Chapter 6

Baseline- Introduction and Geographical Context

CONTENTS

6.1 OVERVIEW AND STRUCTURE OF THE EIA BASELINE

This baseline volume of the EIA Report describes the existing marine and terrestrial environmental characteristics of the Afungi Project Site and surrounding areas. It provides descriptions of the nature, value and sensitivity of the physical, biological and socio-economic resources and receptors potentially affected by the Project.

The purpose of this chapter is to define the Project's Areas of Direct and Indirect Influence (see *Section 6.5*) and provide a general overview of the physical characteristics that provide the context for both the onshore and offshore activities proposed.

6.1.1 Structure of the EIA Baseline Chapters

The description of the affected environment has been divided into the following chapters and sections:

- *Chapter 6* – Baseline Introduction and Geographical Context:
  - Overview and Structure of EIA Baseline Chapters;
  - Summary;
  - Sources of Information;
  - Geographical Setting;
  - Areas of Influence and Study Area;
  - Climate and Meteorology;
  - Air Quality;
  - Noise;
  - Landscape and Seascape Character and Visual Amenity; and
  - Nature Conservation.

- *Chapter 7* – Offshore and Near Shore Environmental Baseline:
  - Introduction;
  - Summary;
  - Sources of Information;
  - Regional Context- Quirimbas Archipelago;
  - Offshore Environment: Physical Conditions;
  - Offshore Environment: Major Biological Features;
  - Near Shore Environment: Physical Conditions;
  - Near Shore Environment: Marine Habitats; and
  - Near Shore Environment: Major Biological Features.

- *Chapter 8* – Onshore Environmental Baseline:
  - Introduction;
  - Geology and Terrain;
  - Soils and Land Capability;

- Groundwater;
- Hydrology;
- Surface Water Ecology;
- Vegetation;
- Herpetofauna;
- Avifauna;
- Mammals; and
- Summary of Key Onshore Environmental Sensitivities.

- *Chapter 9* – Socio-economic and Community Health Baseline:
  - Introduction;
  - Summary
  - Sources of Information;
  - Socio-economic Study Area;
  - Overview of Palma District;
  - Cabo Delgado Province: Administrative and Political Overview;
  - Cabo Delgado Province: Socio-demographic Indicators;
  - Cabo Delgado Province: Economic Activities;
  - Palma District Political and Administrative Organisation;
  - Palma District and Afungi Project Site: Socio-demographic Indicators;
  - Palma District and Afungi Project Site and Surrounds: Use of Natural Resources;
  - Palma District, Afungi Project Site and Surrounds: Land Use and Occupation Patterns;
  - Palma District: Non-governmental Organisations (NGOs) and Donors;
  - Palma District and Afungi Project Site: Social Services;
  - Palma District and Afungi Project Site: Economic Activities and Livelihoods;
  - Afungi Project Site and Surrounds: Cultural and Religious Profile;
  - Afungi Project Site and Surrounds: Expectations Regarding the Project;
  - Shipping and Navigation; and
  - Archaeology and Cultural Heritage.

6.2 *SUMMARY*

The proposed LNG Facility will be located on Afungi Peninsula, on the southern shores of Palma Bay, close to the town of Palma. Area 1 extends up to 50km offshore in the Rovuma Basin, and the Mamba Gas Field located in Area 4, extends approximately 30km further offshore. Both Area 1 and Area 4 border with Tanzania in the north. The Project's Areas of Direct and Indirect Influence include elements of the offshore, near shore and onshore environment where Project activities will take place or will potentially impact, either positively or negatively.

The area experiences one wet season and one dry season annually. The average annual temperature and humidity is 25.9°C and 75.8 percent respectively, with peaks during the wet season from December to April. From March to September, wind patterns in the Palma area are predominantly

south-south-easterly, while from October to February, they are predominantly north-easterly.

The baseline concentrations of air pollutants onshore, including nitrogen dioxide (NO_2) and nitrogen oxides (NO_X), are low. The current offshore air quality is considered to be acceptable and within Mozambican or international standards. Noise levels at the ocean are relatively steady between daytime and night-time, whereas inland night-time levels are quieter. Dominant sound sources across the Afungi Project Site are from wildlife activities such as birdsong, frogs, insects and daily human activities. In locations where these sources are not present, or are to a lesser extent, noise levels tend to be lower.

Palma Bay is a large distinct natural bay. The wider area includes remote wooded landscapes, located inland of coastal settlements. The islands to the northern extreme of the Quirimbas Archipelago (ie Rongui, Tecomaji, Vamizi islands, etc) form an important part of the overall seascape in the area. There are no gazetted protected areas within the Area of Direct Influence (ADI). However, there are a number of designated and proposed conservation areas in the greater region, both terrestrial and marine, including Quirimbas National Park and Mnazi Bay–Rovuma Estuary Marine Park.

6.3 SOURCES OF INFORMATION

The majority of the data outlined in the baseline descriptions have been derived from surveys (primary data collection) carried out by environmental, social and health specialists specifically for the EIA, in accordance with the Terms of Reference (ToR) detailed in the EPDA Report. Where required (primarily the biophysical studies), fieldwork was undertaken during both the wet and dry seasons. The methodologies applied by the various specialists are presented in *Annex C*. The various specialists and organisations involved in the EIA and their respective studies are outlined in *Chapter 3*. It should be noted that the specialists' baseline descriptions have been incorporated directly into relevant sections of this EIA Report, hence no separate specialist reports are appended.

The baseline also draws upon a comprehensive review and analysis of existing information (known as secondary information), including data collected for EIAs for the exploration phase of the Project, from EIAs for other projects in Cabo Delgado Province, including onshore and offshore projects, and from other relevant reports and studies (1).

(1) The other EIAs are in the public domain and were undertaken by Impacto. Other studies were undertaken or commissioned by Government or by independent scientists. All reports and studies used are in the public domain and referenced in this report.

The analysis and review of primary and secondary data have allowed the offshore and onshore environmental baselines and their sensitivities to be defined accurately.

6.4 GEOGRAPHICAL SETTING

Area 1 and Area 4 are located in the Rovuma Basin and extend from Pangane north to the Rovuma River, a natural boundary with the Republic of Tanzania. Area 1 extends up to 50km offshore and Area 4 extends up to 60km further offshore, as shown in *Figure 6.1*. Area 1 comprises an area of approximately 10,500km^2.

The proposed LNG Facility will be located on Afungi Peninsula, close to the town of Palma, as shown in *Figure 6.2*. The peninsula is located on the southern shores of Palma Bay, a large distinct natural bay in the north-east of Cabo Delgado Province. The Afungi Project Site falls in Palma District, within the Administrative Post of Palma.

The distances by road from Palma to Mocímboa da Praia and Pemba are 70km and 320km respectively.

38°0'0"E 38°30'0"E 39°0'0"E 39°30'0"E 40°0'0"E 40°30'0"E 41°0'0"E 41°30'0"E 42°0'0"E

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Quionga
Assame
Quiwia
Issa
Palma
Quitupo
Senga
Maganja
Bawala
Olombe
INSET MAP
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© Harris Corp, Earthstar Geographics LLC
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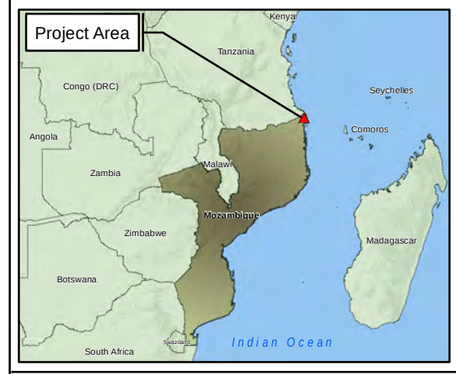
TANZANIA
Palma
INSET MAP
Nangade
Mocimboa da Praia
Mocimboa da Praia
Muidumbe
Nassa
Macomia
Meluco
Montepuez
Quissanga
Marrupa
Pemba
Pemba
Ancuabe
Balama
Mecufi
Chiúre
Namuno
Namapa
bing
Image courtesy of NASA State of Michigan

AREA 1
AREA 4
Pangane

Legend

- Towns
- Regional Roads
- Afungi Project Site
- Area 1
- Area 4
- District Boundary
- Boundary with Tanzania



MAIN MAP SCALE:

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Kilometers

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Figure 6.1:
Regional Locality extent of Area 1 and Area 4

CLIENT:

Anadarko
Moçambique Área 1, Lda
eni

DATE: Jun 2013	CHECKED: IE	PROJECT: 0133576
DRAWN: AB	APPROVED: KG	SCALE: 1 : 1 500 000

DRAWING: Regional Locality.mxd

REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

Impacto Projectos e Estudos Ambientais
ERM

Projection: UTM Zone 37 S Datum: WGS84
Source: Bing Maps ©2010 Microsoft Corporation.
Impacto, 2012. Inset Map: Esri Data & Maps

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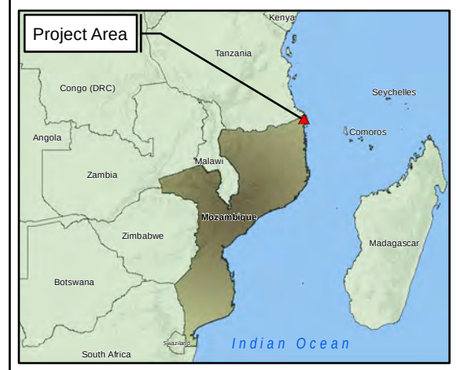
Legend

- Villages / Settlements
- Local Roads
- Regional Roads
- Afungi Project Site



MAIN MAP SCALE:

0 2 4 6
Kilometers

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Figure 6.2:
Locality Map

CLIENT:

Anadarko Moçambique Área 1, Lda

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DATE: Oct 2013	CHECKED: IE	PROJECT: 0133576
DRAWN: AB	APPROVED: KG	SCALE: 1 : 120 000

DRAWING:
Locality Map.mxd

REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

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Projection: UTM Zone 37 S Datum: WGS84
Source: Bing Maps ©2010 Microsoft Corporation.
Imapcto, 2012. Inset Map: Esri Data & Maps

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6.5 AREAS OF INFLUENCE AND STUDY AREA

6.5.1 Areas of Influence

This section defines the Areas of Direct and Indirect Influence. The Project Area can be divided into Areas of Direct Influence (ADI) and Areas of Indirect Influence (AII).

The ADI comprises the areas offshore, near shore and onshore where the Project infrastructure will be located, ie the direct Project Footprint. Offshore, the ADI comprises the immediate vicinity of each natural gas well in the Golfinho, Prosperidade and Mamba gas fields and the subsea production infrastructure located within Area 1 and in the vicinity of the Mamba Gas Field in Area 4, including the route of the proposed gas pipelines that will connect the offshore infrastructure to Palma Bay. Near shore, the ADI comprises areas disturbed by dredging, near shore infrastructure such as trestles/causeways and MPD. In addition, it includes the routes that the Project vessels (eg LNG Carriers, support vessels, etc.) will travel between the offshore gas fields in Area 1 and Area 4 and Palma Bay. The offshore and near shore ADIs are referred to as the Offshore Project Footprint Area in this EIA Report.

The ADI comprises two broadly defined areas of interest:

- Offshore Project Footprint Area
  - the offshore environment (Golfinho, Prosperidade and Mamba gas fields, pipeline routes, shipping routes, etc) with wider consideration of certain issues (eg visual impacts) where appropriate; and
  - the near shore, where the MPD, trestles/causeways, pipeline landfall, vessel navigation channels, exclusion zones around infrastructure, etc will be situated in Palma Bay.
- Afungi Project Site and Surrounds
  - the onshore environment at Afungi Peninsula where the LNG Facility and associated infrastructure (roads, airstrip, accommodation, etc) will be located, and
  - the areas around the Afungi Project Site (the surrounds) where people's access to livelihood assets will be affected.

These broadly defined ADIs are shown in *Figure 6.3.*

The AII refers to areas where the Project Footprint has an indirect influence, and comprises:

- Palma Bay and offshore deepwater in the vicinity of the Golfinho, Prosperidade and Mamba gas fields;

- Palma Town and villages or settlements outside of the Afungi Project Site that are indirectly impacted;

- the islands at the mouth of Palma Bay: Tecomaji, Rongui and Queramimbi, and possibly islands further south along the coast eg Vamizi Island; and

- the broader district, province and potentially the region, which can also be included in the AII from a socio-economic perspective. Similarly, the AII potentially extends to a national level, as the Project may have benefits on a national scale.

40°20'0"E 40°30'0"E 40°40'0"E 40°50'0"E 41°0'0"E

10°30'0"S 10°40'0"S 10°50'0"S 11°0'0"S 11°10'0"S

TANZANIA

Quionga

Assame

Calomba

Quiwia

Cabo Delgado Peninsula

Issa

Palma Bay

Tecomaji Island

Palma

Manguna

Nkalanga

Macala

Quitupo

Afungi Peninsula

Senga

Nkumbi

Maganja

Matapata

Rongui Island

Queramimbi Island

Bawala

Olumbe

Vamizi Island

Metundo Island

bing

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Legend

- Villages / Settlements
- Regional Roads
- Proposed Pipeline Route
- Afungi Project Site
- Area of Direct Influence

MAIN MAP SCALE:

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Kilometers

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Figure 6.3: Areas of Direct Influence

CLIENT:

Anadarko Moçambique Área 1, Lda

eni

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DRAWN: AB	APPROVED: KG	SCALE: 1 : 300 000

DRAWING: Areas of Direct Influence.mxd

REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

Impacto Projectos e Estudos Ambientais

ERM

Projection: UTM Zone 37 S, Datum: WGS84
Source: Bing Maps ©2010 Microsoft Corporation
AMA1, 2012. Inset Map: Esri Data & Maps

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6.5.2 *Study Area versus Survey Area*

Due to the complexity and scale of the Project, the zone of influence (and hence the extent of the area under baseline investigation) varies depending on the receptor or resource under consideration. Specialists have used the following terminology to describe the area under baseline investigation:

- **Study Area**: this term is used when referring to the entire area under baseline investigation where impacts may occur as a result of the Project. Often, this will include areas outside the Afungi Project Site. For example, the Study Area for the landscape and seascape visual study includes a radius of 30km from the centre of the Afungi Project Site, as it is considered that the LNG Facility may be visible at such a distance. The Study Area comprises the ADI and AII.

- **Survey Area**: this term is used when referring to areas where field investigations or surveys by the specialists were undertaken. These areas will differ for each specialist study, but are typically confined to the Afungi Project Site or ADI.

Throughout the baseline chapters, the Study Area or Survey Area under consideration or investigation is defined for each specialist study where applicable.

6.6 *CLIMATE AND METEOROLOGY*

The proposed Project has the potential for the release of certain air emissions during construction and operations. Winds and other climatic criteria are also key factors in the dispersion of atmospheric and sea surface pollutants. Moreover, meteorological and climatic conditions dictate much of the design of offshore facilities, particularly through their role in determining wave height; therefore, the baseline climate environment must be understood. This section describes the historical trends and climatic patterns in the Project Area.

6.6.1 *Seasons*

The climate in the Study Area is strongly influenced by the Intertropical Convergence Zone (ITCZ) (1). In January, the ITCZ is located about 15°S of the equator and the East African coast is under the influence of north-easterly winds (2). In July, the ITCZ is situated at about 15°N, and most of East Africa is under the influence of south-easterly and southerly winds (3). The climate is thus subject to alternating and distinctive wet (November to April) and dry (May to October) seasons.

(1) The ITCZ is an area of low pressure that forms where the north-east trade winds meet the south-east trade winds near the equator. As these winds converge, moist air is forced upward, causing water vapour to condense and cool, resulting in heavy precipitation.
(2) South of the equator, the winds may become more north-westerly due to the effect of the earth's rotation.
(3) These seasonal wind regimes are known as monsoons.

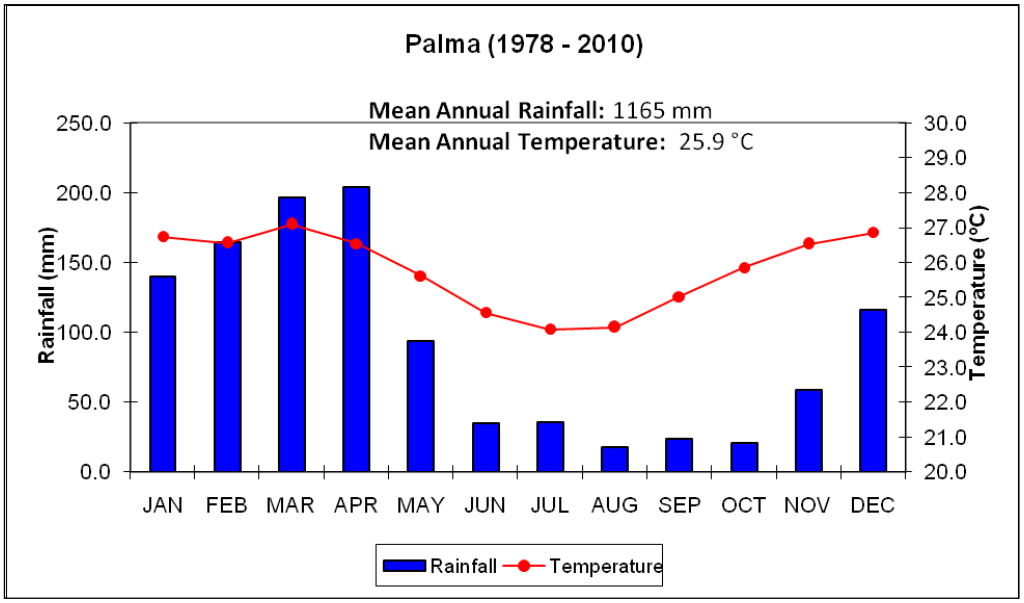
The two distinct seasons apparent in the region are shown in *Figure 6.4*: a distinct warm wet season (November to May) and a cooler drier season (June to October). These climate data were obtained from the National Institute of Meteorology (INAM) in Mozambique, which collected climate data from 1951 to early 2010 in the town of Palma [(1)].

6.6.2 *Rainfall and Temperature*

Mean annual rainfall for Palma town is 1,165mm, with the highest rainfall occurring during the months of March and April (196mm and 204mm respectively). Lowest rainfall occurs during the months of August, September and October (18mm, 24mm and 21mm respectively).

The average annual temperature in Palma is 25.9°C. There is little variation in average monthly temperatures, and these range between 24.1°C in August and 27.1°C in March. Average monthly rainfall and temperatures for the Palma area are shown in *Figure 6.4*.

Figure 6.4 Climate (Temperature and Rainfall) in Study Area



Source: INAM.

6.6.3 *Humidity*

High relative air humidity is typical for the region, with higher relative humidity in the wet season (January to April). The mean annual value of the relative humidity is close to 76 percent, varying between 68 percent and 82 percent. The monthly relative humidity at Palma over the year is shown in *Table 6.1*.

(1) These are the most recent data available from INAM.

Table 6.1 Mean Monthly and Annual Relative Humidity, Palma

	Jan (%)	Feb (%)	Mar (%)	Apr (%)	May (%)	Jun (%)	Jul (%)	Aug (%)	Sep (%)	Oct (%)	Nov (%)	Dec (%)	Annual (%)
Mean	81.1	81.5	81.7	80.1	77.8	75.3	74.1	70.6	68.2	68.9	72.3	78.2	75.8

Source: INAM data for period 1951–2010.

6.6.4 Winds

Onshore

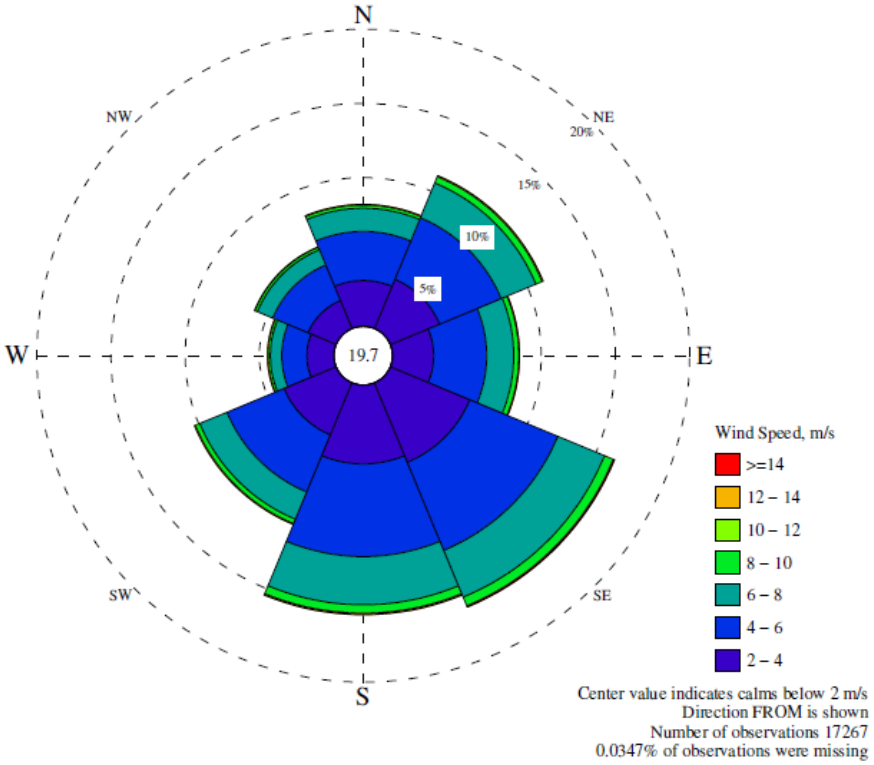
From March to September, wind patterns in Palma are predominantly south-south-easterly, while from October to February, they are predominantly north-easterly. The wind patterns for the area for 1960 to 2009 are illustrated in *Figure 6.5*. The mean annual wind speed recorded for this period is 4.1m/s, as shown in *Table 6.2*.

Table 6.2 Mean Monthly and Annual Wind Speed, Palma

	Jan (m/s)	Feb (m/s)	Mar (m/s)	Apr (m/s)	May (m/s)	Jun (m/s)	Jul (m/s)	Aug (m/s)	Sep (m/s)	Oct (m/s)	Nov (m/s)	Dec (m/s)	Annual (m/s)
Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	3.7	3.3	3.3	3.8	3.9	4.1	4.3	4.5	4.6	4.8	4.6	4.0	4.1
Max	26.7	12.8	9.2	12.2	11.4	12.2	25.3	13.3	11.9	10.3	11.4	16.7	26.7

Source: INAM data for period 1960–2009.

Figure 6.5 ***Wind Rose for Palma***



Source: INAM data for period 1960–2009.

Offshore

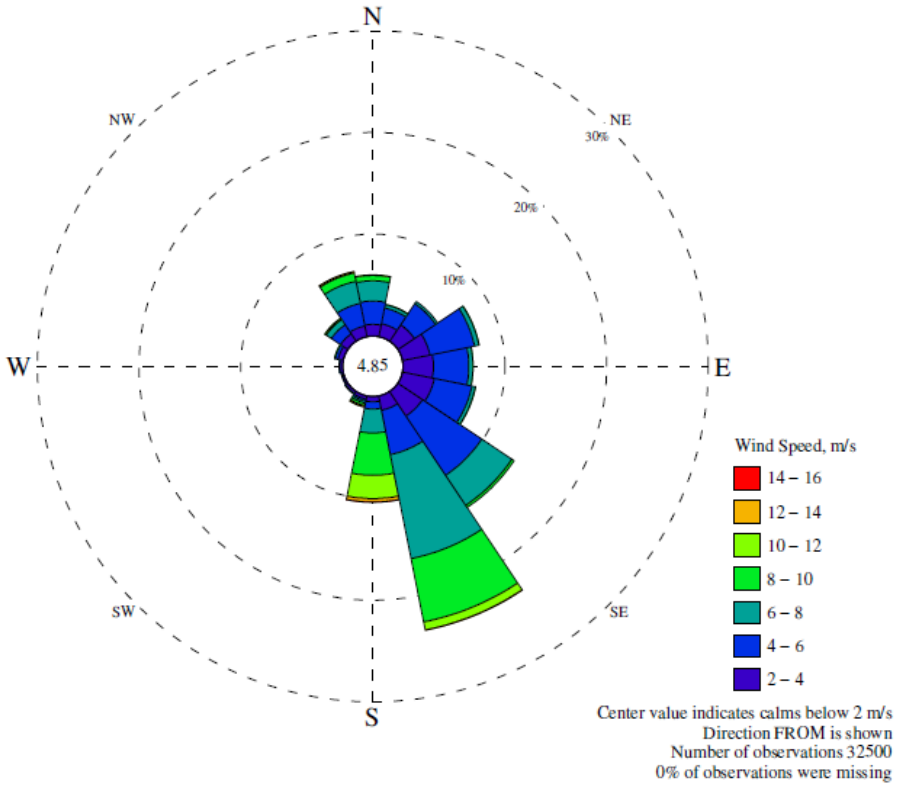
Figure 6.6 shows the annual wind pattern for the location 10.8125°S 40.6250°E, approximately at the south-east entrance to Palma Bay, offshore off Vamizi Island, for the period 1987 to 2009. Three main wind axes are evident: south-south-easterly, north-north-westerly and east-north-easterly. Wind speeds are strongest from the south-south-easterly sector, with winds from east-north-easterly generally being weak. There is a marked monsoon pattern, with southerly winds dominating in the mainly dry season (May to October). Northerly and easterly winds are most common in the warm wet season (November to April). The mean annual wind speed recorded for this period is 5.5m/s, as shown in *Table 6.3*.

Table 6.3 ***Mean Monthly and Annual Wind Speed, at 10.8125°S 40.6250°E***

	Jan (m/s)	Feb (m/s)	Mar (m/s)	Apr (m/s)	May (m/s)	Jun (m/s)	Jul (m/s)	Aug (m/s)	Sep (m/s)	Oct (m/s)	Nov (m/s)	Dec (m/s)	Total (m/s)
Min	0.6	0.7	0.4	0.7	1.0	1.3	1.0	1.1	1.2	1.0	0.8	0.7	0.4
Mean	5.2	4.8	4.0	5.3	6.6	7.0	7.1	6.2	5.2	4.9	4.8	4.9	5.5
Max	12.3	18.4	11.2	12.9	13.0	13.6	14.2	13.0	13.7	13.4	16.6	9.5	18.4

Source: Moffatt & Nichol, 2012. Data from the Tanzania–Mozambique Metocean Study Joint Industry Project, period 1987–2009.

Figure 6.6 Annual Wind Rose for Offshore Mozambique at 10.8125°S 40.6250°E



Source: Moffatt and Nichol, 2012. Data from the Tanzania–Mozambique Metocean Study Joint Industry Project, period 1987–2009.

6.6.5 *Extreme Weather – Cyclones and Tropical Storms*

Historically and statistically, northern Cabo Delgado Province is not a cyclone-prone region. Over the last 50 years, 30 cyclones (1) have struck the Mozambican coast, affecting mainly the central sector of the coastline and bringing torrential rains, flooding and severe wind damage. No cyclones struck the Mozambican coast between 2009 and 2010. However, a few cyclones and tropical depressions struck the country's coast between 2011 and 2012, mostly in southern and central Mozambique. Only one cyclone struck the northern Mozambican coastline (north of Pemba) in the last 50 years; this cyclone made landfall near Mocímboa da Praia in 1959.

The average occurrence of cyclones in the Mozambique Channel is just over three per annum, according to Tinley (1971, cited in ERM and Consultec, 2006). The Project Area has been classified as an area of low risk for tropical cyclones by INAM, as represented in *Figure 6.7*. The main cyclone season is between November and April.

(1) A tropical storm is upgraded to a cyclone (or hurricane) when maximum sustained surface winds reach greater than 33m/s.

In 2008, a moderate tropical storm, named Asma, struck Mocímboa da Praia, 70km south of the Afungi Peninsula. It brought unseasonal heavy rains to the northern area of Mozambique and southern Tanzania, which destroyed up to 94 houses in the town (INAM, 2011).

Mozambique has adopted a cyclone alert or warning system that rapidly provides information and warnings via national, local and naval radio stations in the event of a risk of a cyclone reaching the Mozambique coast. See further details in *Box 6.1*.

Box 6.1 Cyclone Warning System in Mozambique

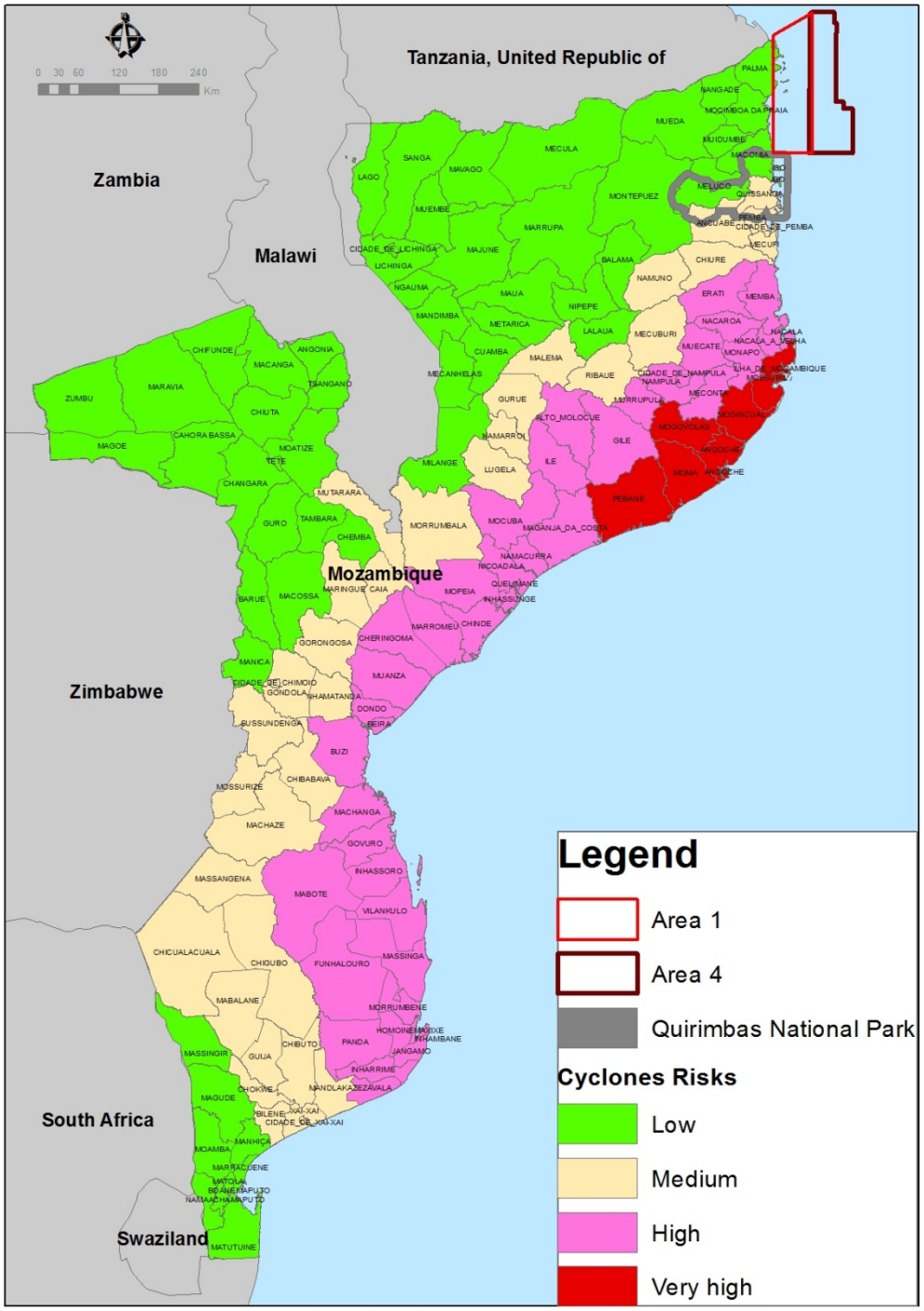
A Cyclone Warning System for Mozambique came into force on 1 November 2002. This system, which was developed by INAM and the National Institute for Disaster Management (INGC) in collaboration with the United States Agency for International Development (USAID) Famine Early Warning System Network (FEWS NET), comprises a cyclone severity category system and a colour alert system.

Categories of cyclone severity range from 1 for a moderate tropical storm to 5 for the most severe tropical cyclones. (Note: Cyclone Atang, which in 2002 made landfall at the border between Mozambique and Tanzania, was classified as a Category 4 cyclone in the Mozambican Channel but was downgraded to a Category 1 storm when it reached the coast. A Category 5 cyclone is rare and has not been recorded in Mozambique).

The colour alerts provide communities with an indication of the time available to prepare for the onset of high winds, as follows:

- **Blue**: a tropical cyclone may affect the area within 24 to 48 hours. High winds are not yet a threat, but communities should start to take precautions. Some ships may leave harbour. Check fishing boat moorings.
- **Yellow**: a tropical cyclone is moving closer and is highly likely to affect communities within 24 hours. Communities are advised to start taking action quickly. Make ships and fishing boats safe. Listen for cyclone advice updates.
- **Red**: high winds are imminent (within six hours) or may already be experienced. In this critical stage, communities are advised to take final safety measures before the onset of high winds. Ensure doors and windows are safely secured, and stay indoors. Roads and bridges may close. Radio will broadcast warning messages around the clock.

Figure 6.7 Frequency of Cyclones per District



Source: INAM.

6.6.6 *Climate Change*

Every five to six years, the Intergovernmental Panel on Climate Change (IPCC) analyses ongoing climate trends and predicts the climate at the end of the century, using a wide variety of models and a predefined set of global GHG emission scenarios. The latest findings are included in the IPCC's Fourth Assessment Report, which was published in 2007. The projections carry a degree of likelihood at a global level. At the scale of the Project Site

and the presumed operational lifetime of the Project, it is far more difficult to establish climate change projections and likely consequences. This notwithstanding, a number of studies indicate that climate changes are occurring in north-eastern Mozambique that may have repercussions for the baseline conditions.

Temperatures in northern Mozambique have increased by 1.1˚C during both summer and winter over the period 1960 to 2005 (INGC, 2009). In addition, the annual mean maximum temperature in the north of the country was rarely above 30˚C prior to 1990, whereas it has been found to have been consistently above 30˚C after 1990. Changes in rainfall patterns in north-eastern Mozambique have been recorded in recent years (Tadross, 2009). Rainfall is projected to increase across the country during December to February and March to May, although this may be largely offset by the increase in evapotranspiration rates as a result of warmer temperatures (INGC, 2009). Recent models indicate that there will likely be a declining trend in the number of cyclones taking place within the Indian Ocean, but that the intensity of cyclone events will likely increase (Emanuel et al., 2008).

Mozambique's low-lying expansive coastline makes it particularly vulnerable to anticipated climate change impacts. The country has a greater proportion of coastline lying lower than 20m above sea level than other East African coastal countries (INGC, 2009) and, as a result, sea level rise is of significant concern. Moffat and Nicol undertook a study of sea level in 2012 rise for Palma Bay and concluded the rise in sea level expected during the lifespan of the Project (ie 30 years) is 4mm/yr, meaning an increase in the sea level of 12cm over the life of the Project (Moffat & Nicol, 2012). However, under the least favourable conditions, the Afungi Project Site may experience sea level rise at a rate of 7mm/yr, generating an increment in the sea level of 21cm.

6.7 AIR QUALITY

A baseline air quality survey has been undertaken at various sampling points within and around the Afungi Project Site, as shown in *Figure 6.8* and outlined in *Table 6.4*. Monitoring of nitrogen dioxide (NO_2) and nitrogen oxides (NO_X) concentrations were taken at each location, over a period of eight months.

Table 6.4 Description of Monitoring Locations

Air Quality Monitoring Station	Description of Sampling Locations
1	The coastal area of Palma – opposite Baza House
2	Maganja – medical clinic
3	Quitupo Village – 500m to west of village, adjacent to road
4	Senga Village – located 50m from dwellings, adjacent to road
5	Senga Village – located north of village
6	Palma – old town
7	Palma – new town adjacent to road frequented by Project vehicles
8	Quiderji Village, adjacent to road
9	Quitunda Village, adjacent to road
10	Between Quitupo and Barabarane villages

The air quality monitoring results indicate that:

- typical baseline NO_2 concentrations are around 1.8µg/m^3, ranging from 3.3 to 4.8µg/m^3 in urban areas of Palma to 0.3 to 0.6µg/m^3 in rural areas; and

- typical baseline NO_x concentrations are around 6.2µg/m^3, ranging from 3.9 to 10.8µg/m^3 in urban areas of Palma to 3.4 to 12µg/m^3 in rural areas.

These results are obtained from a sample period of eight month and are therefore comparable to the annual mean air quality standard. For comparison, the WHO (as cited by IFC) annual mean air quality standards for NO_2 (human health) and NO_x (ecological receptors) are 40µg/m^3 and 30µg/m^3 respectively. The Mozambique national annual mean air quality standard for NO_2 is 10µg/m^3 (see *Chapter 2*). The monitoring results observed illustrate that the baseline concentrations of NO_2 and NO_x are substantially below the WHO and national air quality standards - even in urban areas of Palma, where there are existing sources of emissions. This is as expected, given the absence of major local sources of emissions.

The baseline concentrations of sulphur dioxide (SO_2) are likely to be substantially below the air quality standards throughout the Study Area, as there are no major local sources of emissions. Again, the baseline may be slightly higher in Palma, where concentrations may be somewhat elevated due to the presence of localised emission sources.

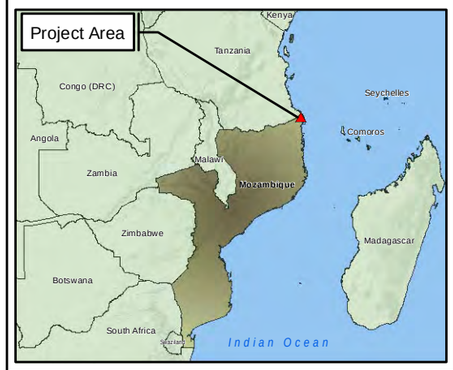
In terms of other pollutants, particulate matter < 10µm (PM_{10}) in the form of dust is of interest from construction activities. No specific baseline monitoring is being undertaken, but it is likely that these pollutants will also be substantially below air quality standards for the majority of the time. Concentrations of PM_{10} may increase during periods of warm, dry weather when natural sources will increase. However, man-made PM_{10} is expected to remain low due to the absence of significant local sources. The baseline conditions of PM_{10} and particulate matter < 2.5µm ($PM_{2.5}$) may be slightly elevated in the Study Area during the dry season (April to November), due to local natural sources (eg dust). Limited short-term elevated levels due to the

burning of crops can also occur and elevate PM_{10} levels. Within Palma, the baseline concentrations may be somewhat elevated due to road traffic (this is, however, very limited).

Although no further information is available on air quality in the offshore environment, it can be safely assumed that the current offshore air quality is acceptable and that all levels are well within Mozambican or international standards such as IFC/World Bank Standards.

Legend

- Air Quality Sampling Points
- Villages / Settlements
- Local Roads
- Afungi Project Site



MAIN MAP SCALE:

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Kilometers

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Figure 6.8:
Air Quality Sampling Points

CLIENT:

Anadarko Moçambique Área 1, Lda
eni

DATE: Oct 2013	CHECKED: KG	PROJECT: 0133576
DRAWN: AB	APPROVED: KG	SCALE: 1 : 53 000

DRAWING: Air Quality Sampling Points.mxd
REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

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ERM

Projection: UTM Zone 37 S, Datum: WGS84
Source: Bing Maps ©2010 Microsoft Corporation.
ERM, 2012. Inset Map: Esri Data & Maps

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6.8 NOISE

6.8.1 Study Area

Representative measurement locations were chosen in the outskirts of a number of settlements within the Afungi Project Site, as well as around Palma and Maganja (*Figure 6.9*), to capture the baseline noise level without being affected by village noise sources such as people, vehicles or the movement of animals. Ambient (background) noise levels were measured at these locations by undertaking long-term measurements during the day and night, and a series of attended short-term measurements during the day over the period 20 to 27 February 2012 at the measurement locations shown in *Figure 6.9,* to capture the existing day and night-time noise baseline. The Study Area for noise receptors is shown in *Figure 6.9*.

Meteorological conditions during the measurement period were observed as predominantly sunny; however, light rain did occur over the period of measurement. An anemometer recorded the average wind speed to be under 5.2km/h during the short-term measurements and recorded an average temperature of 34°C.

6.8.2 Long-term Measurements

Long-term measurements were collected at a total of four locations (see *Figure 6.9*). At each long-term location, a minimum of 24 hours of continuous noise monitoring was conducted to provide a description of the noise levels and to understand the variation between the daytime and night-time periods (see *Annex C*). Location D (NML 1) is situated along the coastline north-east of the Project Site, Maganja (NML 2) to the south-east, Quitupo (NML 3) to the west, with the final location (NML 4) being the road closest to the airstrip, south-west of the Project Site. These four locations were deemed representative of the acoustic environment for the typical rural villages, located in and around the Afungi Project Site.

Long-term Measurement Results

The results of measurements recorded at each of the four long-term noise monitoring locations (NML 1, NML 2, NML 3 and NML 4) are summarised in *Table 6.5* and presented graphically in *Annex C*.

40°25'0"E 40°30'0"E 40°35'0"E 40°40'0"E

10°40'0"S 10°45'0"S 10°50'0"S 10°55'0"S

Quiwia
Cabo Delgado Peninsula
Palma Bay
Tecomaji Island
NSR 3
NSR 5
NSR 6
NSR 2
Palma
NSR 1
NML 1
NML 9
NML 8
NML 10
NML 3
NML 7
NML 5
Quitupo
NSR 7
Afungi Peninsula
Manguna
Nkalanga
Macala
Senga
NML 4
NML 11
NML 6
NML 2
NSR 4
Maganja
Nkumbi
Matapata
Rongui Island
Queramimbi Island
Bawala

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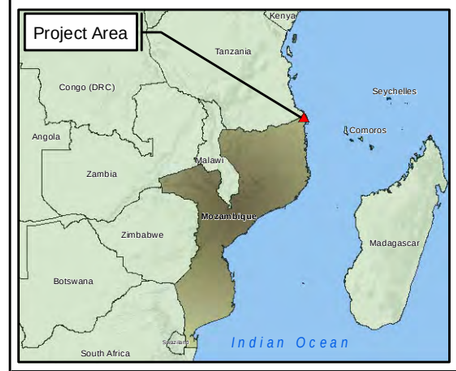
Legend

- Noise Sensitive Receptors
- Noise Monitoring Receptors
- Villages / Settlements
- Local Roads
- Regional Roads
- Afungi Project Site



MAIN MAP SCALE:

0 2 4 6
Kilometers

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Figure 6.9:
Noise Sensitive Receptors and Noise Measurement Locations

CLIENT:

Anadarko Moçambique Área 1, Lda
eni

DATE: Oct 2013	CHECKED: RL	PROJECT: 0133576
DRAWN: AB	APPROVED: KG	SCALE: 1 : 120 000

DRAWING: Noise Monitoring Receptor Locations.mxd
REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

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Projection: UTM Zone 37 S Datum: WGS84
Source: Bing Maps ©2010 Microsoft Corporation.
ERM, 2012. Inset Map: Esri Data & Maps

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Table 6.5 Long-term Unattended Noise Monitoring Results

Measurement Location	Measurement Parameter (dBA)				
Location D NML 1	**LAmax**	**LA10**	**LAeq**	**LA90**	**LAmin**
Daytime	50	41	46	35	32
Night-time	58	44	40	36	33
Maganja NML 2	**LAmax**	**LA10**	**LAeq**	**LA90**	**LAmin**
Daytime	59	43	45	35	31
Night-time	59	40	44	32	30
Quitupo NML 3	**LAmax**	**LA10**	**LAeq**	**LA90**	**LAmin**
Daytime	57	49	55	41	37
Night-time	62	55	59	49	42
The road NML 4	**LAmax**	**LA10**	**LAeq**	**LA90**	**LAmin**
Daytime	59	49	53	42	38
Night-time	55	49	51	43	39

6.8.3 Short-term Attended Measurements

A series of attended short-term (daytime) measurements were undertaken to identify the nature, character and dominant noise sources surrounding and within the Project Site. Short-term measurements had also been undertaken beforehand at each long-term location to verify the long-term measurements. Short-term measurements were recorded at a total of 11 locations.

Short-term Measurement Results

Table 6.6 summarises the daytime ambient noise levels at each of the operator-attended monitoring locations.

Table 6.6 Short-term Operator-attended Noise Monitoring Results

Location ID	Description	Wind speed Ave. (km/h)	LAeq (dBA)	LA90 (dBA)	LAmax (dBA)	Temp (°C)
NML 1	Location D	calm	39	24	60	36
NML 2	Maganja Village	6	38	32	56	34
NML 3	Quitupo Village (between points 3 and 8)	14	48	44	64	35
NML 4	Road closest to airstrip	calm	46	40	58	33
NML 5	Shoreline of beach (near point B)	8	40	31	58	34
NML 6	East of Maganja	14	41	35	59	34
NML 7	Helipad	5	31	23	49	34
NML 8	Location between C and B	calm	38	33	52	36
NML 9	Location C	5	38	34	49	36
NML 10	Near Village 5, 6, 7	calm	34	25	55	31
NML 11	Road to Maganja	5	39	34	51	34

Ambient noise levels at each location were found to vary throughout the day, based on levels of human activity in the villages. The hourly values presented in *Table 6.5* and *Table 6.6* are for periods when human activities and insect noise were less evident.

The L_{Aeq} parameter provides a description of the overall ambient noise level, and the L_{A90} parameter is an indicator of the background noise level or the underlying noise level. Conclusions from the review of the noise survey results (long-term and short-term monitoring) are summarised below.

- For the receptors closer to the ocean (NML 1, NML 2), both ambient L_{Aeq} and background L_{A90} noise levels are relatively steady between daytime and night-time, as there is less influence from human activities. Night-time noise levels are generally lower than daytime.

- Receptors further inland are more influenced by human activities and, in conjunction with insect noise, are likely to be the cause of night-time noise levels being generally higher than daytime for receptors NML 3 and NML 4.

- From observations during short-term operator-attended noise measurements, the dominant sound sources are wildlife activities such as birdsong, frogs, insects and daily human activities. In locations where these sources are not present, or are present to a lesser extent, noise levels tend to be lower. At receptors further afield from the ocean and the Project Site, daytime L_{Aeq} noise levels were observed to approach 30dBA, and L_{A90} noise levels approached 25dBA.

- Maganja and Nsemo are the two closest villages to the Afungi Project Site that are not planned to be resettled. NML 2, 5 and 6 can be used to estimate ambient noise levels at these villages. From *Table 6.5* and *Table 6.6*, it can be seen that existing background (L_{A90}) noise levels at NML 2, 5 and 6 range from 31 to 35dBA, which are lower than the IFC night-time threshold level of 45dBA. This low baseline night-time noise level means that Maganja and Nsemo would be sensitive to increased noise.

6.9 LANDSCAPE AND SEASCAPE CHARACTER AND VISUAL AMENITY

6.9.1 Study Area

The Study Area for the landscape, seascape and visual baseline is defined as a 30km radius area from the centre of the Afungi Project Site. The basis for defining this Study Area is outlined in detail in the methodology developed for the landscape, seascape and visual impact assessment (see *Annex C*). Both landscape and seascape have been considered in the Study Area, as the proposed location for the Onshore LNG Facility is in a coastal location and as a consequence incorporates land, sea and coastline environments, as well as the nearby islands.

The Study Area is shown in *Figure 6.10*. From the coastal settlement of Quionga in the north, approximately 15km from the Tanzanian border, it extends southwards to include the coastal settlement of Palma and further south to Olumbe. The Study Area includes vast areas of remote wooded

landscapes located inland of the coastal settlements. These settlements and various bays overlooking the Indian Ocean are defined by the prominent headlands and peninsulas along the Cabo Delgado coast. The islands to the northern extreme of the Quirimbas Archipelago (ie Rongui, Tecomaji, Vamizi, etc) are located relatively close to Afungi Peninsula and form an important part of the overall seascape in the Study Area. The gas fields in the deep waters offshore in Area 1 and Area 4 and shipping routes to be used by Project vessels (eg LNG Carriers and support vessels) also form part of the Study Area.

One landscape character area (1) and three seascape character units (2) have been identified within the Study Area:

- Wooded Inland Landscape Unit;
- Quionga to Cabo Delgado Seascape Unit;
- Palma Bay Seascape Unit; and
- Afungi Peninsula to Cabo Nondo Seascape Unit.

These are illustrated in *Figure 6.10* and described in the sections that follow.

(1) A landscape area is the land-based element only. It starts at the coastline and extends inland.
(2) A seascape unit is the coastal landscape and adjoining areas of open water, including views from land to sea, from sea to land and along the coastline. Every seascape unit has three components: an area of sea (the seaward component), a length of coastline (the coastline component) and an area of land (the landward component).

40°20'0"E 40°30'0"E 40°40'0"E 40°50'0"E

10°40'0"S 10°50'0"S 11°0'0"S

Quionga D E Cabo Massungo

Quiwia J K C Cabo Delgado

Palma F G H B A

Quitupo

Tecomaji

Afungi Peninsula

Rongui

Qeramimbi

Olumbe M

Cabo Nondo L

Vamizi

Legend

- Afungi Project Site
- 30km Buffer Study Area

Seascape Character Units

- Afungi Peninsula to Cabo Nondo Seascape Unit
- Palma Bay Seascape Unit
- Quionga to Cabo Delgado Seascape Unit

Landscape Character Areas

- Wooded Inland Landscape Unit

Photo Points

A - Undulating Woodland and Scrub Landscape west of Palma

B – Wooded landscape with watercourse catchment near the Afungi Peninsula

C- Coral at Cabo Delgado

D - Estuarine Saltmarsh near Quionga

E- Inland watercourse catchment east of Quionga

F- Palma Bay Seascape Unit

G- Urban Centre of Palma

H- Coastline at north shoreline of Afungi Peninsula

J- Vegetated coastline and beach near Quiwia

K- Wooded Peninsula near Cabo Delgado

L- Vamisi Island (western tip)

M- Coastal landscape and seascape near Olumbe

MAIN MAP SCALE:

0 2 4 6 8 10

Kilometers

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Figure 6.10: Landscape and Seascape Character - Photo Points Locations

CLIENT:

Anadarko Moçambique Área 1, Lda

eni

DATE: Oct 2013	CHECKED: EO	PROJECT: 0133576
DRAWN: AB	APPROVED: KG	SCALE: 1 : 225 000

DRAWING: Landscape and Seascape Character-Photo Points.mxd

REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

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Projection: UTM Zone 37 S, Datum: WGS84
Source: DINAGECA. ERM, 2012.

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6.9.2 *Wooded Inland Landscape Unit*

This landscape character area features two main landscape types, undulating woodland and scrub understorey, and the inland watercourse or river catchment landscape. These are described in turn below.

Undulating Woodland and Scrub with Scattered Farmland

This land cover comprises mainly dense woodland or dry forests with shrub understorey. These wooded areas generally comprise an upper canopy of deciduous species, mainly Caesalpinoideae (eg *Guibourtia schliebenii*, *Hymenaea verrucosa*, *Micklethwaitia carvalhoi*), with sclerophyllous evergreen species in the sub-canopy. Man-made clearings are present within these wooded areas and these feature plantations of cassava and occasionally fruit orchards, which are cultivated by hand. Cash crops such as mango and cashew are found scattered throughout the area. This is a gently undulating landscape and the variation in topography arises from the presence of rivers and watercourses, which usually have an east to west orientation. As a result, ridgelines with an east to west orientation are often located in the vicinity of these catchments.

Existing roads are dirt, typical of the region. The main access route in the area runs in a north to south direction (as shown in *Figure 6.10*) and crosses occasional wooded ridgelines, which generally assume a west to east orientation. This main road connects the larger settlements of the north-east coast of Cabo Delgado, including Quionga in the north and Palma further south. Smaller linear settlements are occasionally found along the main road routes, which present as broad, unsealed dirt tracks. Settlements are generally few in number throughout the landscape character area.

Figure 6.11 Undulating Woodland and Scrub Landscape West of Palma (Marked 'A' in Figure 6.10)

Source: ERM, 2012.

Inland Watercourse Catchment

A number of watercourses, including rivers and streams, flow generally from west to east within the undulating wooded inland character unit. The watercourses are at low elevation and dissect the landscape from west to east,

resulting in an undulating topography. The catchments of these watercourses are often present and visible as low-lying open areas featuring the watercourse itself surrounded by areas of low-lying, damp grassland or wetlands, some of which are cultivated.

Figure 6.12 ***Wooded Landscape with Watercourse Catchment near Afungi Peninsula (Marked 'B' in Figure 6.10)***

Source: ERM, 2012.

6.9.3 Quionga to Cabo Delgado Seascape Character Unit

This seascape character unit extends from Quionga in the north to Cabo Delgado Peninsula in the south, as shown in *Figure 6.10*. The seascape character is defined by three prominent headlands that project out to sea and define the profile of the intervening stretches of coast.

The first of these headlands lies north-east of the settlement of Quionga and represents the mouth of the estuary near this settlement. From this headland, a shoreline with an undulating edge extends south-east to the next main headland, Cabo Massungo. Further south, a C-shaped bay defined by a long sandy beach is located, and this leads to the most southerly headland within this character unit, Cabo Delgado Peninsula. The seaward component of this seascape unit features no islands. The seaward component commands views inland of the variable profile of the coastline, in particular Cabo Delgado Peninsula, as this is a prominent feature in the landscape, projecting further out to sea than any other part of the mainland along this stretch of coastline. The seaward component near Cabo Delgado Peninsula features large stands of carbonaceous rock formed by ancient coral deposits. These are located in the intertidal area during low tide and are tall (up to 8m in height), as shown in *Figure 6.13*. The tidal range is high and during high tide, these formations are mostly covered, and appear much smaller in the seascape.

Figure 6.13 Carbonaceous Rock Formed by Ancient Coral Deposits at Cabo Delgado (Marked 'C' in Figure 6.10)

Source: ERM, 2012.

The coastal and landward components of this seascape character unit are described below, in the context of the main landscape types found therein. These include estuarine salt marsh, inland watercourse catchment and coastline.

Estuarine Salt Marsh

The most northerly part of this seascape character unit features a broad expansive area of estuarine salt marsh, associated with a tributary of the River Rovuma. This tributary follows a sinuous course from the north-west and divides into two tributaries before draining into the sea near Quionga. The division of this watercourse has resulted in the formation of at least two islands in the estuary, which has been naturally shaped by coastal and intertidal water flows. This estuary is large in scale and features abundant mangrove vegetation. The estuarine landscape itself is entirely natural, featuring no signs of man-made influences and, as a result, it is very rural and remote in character.

The settlement of Quionga, which features both colonial and local building styles, overlooks the estuary from a short distance further south. The settlement itself is mostly enclosed within a wooded landscape setting, featuring numerous cashew nut trees. Some clearings are present in which rice and cassava are cultivated.

Figure 6.14 Estuarine Salt Marsh near Quionga (Marked 'D' in Figure 6.10)

Source: ERM, 2012.

Inland Watercourse Catchment

Watercourses flow through the inland part of this seascape unit and are similar to those found within the undulating, wooded, hinterland landscape character area described in *Section 6.9.2*. These are low-lying open areas featuring the watercourse itself and expanses of low-lying grasslands, which are often used for cultivation.

Figure 6.15 Inland Watercourse Catchment East of Quionga (Marked 'E' in Figure 6.10)

Source: ERM, 2012.

Coastline

The coastline extends eastwards from Quionga, featuring beaches until it reaches the headland at Cabo Massungo. Thereafter, the profile of the coast follows a C-shaped pattern, defined again by the beach edge until it reaches Cabo Delgado Peninsula. Inland from the beach, dense wooded vegetation is a common feature. The woodland at Cabo Delgado Peninsula is considered unique and comprises an almost impenetrable thicket of dry forest on raised coral rock.

When looking seaward from the coast, no islands can be seen from within this seascape unit. The promontories associated with Cabo Massungo and Cabo Delgado are strong defining landmarks in the overall seascape. These and the coastline further inland present to the eye as gentle low-lying topography, with little variation in relief.

6.9.4 Palma Bay Seascape Unit

The Palma Bay seascape character unit comprises a large-scale V-shaped bay extending from Cabo Delgado Peninsula in the north to Afungi Peninsula in the south. Cabo Delgado Peninsula comprises large areas of regionally important miombo and coastal coral rag forest, with some pockets of fragmented closed-canopy dry forests. The peninsula's vegetation is dense and largely undisturbed. Further south towards Palma, there are intermittent areas of miombo woodland, fragmented by cultivation and undifferentiated open savannah.

The Afungi Project Site is located on Afungi Peninsula and comprises a mosaic of woodland with understorey thicket of scrub vegetation and open areas of grassland. Clearings are present throughout the area, which features open areas of grassland, albeit with some signs of succession as evidenced by the presence of shrub vegetation. Plots used for subsistence farming are common within the Afungi Project Site. The topography is gently undulating and is defined by the presence of watercourses with an east to west orientation. A locally prominent ridgeline with a north to south orientation is located in the vicinity of the settlement of Palma which, located on this particular ridge, commands views out over the bay.

The relatively large settlement of Quitupo is located in a clearing within the woodland near the centre of the peninsula. The settlement features mostly simple buildings with thatched roofs, which blend visually into the wooded setting. However, much of the land surrounding the village has been cleared for subsistence crop farming.

The most westerly or inland point of the bay is marked by the settlement of Palma, which features a busy fishing harbour. The bay itself comprises a large seascape that is visually limited by the peninsulas to the north and south. The seaward element of this seascape features regular and almost continuous fishing activity. Dhows sail up through the bay from various directions heading for the port at Palma to land the catch of the day. Transportation of people and merchandise by sea frequently occurs along the coast, with the community of Palma and of the fishing centres located in the Palma District travelling to the north and south of the Study Area. The sea is the dominant mode of transport, used for trade and the transportation of merchandise in particular (refer to *Chapter 9*). Other boat-based activities include recreational vessels transporting visitors and tourists associated with the nearby tourism resorts located on the islands for sightseeing, snorkelling, fishing and diving. Visitors to the islands also pass through this seascape.

The islands of Tecomaji and Rongui are located in relatively close proximity, 4km and 5km respectively, to Afungi Peninsula. These islands have a relatively flat topography and are therefore seen from the Indian Ocean and the coast as gentle landmasses of relatively low profile. The islands are densely vegetated, with woodland and shrub understorey. Small tracks cross the island landscapes, but are few in number. Settlements are also few and are generally located on the coast. The north and north-western shoreline of Tecomaji is currently being developed as a tourist destination by 'Tecomaji Lodge', with local-style, eco-like dwellings being built close to the beach. In addition, a luxury lodge is planned for Rongui Island. This will form part of the well-known Maluane Project, a recognised national conservation project (see *Section 6.10.1*).

These islands features coral fringing reefs, some of which are visible in the intertidal zone.

Figure 6.16 Palma Bay Seascape Unit (Marked 'F' in Figure 6.10)

Source: ERM, 2012.

The coastal and landward components of this seascape character unit are described below in the context of the main landscape types found therein. These include the urban area of Palma, coastline, estuarine salt marsh and wooded peninsula landscape types.

Urban Area of Palma

The settlement of Palma itself extends inland from the bay and occupies a high point or ridgeline with a north to south orientation. The coastal area of Palma comprises a series of buildings that date back to former Portuguese occupation. The town centre overlooks Palma Bay, and the northerly promontory of Afungi Peninsula presents as a focal point, together with the vegetation cover along the peninsula.

The streets of the wider urban area of Palma follow a grid pattern and have dirt surfaces. Dwellings and shops – single-storey buildings made of the local building materials of clay and straw, with thatched roofs – line these streets, forming a very low-rise built-up area. By contrast, the colonial architecture in

the town centre, left by the Portuguese, is of a larger scale and is more elaborate in terms of design style and use of materials.

Figure 6.17 Urban Centre of Palma (Marked 'G' in Figure 6.10)

Source: ERM, 2012.

Coastline

Much of the coastline associated with this seascape comprises gently graded sandy beaches featuring linear stands or plantations of coconut trees at the coastal edge. Further inland from the linear coconut plantations, a dense thicket of evergreen woody vegetation is typically present.

The coastal edge and the intertidal areas of Palma Bay feature sandbars, which host mangrove stands. These are often associated with watercourses and estuaries that drain into the sea.

Small scattered settlements are located at or near the coastline, and include the settlement of Quiwia, which overlooks Palma Bay from the north. This settlement is almost camouflaged, with its thatched roofs blending into a backdrop of woody vegetation.

Figure 6.18 Coastline at North Shoreline of Afungi Peninsula (Marked 'H' in Figure 6.10)

Source: ERM, 2012.

Figure 6.19 Vegetated Coastline and Beach near Quiwia (Marked 'J' in Figure 6.10)

Source: ERM, 2012.

Estuarine Salt Marsh

South of the settlement of Palma is an extensive area of estuarine salt marsh, associated with an unnamed river. This watercourse follows a sinuous path and is lined throughout with dense mangrove vegetation. It widens to form

the estuarine salt marsh, featuring abundant mangrove vegetation, at the coastal edge.

Channels associated with minor watercourses drain into the Indian Ocean at various points, forming small estuaries along the coastline. These locations are marked by the presence and visibility of extensive mangrove vegetation at varying stages of maturity.

Wooded Peninsula

The Palma Bay Seascape Unit extents to the eastern tip of Cabo Delgado Peninsula, which is densely vegetated with dry coastal forest as described in *Section 6.9.3*, and features a unique thicket of woody vegetation.

Figure 6.20 Wooded Peninsula near Cabo Delgado (Marked 'K' in Figure 6.10)

Source: ERM, 2012.

At the tip of this wooded peninsula is an abandoned Portuguese settlement, featuring a collection of colonial-style buildings and a lighthouse. Dwellings associated with a more recent local settlement are located nearby. These feature simple mud-built houses with thatched roofs, which effectively camouflage themselves against the backdrop of woody vegetation. The wooded cape overlooks the Indian Ocean, with extensive areas of beach in the foreground featuring large stands of carbonaceous rock, formed by ancient coral deposits and associated vegetation.

6.9.5 Afungi Peninsula to Cabo Nondo Seascape Character Unit

This seascape character unit extends from Afungi Peninsula in the north to Cabo Nondo in the south. The seaward component is defined by a large-scale gently sweeping coastline, which extends from the cape in the north-east to Olumbe in the south-west. The coastline curves gradually in a south-easterly direction towards the headland, Cabo Nondo. The seaward component of this seascape unit incorporates islands, including the southern part of Rongui and Queramimbi.

Vamizi Island is an elongated narrow landmass, the westerly tip of which is visually associated with Cabo Nondo due to its proximity to the mainland, approximately 4km distant. Vamizi Island, like Tecomaji and Rongui islands, is densely vegetated inland. The coastline features mostly sandy beaches, and fringing coral reefs are found in the intertidal and subtidal zones.

Figure 6.21 Vamizi Island (Western Tip) (Marked 'L' in Figure 6.10)

Source: ERM, 2012.

Settlements are few in number and are generally located on the coast. Vamizi Island is an exclusive tourist destination and features luxury tourism accommodation along the shores of the island, designed and built in keeping with the local style of architecture.

The coastal and landward components of this seascape character area are described below in the context of the main landscape types found therein. These include coastline and estuarine salt marsh.

Coastline

The shoreline extending southwards from Afungi Peninsula is largely defined by white sandy beaches. Occasional isolated dwellings and small settlements are located at or near the shoreline. These settlements comprise single-storey dwellings built of clay with thatched roofs, which are often visually camouflaged against the backdrop of evergreen vegetation.

The settlement of Maganja, which has a population of approximately 1,900 inhabitants (see *Chapter 9*), is located on the northern part of this seascape character area, in a clearing within a densely wooded area near the tip of Afungi Peninsula. It is located 700m inland from the beach, separated by an extensive wetland area with intermittent dry palm plantations.

Estuarine Salt Marsh

A striking example of the estuarine salt marsh landscape type is found on the northern limit of this seascape character area, near the settlement of Maganja. It also dominates the outline profile of the tip of Afungi Peninsula, and is also found further south, at the southern end of the Study Area, near the settlement of Olumbe. This large settlement overlooks the estuary associated with the River Nonge – an extensive, densely vegetated watercourse that follows a winding path out towards the beach and estuary in the vicinity of Olumbe.

An intertidal area east of Olumbe features extensive tracts of mangrove vegetation, which extend in finger-like fashion out to sea from the beach at the edge of this coastal settlement.

Figure 6.22 Coastal Landscape and Seascape near Olumbe (Marked 'M' in Figure 6.10)

Source: ERM, 2012.

6.9.6 Visual Receptors in the Baseline Environment

The computer-generated Zone of Theoretical Visibility (ZTV) for the larger elements of the proposed Project are described in detail in the landscape, seascape and visual impact assessment section (*Chapter 12*). The ZTVs extend over a 30km radius from the centre of the Afungi Project Site. This Study Area has been selected to capture likely significant effects, to the coastline, headlands and promontories in particular. It is of lesser relevance to the inland landscape, because this is mostly wooded and the potential for wide-ranging impacts is limited.

A wide variety of visual receptors occur within the Study Area. These receptors will vary considerably in both type and number, depending on the intricacies of the coastline and adjacent islands. They will include local residents, those travelling through the area and those visiting the area for recreational and amenity purposes. Many of these will be onshore receptors, but there is potential for offshore receptors, including those travelling or working on boats and those engaged in recreational sea-based activities, such as diving, sailing or island hopping by boat.

Local residents are judged to have a generally high level of sensitivity to changes that the proposed Project development site will have on the natural views to which they have become accustomed. The ZTVs indicate that residents who live within the coastal settlements of Palma, Quiwia and Maganja are most likely to have views of the proposed LNG Facility.

Those engaged in travel to or through the Study Area, both on land and at sea, are considered to have an average medium to low level of sensitivity to the proposed change, depending upon the purpose and objective of the traveller, on account of the transitory nature of views in any one direction.

Tourist visitors and recreational users comprise a wide variety of individual visual receptor groups, whose principal objective is the enjoyment of the outdoor environment, the open countryside and the tourism/amenity resources offered by the coastline and islands. These visual receptor groups will have slightly different objectives and thus differing levels of sensitivity to any change in the character of the landscape or seascape of the Study Area. The sensitivity of this receptor group is usually considered to be high.

Tourism is recognised as an important element in the local and regional economy of the Study Area, although it currently only comprises 7 percent of the economic activity of the region (see *Chapter 9*). Tourism is dependent upon high-quality coastlines and seascapes as valued recreational resources. People in this receptor group include visitors to the island of Vamizi and eventually Tecomaji (on which tourism accommodation is nearing completion). These visitors will potentially be affected, as users of island beaches for recreation or users of the ocean for water sports (diving, snorkelling and fishing) or boating.

Workers are generally less sensitive to effects, as they are focused on the tasks they are carrying out. Outdoor workers associated with farming, offshore and inshore fishing and shipping are also considered to have a low sensitivity to the proposed changes.

Viewpoint locations for the main areas from which the development may be seen, and the different viewer types and viewing opportunities they offer (residents, passers-by, walkers, etc), are shown in *Figure 6.23*. The viewer types and a description of the existing views are presented in *Table 6.7* below.

40°20'0"E 40°30'0"E 40°40'0"E 40°50'0"E

10°40'0"S 10°50'0"S 11°0'0"S

Quionga
Cabo Massungo
Quiwia
Cabo Delgado
Palma
Tecomaji
Quitupo
Afungi Peninsula
Rongui
Qeramimbi
Olumbe
Cabo Nondo
Vamizi

1 Palma
2
3
4
5
6
7
8
9 Olumbe

Legend

- Afungi Project Site
- 30km Buffer Study Area

Seascape Character Units

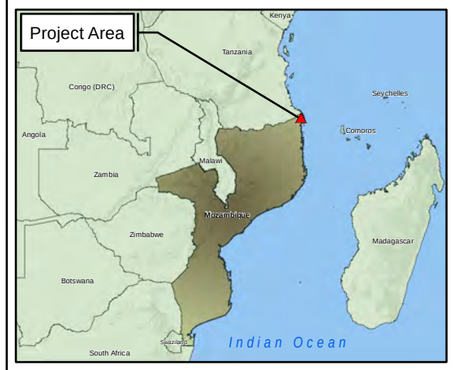
- Afungi Peninsula to Cabo Nondo Seascape Unit
- Palma Bay Seascape Unit
- Quionga to Cabo Delgado Seascape Unit

Landscape Character Areas

- Wooded Inland Landscape Unit

Viewpoints for Visual Impact Assessment

1. Palma
2. Maganja
3. Quiwia
4. Tecomaji
5. Rongui
6. Vamisi west
7. Vamisi east
8. Location at sea within Palma Bay
9. Olumbe



MAIN MAP SCALE:

0 2 4 6 8 10
Kilometers

N

TITLE:

Figure 6.23: View Point Locations

CLIENT:

Anadarko Moçambique Área 1, Lda
eni

DATE: Oct 2013	CHECKED: EO	PROJECT: 0133576
DRAWN: AB	APPROVED: KG	SCALE: 1 : 225 000

DRAWING: View Point Locations.mxd | REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

Impacto Projectos e Estudos Ambientais
ERM

Projection: UTM Zone 37 S, Datum: WGS84
Source: DINAGECA. ERM, 2012
Inset Map: Esri Data & Maps

SIZE: A3

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Table 6.7 Visual Baseline at Selected Viewpoints

Viewpoint No.	Description of Viewpoint	Viewer (Receptor) Type and Number	Description of Existing View
1	Palma Town – location in the town centre	H = residents of Palma (Many)	View from an elevated location over Palma Bay and Afungi Peninsula (including the site for the proposed LNG Facility), which features abundant vegetation. In this view, the most northerly tip presents as a landmark promontory with a sandy beach.
2	Settlement of Maganja	H = residents of Maganja (Moderate)	Wooded vegetation in the foreground, including mature mango trees and an understorey of cashew nut trees.
3	Settlement of Quiwia and adjacent beach	H = residents of Quiwia R = users of the beach (Moderate)	Seascape associated with Palma Bay. Settlement of Palma as a small visible element in the distance to the south-west. Further south, the outline of the island of Tecomaji is visible, though the visibility of this will vary depending on weather conditions. The northern shoreline and most easterly headland of Afungi Peninsula are visible in the far distance. The visibility of Afungi Peninsula, including the site for the proposed LNG Facility, will vary with weather conditions.
4	Tecomaji Island	R = tourist users of the beach (Few)	Views to the north of the seascape are associated with Cabo Delgado Peninsula in the distance, and include the headland, identifiable by the lighthouse. Further west, the coastal settlement of Palma is visible as a relatively small element in the large seascape of Palma Bay. The northern shoreline of Afungi Peninsula (including the site for the proposed LNG Facility) is clearly visible in the distance.
5	Rongui Island	R = tourist users of the beach (Few)	This view sweeps in a north-easterly direction over Palma Bay. The southern part as well as the headland of Afungi Peninsula are visible in the near distance. Tecomaji Island is visible further north and, barely visible in the very far distance, is the shoreline associated with Cabo Delgado Peninsula.
6	Vamizi Island (beach on north-western tip)	R = tourist users of the beach (Few)	The view takes in the expansive seascape south of Afungi Peninsula, including the islands of Rongui and Queramimbi. The southern shore of this peninsula is visible in the far distance, although visibility of this will vary with weather conditions.
7	Vamizi Island (beach on north-eastern tip)	R = tourist users of the beach (Few)	This view is the same as Viewpoint as above. From this particular location, Afungi Peninsula is a little further away from the viewer.

Viewpoint No.	Description of Viewpoint	Viewer (Receptor) Type and Number	Description of Existing View
8	Location at sea within Palma Bay	R = tourists on boats W = working fishermen at sea Locals travelling to and from Palma (Many)	Viewers at this location will command views over the seascape and the C-shaped shoreline of Palma Bay. The settlement of Palma will be visible as a small element in this vast-scale seascape.
9	Settlement of Olumbe	H = residents of Olumbe at or near the beach (Many)	Views are available of the immediate seascape to the north and east. The short-range view in the direction of the site features extensive linear tracts of semi-mature mangrove vegetation. Consequently, these visually screen any views of the seascape further north (including the site for the proposed LNG Facility).

Key: viewer type: H = housing (residential); R = recreational; T = road users; W = workers.
Viewer numbers: residential and recreational: many >50, moderate 15–50, few 0–15; road users and workers: many >1000, moderate >500, few <500.

6.10 NATURE CONSERVATION

Baseline chapters may make reference to the protection status of the species and habitats found, as well as the notable presence of key conservation areas. An introduction to these is presented below.

6.10.1 *Protected Areas*

There are no gazetted protected areas within the ADI. There are, however, a number of designated and proposed conservation areas in the greater region (AII), both terrestrial and marine, which are described below. The location and extent of these are shown in *Figure 6.24*.

Eastern Africa Marine Eco-region

The Study Area lies within the Eastern Africa Marine Eco-region (EAME), which extends from Mozambique to Somalia. It falls within the Mtwara-Quirimbas complex, one of 21 biodiversity hotspots in the eco-region. This marine eco-region is of global importance due to its high biological diversity and because of the way the marine and coastal habitats are linked, both physically and ecologically (EAME, 2004). The Eastern African Marine Eco-region in the Western Indian Ocean is one of about ten marine eco-regions worldwide, for which a special focus towards the preservation of biodiversity is being developed.

TRANSMAP (2007) attempted to assess local and regional biodiversity across areas of the East African Marine Eco-region in the Quirimbas Archipelago from Pemba, Mozambique to Mtwara, Tanzania. Inter-governmental bodies have been working to create transboundary networks of Marine Protected Areas (MPAs) connecting local MPAs in each country for integrated conservation and sustainable development. An assessment of the biological diversity of key habitats (intertidal flats, seagrass, mangroves, coral reefs) and species, in particular fauna, was undertaken. Areas or hotspots identifying specific sites that would justify special protection within both countries were identified. However, the criteria or specifications used to select the different areas proposed by the study were limited to specific ecological features; namely the occurrence, abundance and distribution of species of special concern considered in the study (TRANSMAP, 2007).

38°30'0"E 39°0'0"E 39°30'0"E 40°0'0"E 40°30'0"E 41°0'0"E 41°30'0"E

10°30'0"S
11°0'0"S
11°30'0"S
12°0'0"S
12°30'0"S
13°0'0"S

TANZANIA

Palma
Palma
Nangade
Mocimboa da Praia
Mocimboa da Praia
Mueda
Muidumbe
Macomia
Pangane
Meluco
Montepuez
Quissanga
Ancuabe
Pemba
Pemba

AREA 1
AREA 4

bing
Image courtesy of NASA State of Michigan

Legend

- Towns
- Regional Roads
- Afungi Project Site
- Area 1
- Area 4
- District Boundary
- Quirimbas National Park
- Existing Mnazi Bay-Rovuma Estuary Marine Park
- Proposed Rovuma National Reserve
- Proposed Extension to Mnazi Bay-Rovuma Estuary Marine Park

MAIN MAP SCALE:

0 20 40 60
Kilometers

N

TITLE:

Figure 6.24:
Designated and Proposed Conservation Area

CLIENT:

Anadarko Moçambique Área 1, Lda
eni

DATE: Oct 2013	CHECKED: IE	PROJECT: 0133576
DRAWN: AB	APPROVED: KG	SCALE: 1 : 1 250 000

DRAWING: Designated and Proposed Conservation Area.mxd
REV: A

ERM
Great Westerford Building
240 Main Road
Rondebosch, 7725
Cape Town, SOUTH AFRICA
Tel: +27 21 681 5400
Fax +27 21 686 073

Impacto Projectos e Estudos Ambientais
ERM

Projection: UTM Zone 37 S, Datum: WGS84
Source: Bing Maps ©2010 Microsoft Corporation.
Impacto, 2012. Inset Map: Esri Data & Maps

SIZE: A3

T:\GIS Projects\0133576_Anadarko_Moz_LNG\Mapping\MXD\ESIA\Chapter6\Designated and Proposed Conservation Area.mxd

Quirimbas National Park

The Quirimbas National Park covers a total area of 9,130km^2, of which 1,185km^2 is marine environment. It is located approximately 8km south of the southern boundary of Area 1, and approximately 130km to the south of Afungi Peninsula. The Quirimbas National Park was established in 2002 as an initiative of the 40 villages within the Park and the Government of Mozambique, supported by the Worldwide Fund for Nature (WWF). It comprises the 11 most southern islands of the Quirimbas Archipelago, banks and coral reefs, seagrass and sand/mudflat habitats, coastal forest, mangroves and marine life, including sea turtles and dugongs.

Mnazi Bay–Rovuma Estuary Marine Park

The Mnazi Bay–Rovuma Estuary Marine Park is located approximately 50km to the north of Afungi Peninsula in southern Tanzania. The Park was gazetted in 2000 and is the second marine park in Tanzania formed under the Marine Parks and Reserves Act, 1994. The Marine Park encompasses Mnazi Bay, nearby islands and approximately 21km of the Rovuma River estuary, which forms the border with Mozambique. The Marine Park was established to conserve the rich coastal resources in the bay and estuary including mangroves, seagrass beds, coral reefs, seaweed and marine fauna including turtles, dolphins, seahorses, whales and sharks.

Proposed Rovuma/Palma National Reserve – Transfrontier Conservation Area

MICOA, under the auspices of the Global Environment Facility (GEF)-funded Marine and Coastal Biodiversity Management Project, commissioned a study in 2007 to investigate the possibility of establishing the proposed Rovuma/Palma National Reserve, which would extend to the Mozambique–Tanzania border to link up with the Mnazi Bay–Rovuma Estuary Marine Park and thus create a Transfrontier Conservation Area. The study recommends modifications to the boundaries of the Mnazi Bay–Rovuma Estuary Marine Park to form a contiguous Transfrontier Conservation Area with the proposed Mozambican conservation area. The extent of the existing and proposed boundaries of the Mnazi Bay–Rovuma Estuary Marine Park and the proposed boundaries of the Rovuma/Palma National Reserve are shown in *Figure 6.24*. Since 2007, when the study to investigate the possibility of establishing this proposed national reserve was undertaken, there has been no progress implementing the proposal. It is not clear when, or if, the proposed reserve will be formally declared.

Other Proposed Protected Areas

In 2010, a study was undertaken by Timberlake et al. to assess the extent, botanical composition and conservation importance of coastal dry forests in northern Mozambique. The study proposed a number of new areas to be conserved in Cabo Delgado Province; none of these fall within the proposed Project Site within Afungi Peninsula.

Cabo Delgado Peninsula, located north of Palma Bay, was considered a 'second priority' site requiring conservation, based on the presence of mostly dry coastal thicket on coral rag (a fairly widespread vegetation type along the East African coastline). This vegetation is in particularly good condition and, given its isolated geographical position, is considered easy to conserve. Although this area, and the other areas identified as priority sites, are not officially declared as conservation areas, the report strongly recommends that these coastal forest areas be awarded some form of protection due to their biological importance. The Cabo Delgado Peninsula is not within the Project ADI.

The Maluane Project

Although the northern fringes of the Quirimbas do not fall within the Quirimbas National Park, a concession of 230km^2 around the islands of Vamizi, Rongui and Macaloe receives protection through the private sector-financed Maluane Project. The Project was initiated in 2001 to ensure biodiversity conservation and socio-economic development within the concession area. The initiative was developed as a partnership between the Zoological Society of London (ZSL), local communities and the private sector, and a group of individual investors. It is due to last 50 years. The Maluane Project falls under the authority of the Government of Mozambique.

6.10.2 Threatened Species

A number of species of special concern have been identified in the Afungi Project Site. Some of these are protected by Mozambican Laws and Regulations, including:

- Forestry and Wildlife Regulations (Decree no. 12/2002);
- Recreation and Sport Fishery Regulation (Decree no. 51/1999); and
- Hunting Law no. 7/1978 and Decree no. 117/1978.

Some species present are listed in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. The IUCN has been successful in identifying species most in need of conservation attention and in creating awareness of loss of biodiversity. Based on criteria established by the IUCN, species are categorised according to their global threat status (see *Box 6.2*).

Species of conservation concern, both marine and terrestrial, are addressed in *Chapters 7* and *8* of this baseline volume according to their relevant faunal taxonomic groups, and are not described further in this section. Throughout the baseline and impact assessment chapters of this EIA Report, specialists have made use of IUCN terminology for describing the threat status and importance of various species.

Box 6.2 IUCN Terminology for Threat Status of Species

The IUCN defines evaluation categories of the status of species, according to the IUCN-specific assessment criteria, namely:

- DD = Data deficient (insufficient available information for listing as threatened);
- LC = Least concern (unclassifiable in any other category, widespread or abundant);
- NT = Near-threatened (not currently threatened but might become so in the near future);
- VU = Vulnerable (high risk of extinction in the wild);
- EN = Endangered (very high risk of extinction in the wild);
- CR = Critically endangered (extremely high risk of extinction in the wild);
- EW = Extinct in the wild; and
- EX = Extinct.

For further information on IUCN categories, refer to the IUCN website at http://www.iucnredlist.org/).