered, they may be able to broker settlements with incoming parties, whereby rights to part of their area is being reconfigured and made available for reallocation. In such case it is assumed that the Project will be negotiating an agreement on behalf of the resettled communities, whereas in case of no "partnership agreement" but rather eviction or *de facto* expropriation, it will be government stipulating the new terms of occupation.

It is very important to conduct thorough identification and analysis of tenure arrangements in the areas targeted for resettlement, to ensure recognition of existing rights, as emphasized by the UN FAO 2012 Voluntary Guidelines on Tenure Governance. This will lay the groundwork to consolidate, reconfigure or adjust community areas to provide for greater efficiency and sustainable co-occupation, and ultimately long-term stability and self-sufficiency.

The most specific directive in the Resettlement Decree is the requirement that the new housing plots be of a prescribed size and dimension – in rural areas at least 5,000m², and that such be registered. Presumably, this means each eligible family unit is entitled to a registered title and adequate land for sustenance activities around their homes. This type of design prescribed by law is however not reflective of the reality of land occupation and usage patterns in the area.

To a great extent, the choice of the resettlement village design will dictate the way in which registration can and must be effected. Affected communities are vital in deciding the most appropriate design to complement their occupation patterns and social structures, which, in the author's opinion, ought to include the option of having some or all of the land registered jointly, and securing the rights by providing certificates to prove their rights. There is the precedent in Gaza province, where the District Government issued "Residential Certificates" to communities who were settled inside another communities' certificated land, though ideally the community ought to obtain their own certificate of delimitation, at minimum. With its purported urbanization objectives, the Resettlement Decree appears to contradict the gist of the Land law and Policy in this regard.

It is worth noting that the Decree is secondary legislation, issued by the Executive branch of Government and lower in the hierarchy of authoritative laws. The Constitution, Land Law and Spatial Planning Law, which recognizes communal rights and alternative tenure arrangements supersede secondary legislation. This is relevant because the determination that housing plots shall be registered individually creates incongruity with the contexture of the Land Policy and other Land legislation that authorize uninterrupted occupation, joint title holding and communal use. It also departs from the best practice guidelines that existing social cohesion and common natural resources be maintained as far as possible.[2]

The prevalent village layout has housing structures at the center, with land under production on the periphery and outskirts. Data collected by the agricultural team indicate that the rural plot size prescribed by the Decree is infinitely larger than what is usually under effective production. A few other consequences of a literal interpretation of a single allocated land tract of 5,000m² per eligible family, also pose other potential undesirable challenges: the needs of eligible persons might not be similar, and the Decree is quiet on allocation criteria; potential restrictions on crop and agricultural diversification due to soil quality; limited potential to scale up activities to economically viable units if limited by neighboring houses; tracts of land that are not under proper production become effectively sterilized from use by other potential users; and common natural resources may become fragmented as a result. If these sizeable areas are however, registered under communal title and allocated in accordance with productive use, it might provide a sensible solution to future community expansion.

CONCLUSION

Given the prevalent land-use patterns and customary norms of informal access to land through traditional social structures, read in the light of IFC recommendations to maintain and preserve social cohesion and facilitate access to communal resources, it is recommended that some form of a hybrid solution be devised that corresponds with existing tenure patterns.

It is conceivable that an individual title (or certificate that proves the right) be granted for access to a housing plot (but to reduce the housing plot size significantly) while consolidating larger tracts of land and registering joint title over communal areas of common resources, including natural resources, through the applicable rules of community access and joint title-holding.

An alternative might be to register (the) entire resettled area(s) under joint title, and to grant membership and membership certificates that prove the right to access and benefit, and which are at least enforceable against third parties, as in the case of certificates issued at the end of Delimitation. The most appropriate tenure regime will be contingent upon the preferences expressed by communities and the choice of the village lay-out, rather than the inverse; the main priority being to secure some form of legally recognized right that will be enforceable against third parties.

APPENDIX F – DECISION PAPER – SUMMARY: "RESETTLEMENT: REPLACEMENT VILLAGE(S) SITE SELECTION"

Decision Paper
Replacement Village(s) Site Selection

MOZAMBIQUE GAS DEVELOPMENT

TABLE OF CONTENTS

FIGURES

TABLES

1 INTRODUCTION AND BACKGROUND

An area of approximately 7,000 hectares on the Afungi Peninsular, close to Palma, has been provisionally granted by the Government of Mozambique for the development and operation of the Project (LNG plant and associated facilities).

In the initial planning phase of the Project, it was proposed that the DUAT Area would need to be for the exclusive use of the Project and any existing communities (an estimated 750 households) would need to be resettled into replacement accommodation at an alternative site or sites. In order to seek compliance with the IFC Performance Standard 5, namely to minimize involuntary resettlement wherever feasible, AMA1 and EEA have explored alternative project designs. As a result, it was possible to significantly reduce the Project footprint to the *Revised Build Zone*. Not only this has the potential to reduce the number of households requiring physical displacement, but has also opened up space so that the Replacement Village(s) and agricultural land could be located closer to the original location of the affected communities. Table 1 summarizes the advantages and disadvantages of this approach:

- It is compliant with the IFC Performance Standard 5, as fewer households will likely be required to resettle;
- There is a reduced livelihoods impact of communities, as they are very familiar with the area and can continue their livelihood activities to the extent possible;
- The communities most impacted by the Project are best placed to enjoy benefits in terms of jobs and improved roads and services;
- It reduces costs, as fewer households may need to be resettled;
- It provides savings on schedule as there is no need to negotiate access to greenfields site access with outside communities, and (as per the Project advice) the EIA for the village will likely consist of an Annex to the LNG Project EIA instead of a stand-alone EIA report and specific EIA procedure;
- It is in line with the preferences of affected communities and it was received positively by the Provincial Government Resettlement Committee

Table 1 Pro's and Con's for Inside DUAT Resettlement

Pro's	Con's
Compliance with IFC PS 5 as fewer households will likely be required to resettle, and as there is a reduced livelihoods impact on communities, and resettled communities are best placed to enjoy Project benefits.	**Impact Assessment**: no comprehensive assessment of impacts of the LNG Project has yet been carried out inside the DUAT Area. **Safety**: Additional security and safety measures need to be developed and implemented to ensure safeguard of local residents and employees.
Positive impact on cost and schedule as fewer households will likely be required to resettle. In addition, as per advice from the Project, the possibility exists that the GoM advices the EIA for the Replacement Village(s) to consist of an *addendum* to the LNG Project EIA instead of a stand- alone report / procedure.	The Project has still to finalise the risk contours from the LNG plant and the mimisation of the area that would be unavailable for local inhabitants to be use is still to be determined (control of this area will fall under LNG Project operations)
Social license to operate: Community consultations and a survey conducted for the LNG Project EIA indicate that households prefer to be resettled to a location nearby their current location.	**In-Migration**: A replacement village close to the Project site will likely attract a significant in-migrant population, posing additional risks to the Project.

In order to better understand the benefits in terms of the actual number of households that will no longer require resettlement, as well as the feasibility to build the Replacement Village(s) inside the DUAT Area, it is necessary to:

- Complete the assessment of the impacts of the LNG Project inside the DUAT Area;
- Complete the asset surveys in order to understand wheter there will be sufficient agricultural land available for re-distribution amongst the households that need to be resettled.

This document summarizes the methodology the Project has used for the Replacement Village(s) Site Selection process inside the DUAT Area, the outcome of the analysis in the form of the identification of a number of suitable Potential Sites for the Replacement Village(s).

A critical step in the site selection process is to seek the opinion of resettlement-affected households. Through a participatory process affected communities will be requested to provide the Project with a decision as to which location they prefer. Depending on the outcomes of the site selection process, engagement will also take place with the host community (if any). The Government of Mozambique has final authority over the decision of the replacement site location.

2 METHODOLOGY

The *Multi-Criteria Assessment & Site Selection Methodology* developed consists of a phased GIS-supported approach. All known parameters that may pose serious constraints to the use of the land for physical resettlement purposes were identified, mapped, and *blocked out* as potential areas, which were then excluded from the subsequent analysis as they are deemed unavailable and/or unsuitable for resettlement.

The remaining areas are all considered *Potentially Suitable Areas*. In order to identify, amongst these, the most suitable areas for resettlement, a GIS-supported "comparison exercise" of the *Potentially Suitable* Areas was developed. A number of *criteria* that allow a comparison between the *Potentially Suitable Areas* (*Comparison Criteria*) were identified, ultimately allowing the ranking of these areas according to their *Overall Suitability*.

This ranking takes into account all the *Comparison Criteria* defined, each classified according to a pre- defined *Classification System* (on a scale from 1 – *least suitable* to 5 – *most suitable*) and also considering the relative importance of each *Comparison Criterion* in the overall assessment (weights assigned to each *Criterion*, on a percentage scale).

The suitability of fishing grounds was also assessed based on a quantitative analysis on fisheries aspects, classified using the same scale, and graphically represented by means of different-colour lines along the coast (ranging from green, representing the most suitable fishing grounds, through to red, representing the least suitable fishing grounds).

The parameters that are relevant to consider as *Constraints* and *Comparison Criteria* for identifying the *most suitable areas* for the construction of the infrastructure associated with the villages are different (and/or have different weights) to those that will lead to the identification of the *most suitable areas* for agriculture. Therefore, two models have been developed, one for *Village(s) Infrastructure* and one for *Agriculture*. The *Constraints* (No-Go Areas) and *Comparison Criteria* for the *Village(s) Infrastructure* and the *Livelihood Restoration / Agriculture* models are summarized in Table 2 and in Table 3. The *Constraints* are depicted as grey areas in Figure 1 (Village Model) and Figure 2 (Agriculture Model), overlapped on top of the Overall Suitability models (based on the respective *Comparison Criteria)*.

In order to short-list a number of *Potential Sites*, areas/sites were identified within the *most suitable areas* for the construction of the villages / infrastructure that were close to *suitable areas* for agriculture. The location of the Potential Site for the Fishing Village took into account the most suitable fishing grounds.

Table 2 Constraints (No-Go Areas)

PARAMETER	CONSTRAINT (NO GO)	NOTES / SOURCE OF INFORMATION	RELEVANT CONSTRAINTS	
			VILLAGES / INFRASTRUCTURE	LIVELIHOOD RESTORATION - AGRICULTURE
Floodable areas	Inside floodable Areas	Results of Surface Water Modelling (LNG Project EIA) "1 in a 100 year Floodline" and "Groundwater Flood Extents" (WP Groundwater modelling)	✓	
Pool fires / Jet fires / Fireballs	Inside risk areas in terms of thermal radiation loads associated with pool and jet fires - Preliminary Worst Credible Case	Based on 5kW/m3 unobstructed heat flux (according to the Technical Note - 1 Revision 0: Consequence Modelling for Resettlement Planning; MMI, Oct 2013)	✓	✓
Flash fires	Inside risk areas in terms of flash fire burns and fatality impacts to personnel exposed (Lower Flammable Limit - Preliminary Worst Credible Case)	(according to the Technical Note - 1 Revision 0: Consequence Modelling for Resettlement Planning; MMI, Oct 2013)	✓	
Vapour Cloud Explosion	Inside risk areas in terms of *personal vulnerability* - areas where the threshold limit of 0.069 bar (6.9 kPa) Overpressure Vapour Cloud Explosion is exceeded (Preliminary Worst Credible Case)	Personal vulnerability, meaning *injury or fatality arising from contact with debries i.e. broken glass, corrugated metal, building panels, etc. (according to the Technical Note - 1 Revision 0: Consequence Modelling for Resettlement Planning; MMI, Oct 2013)*	✓	
Cultivated areas - existing agriculture	Inside cultivated areas (existing agriculture)	Developed by CES, based on interpretation of satellite imagery of the DUAT Area, based on the knowledge and experience gained on-site during the Rapid Site Assessment (outside the DUAT Area)		✓
Household and/or community infrastructure	Inside existing infrastructured areas (household and/or community infrastructure)	Developed by CES, based on interpretation of satellite imagery of the DUAT Area	✓	✓
Mangroves	Inside mangrove stands	Data from the LNG Project EIA	✓	✓
Wetlands	Inside wetlands	Data from the LNG Project EIA	✓	
Noise levels	Inside areas with estimated noise levels at the receptors higher than 45 dB(A) – worst case scenario (LNG flare processing and shipping scenario)	Data from "Supplementary Noise Assessment" Report - Figure A.4a - Predicted Noise Levels Scenario 4 (14 LNG Train Units) - ERM	✓	
Air Quality	Inside areas where the NO2 annual average concentration exceeds the Mozambican Guideline Value	The Mozambican Guideline Value for the NO2 annual average concentration is 10 ug NO2/m3 (Decree no. 67/2010) Data from ERM Revised Air Quality Report - Figure 4.1: Annual NO2 impact (Scenario 1: 14 Trains operational, no flaring)	✓	
Ecological sensitivity	Inside areas classified as "Very High Sensitivity" for vegetation and herpetofauna	Data from the LNG Project EIA	✓	

Table 3 Criteria, Classification and Weights

PARAMETER	*CRITERION*	CLASSIFICATION SYSTEM		NOTES / SOURCE OF INFORMATION	WEIGHT (%) VILLAGE(S) INFRASTRUCTURE	WEIGHT (%) LIVELIHOOD RESTORATION - AGRICULTURE
Access to the sea	"Proximity to the coast"	Classes of "Distance to the coast"	5 = 0 - 1.5 km 4 = 1.5 - 3.0 km 3 = 3.0 - 4.5 km 2 = 4.5 - 6 km 1 = > 6 km	Buffers were considered and classes defined according to the Classification System	**25**	**0**
Access to and availability of services and markets I trade	"Proximity to Palma", considered to be the neighbouring town that can serve as hub for services and markets I trade	Classes of "Distance to Palma"	5 = 0 - 3 km 4 = 3 - 6 km 3 = 6 - 9 km 2 = 9 - 12 km 1 = > 12 km	Buffers were considered and classes defined according to the Classification System	**15**	**15**
Access to suitable agricultural land	Agricultural potential of the soils	Classes of "agricultural potential" of the soils	5 - High (Map Unit 3) 4 - Moderate (Map Unit 2) 3 - Moderate to low (Map Unit 1) 2 - Low (Map Unit 5) 1 - Very low (Map Unit 4)	Revised soils map provided by RS2; classes defined based on the "Agriculture: Reconnaissance Soil Survey (14-24 May 2013) and respective *addendum* considering the "map units" defined	**5**	**40**
Access to Water (in quantity and quality)	Ground Water Availability (Quantity and Quality of the deep and shallow aquifers)	Classes of groundwater quality and availability	5 - Very Good 4 - Good 3 - Fairly good 2 - Poor 1 - Bad	Classes defined based on WP model of Ground Water Availability (of the deep and shallow aquifers)	**15**	**25**
Access to a quiet environment (in terms of noise)	Noise levels - worst case scenario (LNG flare processing and shipping scenario)	Classes of Estimated "noise levels" at the receptors	5 = < 37 dB(A) 4 = 37 dB(A) <= X < 39 dB(A) 3 = 39 dB(A) <= X < 41 dB(A) 2 = 41 dB(A) <= X < 43 dB(A) 1 = 43 dB(A) <= X < 45 dB(A)	Data from "Supplementary Noise Assessment" Report - Figure A.4b - Predicted Noise Levels Scenario 4 (14 LNG Train Units)	**15**	**0**
Access to an unpolluted environment (in terms of air quality)	N02 annual average concentration (14 Trains operational, no flaring)	Classes of "N02 annual average concentration" (in ug N02lm3)	5 = < 5.0 3 = 5.0 <= X < 7.5 1 = 7.5 <= X < 10.0	Data from revised LNG EIA Air Quality Assessment Report - Figure 4.1: Annual N02 impact (Scenario 1: 14 Trains operational, no flaring)	**5**	**0**
	Short term (1 hour max) N02 concentration (14 Trains operational, 2 flares in emergency blowdown event)	Classes of "N02 Short term (1 hour max) concentration" (in ug N02lm3)	5 = < 95.0 3 = 95.0 <= X < 142.5 1 = 142.5 <= X < 190.0	Data from revised LNG EIA Air Quality Assessment Report - Figure 4.2: Short term (1 hour max) N02 impact (Scenario 2: 14 Trains operational, 2 flares in emergency blowdown event)	**5**	**0**
Ecological Sensitivity	Key onshore environmental sensitivities (combined)	Classes of Ecological Sensitivity	5 - Very Low Sensitivity 4 - Low Sensitivity 3 - Moderate Sensitivity 2 - High Sensitivity 1 - Very High Sensitivity	Data from the LNG EIA	**15**	**20**
Access to suitable fishing grounds (qualitative criterion)	Suitability of the fishing grounds (qualitative criterion)	Classes of suitability of the fishing grounds	5 - High 4 - Moderate I High 3 - Moderate 2 - Low I Moderate 1 - Low	As provided by the AMA1 Fishing Team	**Qualitative analysis**	-

3 RESULTS

The overall suitability of the areas is shown in gradation of colours from dark green (most suitable) through to red (least suitable), as per Figure 1 and Figure 2, for the *Village Infrastructure Model* and the *Livelihood Restoration / Agricultural Model*.

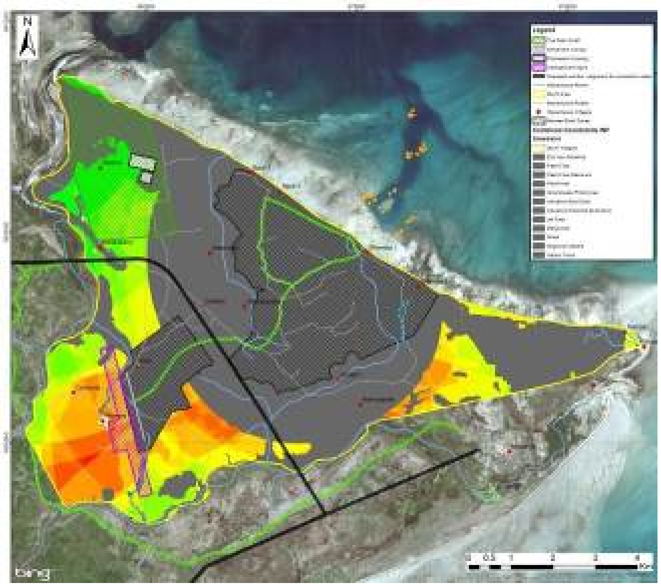


Figure 1 Overall Suitability Village Model

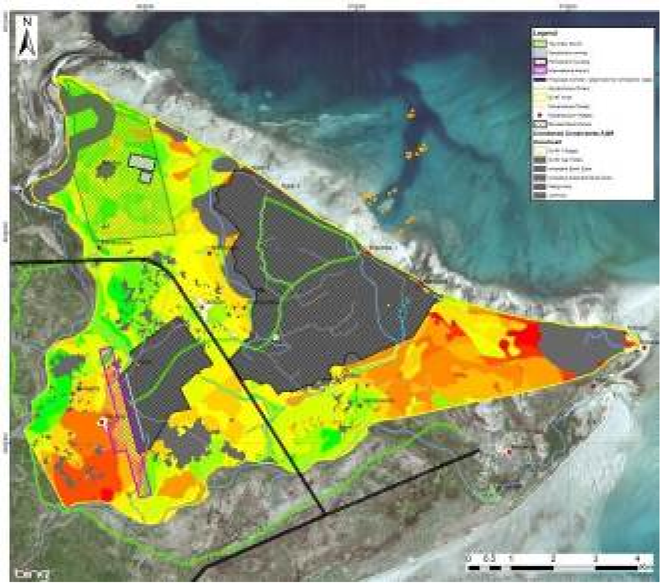


Figure 2 Overall Suitability: Livelihood Restoration/Agricultural Model

Based on the overall suitability of the areas, four Potential Sites were identified for a Replacement Village located inland (see sites named ‘Village 1’, ‘Village 2’, ‘Village 3’ and ‘Village 4’ in Figure 3) and one site was identified for a Replacement Village for fishing communities (Milamba and Ngodji) currently living along the coast (see the site named ‘Fishing Village’ in Figure 3).

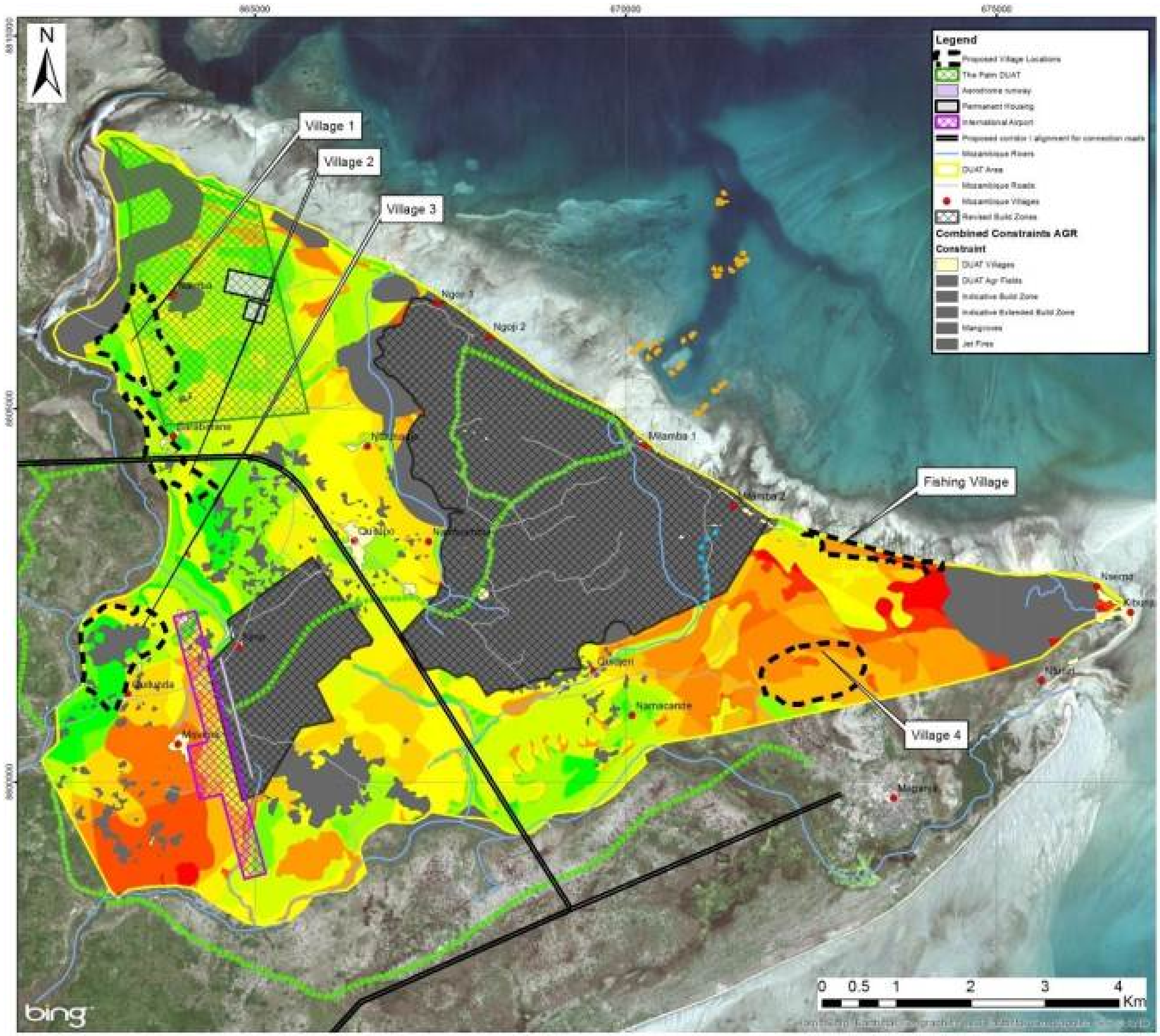


Figure 3 Potential Sites for the Fishing Village and Villages 1, 2, 3 and 4

For preliminary planning purposes, it was assumed that:

- One main village (inland) will be built, complemented by one Fishing Village (in case consultations with resettlers reveal a divergence in site preferences, tvvo inland Replacement Villages may be developed).

- The fishing villages of Milamba and Ngodji will be relocated along the coast, outside the *revised build zone*. Specific building materials to be used and location(s) will be finalised following consultations with affected communities.

- In the event that the selected Replacement Village site is located immediately adjoining an existing settlement (e.g. in the case of Barabarane or Quitunda), inhabitants of the existing settlement will also be offered replacement housing.

- Livelihood development activities (agriculture and fishing) will be implemented outside the *revised build zone*, restricted only by the marine exclusion zone and areas not suitable for public activities as determined by the Qualitative Risk Assessment process.

- It is assumed that there will be sufficient land available inside the DUAT Area for re-distribution amongst the households that need to be resettled. If insufficient quantities of agricultural land are available and/or agricultural land re-distribution between host and resettled communities is not feasible, options for allocating replacement agricultural land outside the DUAT Area will be pursued;

- The environmental licencing process for the Replacement Village(s) is to be agreed with MICOA.

- “Total Protection Areas” as defined in Article 8 of the Land Law 19/97 will be investigated and negotiated with GoM as part of the detailed site investigation, once a preferred site has been selected.

Ratification of the decisions taken and suggestions made listed in Table 4 is required.

Table 4 Ratification of Decisions Needed

Decision	Ratification Required
Resettlement to take place inside DUAT. At least 2 villages will be required to be constructed (inland village/fishing village).	The Project first then GoM and communities
Security of tenure will be required for households requiring resettlement (includes both village and agricultural land)	The Project first then GoM
Leasing/purchase of Palm (Tourism) DUAT within the DUAT Area	The Project
Formal approval of the redefined build zone	The Project
Additional security and safety measures to be developed and implemented to ensure safeguard of local residents and employees	The Project
Construction of a public road to connect up new and existing villages (including Palma and Maganja) using under/overpasses where necessary.	The Project first then GoM
The location of permanent housing for Project Operations Staff to be decided once replacement village and land allocation is known	The Project
Livelihood development activities (agriculture and fishing) can continue outside the *revised build zone*, restricted only by the marine exclusion zone and areas not suitable for public activities as determined by the Qualitative Risk Assessment process.	The Project
Environmental licensing process to be agreed on	MICOA