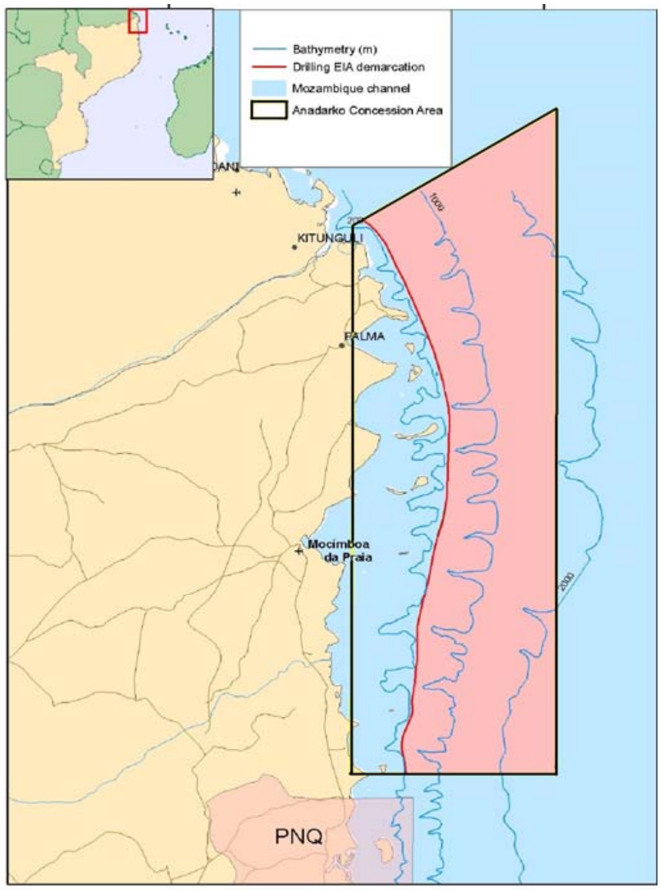
Anadarko
Moçambique Área 1, Lda

DEEPWATER EXPLORATION

DRILLING OPERATIONS IN ROVUMA OFFSHORE AREA 1



VOLUME II

PART A: ENVIRONMENTAL IMPACT STUDY

October, 2008

Impacto
Projectos e Estudos Ambientais

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LIST OF ACRONYMS AND ABBREVIATIONS

2-D	Two-dimensional
3-D	Three-dimensional
ACER	ACER (Africa) Environmental Management Consultants
AMA1	Anadarko Moçambique Área 1, Lda
AO Operators	Accommodation Only Operators
APC	Anadarko Petroleum Corporation
BET	Big Eye Tuna
BID	Background Information Document
BOD	Biochemical Oxygen Demand
BOP	Blowout Preventor
CDBTP	Cabo Delgado Biodiversity and Tourism Project
CDTUR	Cabo Delgado Tourism Association
CE	Critically Endangered
CFM	Mozambique Railways Company (Public Company responsible for the Management of Ports and Railways)
COLREG	IMO Collision Regulations International Convention
CSA	Continental Shelf Associates
CSA	CSA International, Inc.
DMAC	Diving Medical Advisory Committee
DNAC	National Directorate for Conservation Areas
DP	Dynamic Positioning
DWD	Deepwater Drilling
EA	Environment Australia
EBI	Energy and Biodiversity Initiative
EC	European Commission
EEZ	Exclusive Economic Zone
EHS	Environmental, Health, and Safety
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EIS	Environmental Impact Study
EMC	East Madagascar Current
EMP	Environmental Management Plan
EN	Endangered
ENH	Hydrocarbons National Company EP
EPC	Exploration and Production Contract
EPDA	Environmental Pre-Viability Report Scope Definition Study
FAD	Fish Aggregating Device
FBS	Fisheries Baseline Study
FCC	Fisheries Community Council
FCCC	Framework Convention on Climate Change
FPA	Fisheries Partnership Agreement
GDP	Gross Domestic Product

GMDSS	IMO General Maritime Distress Signaling System
GOM	Government of Mozambique
GPS	Geographical Positioning System
HESS	High Energy Seismic Survey
I&APs	Interested and Affected Parties
IDPPE	Small Scale Fisheries Research Institute
IFC	International Finance Corporation
IIP	National Institute for Fisheries Research
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
IMPACTO	Projectos e Estudos de Impacto Ambiental Limitada
INAHINA	National Institute for Hydrography and Navigation
INAM	National Institute of Meteorology
INAMAR	National Maritime Institute
INE	National Institute of Statistics
INGC	National Institute for the Management of Calamities
INMARSAT	International Maritime Satellite System
INP	National Institue of Petroleum
IOTC	Indian Ocean Tuna Commission
IPIECA	International Petroleum Industry Environmental Conservation Association
ITCZ	Intertropical Convergence Zone
ITU	International Telecommunications Union
IUCN	International Union for the Conservation of Nature and Natural Resources
JNCC	U.K. Joint Nature Conservation Committee
L&A Operators	Leisure and Accommodation Operators
LC	Least Concern
LO Operators	Leisure Only Operators
MBREMP	Mnazi Bay-Rovuma Estuary Marine Park
MdP	Ministry of Fisheries
MF	Modulated Frequency
MICOA	Ministry for Coordination of Environmental Affairs Mozambique
MITUR	Tourism Ministry
MMS	U.S. Minerals Management Service
MPFS	Master Plan for the Fisheries Sector
MTC	Ministry of Transport and Communications
NCSD	National Commission for Sustainable Development
NEMP	National Environmental Management Program
NFAC	National Fisheries Administration Commission
NGO	Non-governmental Organization
NMFS	U.S. National Marine Fisheries Service
NO_x	Nitrogen Oxides
NT	Near Threatened
PA	Administrative Post
PATI	Priority Areas Tourism Investment

PNQ	Quirimbas National Park
PPAH	Pollution Prevention and Abatement Handbook
PPANCD	Artisinal Fisheries Project in the Norht of Namupula and Cabo Delgado
PPC	Provincial Co-management Committee
PTS	Permanent Threshold Shift
ROV	Remotely Operated Vehicle
SAMSA	South African Maritime Authority
SAR	Search and Rescue (IMO International Convention on Search & Rescue)
SBM	Synthetic-Based-Muds
SCP	Strategic Communication Plan
SCP	Stakeholder Communications Plan
SEA	Simplified Environmental Assessment
SEC	South Equatorial Current
SEL	Sound exposure level
SIA	Social Impact Assessment
SKJ	Skipjack Tuna
SO_2	Sulphur dioxide
SOLAS	IMO International Convention on Safety of Life at Sea
SOPEP	Shipboard Oil Pollution Emergency Plan
SPL	sound pressure level
SPTDTM	Strategic Plan for the Development of Tourism in Mozambique
StatoilHydro	Norsk Hydro ASA and/or Hydro Oil and Gas Mozambique AS
Ss	Subsurface
TBS	Tourism Baseline Study
TFCA	Transfrontier Conservation Area
TOR	Terms of Reference
TPIS	Tourism Policy and Implementation Strategy
TSW	Tropical Surface Water
TTS	Temporary Threshold Shift
TWT	Two-way traveltime
U.S. EPA	U.S. Environmental Protection Agency
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
VHF	Very High Frequency
VMS	Vessel Monitoring System
VOC	Volatile Organic Compounds
VU	Vulnerable
WBC	Western Boundary Current
WBM	Water-Based-Muds
WHP	[World Ocean Circulation Experiment] Hydrographic Program
WIO	Western Indian Ocean
WOCE	World Ocean Circulation Experiment
WWF	World Wildlife Fund
YFT	Yellow Fin Tuna

1.0 INTRODUCTION

Anadarko Moçambique Área 1, Lda (AMA1) signed an Exploration and Production Concession (EPC) contract with the Government of the Republic of Mozambique for Offshore Area 1 (Area 1) in the Rovuma Basin. The EPC contract gives AMA1 exclusive rights to explore for and produce commercial quantities of hydrocarbons in the block. As part of the agreement AMA1 has committed to undertake 2D and 3D seismic surveys and to drill a minimum of seven wells, with a minimum of four in water depths greater than 200m.

The main objective of the drilling phase is to determine if the identified prospects (arising from the seismic survey[1] initiated in January 2008) have hydrocarbons in commercial quantities. The exploratory drilling is a temporary activity.

This project refers only to the drilling of a minimum of 4 exploratory wells in water depths greater than 200m in Area 1 in the Rovuma Basin. According to the Environmental Impact Assessment Decree (Decree 45/2004) and the EPC, an Environmental Impact Study (EIS) must be prepared for the project.

The Ministry for the Coordination of Environmental Affairs (MICOA) has already classified the project as a Category A project, requiring a full EIS. AMA1 has appointed the Mozambican company, Impacto Lda, to undertake the EIS for the project.

This document represents the EIS report for the deepwater drilling (DWD) operations proposed by AMA1 in the Rovuma Offshore Area 1. The EIS report is part of a larger Environmental Impact Report (EIR), which consists of three volumes:

- Volume I – Non - technical Summary (this document);
- Volume II – Part A: EIS and Part B: Environmental Management Plan (EMP); e
- Volume III – Public Participation Report.

It should be highlighted that no fatal flaws (i.e., irreversible negative impacts that would render the project unfeasible) have been found as a result of the environmental analysis conducted both for the seismic and drilling projects.

It should be noted that once the well locations are known, the relevant addendums shall be produced for each site. The types and quantities of the studies will be determined on a case-by-case basis.

[1] The seismic survey allows for the identification of the most suitable locations for the drilling wells.

1.1 ANADARKO MOÇAMBIQUE AREA 1, LDA

AMA1 is a Mozambique-registered company and a wholly-owned subsidiary of Anadarko Petroleum Corporation (APC). AMA1 is responsible for operating Area 1 on behalf of its partners and the parent company. APC is based in The Woodlands, Texas, U.S.A. With nearly 2.4 billion barrels of oil equivalent (BOE) of proved reserves at year-end 2007, Anadarko Petroleum Corporation is among the largest independent oil and natural gas exploration and production companies in the world. The company's major areas of operation are located onshore in the Rocky Mountain and Texas/Mid-Continent Regions of the United States and the deep water of the Gulf of Mexico. Anadarko also has production and/or exploration in Alaska, Brazil, China, Indonesia, Mozambique and West Africa.

Anadarko is a premier deepwater explorer and producer that has discovered 26 fields and operates eight platforms in the deepwater Gulf of Mexico. The company has also successfully transferred this deepwater skill set to international basins, where it has made three recent deepwater discoveries offshore Ghana and is executing strategic exploration programs offshore Mozambique, Brazil and Southeast Asia.

APC is a member of the International Association of Oil and Gas Producers (OGP) and is committed to promoting a safe, responsible, and profitable performance as a member of the global upstream oil and gas industry. By forming the subsidiary company AMA1, APC has made a long-term commitment to the Government and people of Mozambique to further the exploration and development of the country's potential petroleum resources in an environmentally sound and fiscally responsible manner.

APC is known for its involvement in community projects, both in the U.S.A. and abroad, and believes commercial success is tied to proper management of its relationship with the environment, the well being of its neighbours, and the safety of its people. For that reason, environmental, health, and safety (EHS) considerations, as well as an active concern for local laws and customs, are integrated into every aspect of APC's business.

APC maintains these goals through a strict system of internal management and accountability that begins with senior management personnel and extends down to individual employees and contractors. The EHS management system ensures that APC maintains consistently high EHS standards wherever it operates. The EHS management system defines how the company protects the health and safety of employees, contractors, neighbouring communities, customers, partners, and the environment. It is a set of organized business processes that, when combined with various resources, helps the company achieve its goals and objectives.

The EHS management system is designed to be easily incorporated into APC's four business phases: planning, implementation, auditing and corrective action, and senior management review. Each phase is tied to key project decision points (Figure 1).

This system and the philosophy it represents ensure all APC operations are safe and that the company will be a good neighbour – environmentally and socially – no matter where it does business. More information on APC can be found by visiting its corporate website (www.anadarko.com).

Planning

Exploration and drilling activities begin with extensive site surveys and the preparation of an Environmental and Social Impact Assessment (ESIA), a document that serves as a core resource for operations planning. By providing a clear understanding of local issues and safety and environmental considerations – and potential sensitivities – the ESIA allows Anadarko to adjust plans to meet local expectations, comply with laws and regulations, and mitigate potential impacts.

Part of environmental understanding includes building relationships with neighbouring communities. Anadarko tries to always work in partnership with local people, making sure they understand what to expect from the Company and its contractors, and at the same time, that Anadarko respects their basic human rights and way of life.

Continuous Improvement for next phase or project

Senior Management Review

Finally, as part of the business cycle, Anadarko's senior management annually reviews all environmental, health, and safety activities. This assures that operations are consistent with Company policy and philosophy and that Anadarko is prepared to deal successfully with future challenges.

Because every operating environment is unique and local environmental laws and regulations vary, there can be no absolute rules for handling local issues. That is why Anadarko subscribes to a uniform environmental, health, and safety management system that promotes a sensitivity and watchfulness regarding the physical and social environments where it operates.

Implementation

Out of the ESIA and dialogue with local stakeholders and government agencies comes a detailed Environmental Management Plan (EMP). Used by employees and contractors, this EMP specifies details of operations ranging from the hiring of local suppliers and employees to safety training, oil spill response, waste handling, protection of groundwater, and mitigation measures.

If the sensitivity of the environment or the situation warrants, a project may be monitored. By employing a third-party monitor, the Company invites a closer look at its operations and reconfirms its commitment to the environment, its employees, and the public. This kind of oversight also provides documentation to host governments that permit requirements and Company procedures are being followed.

Auditing and Corrective Action

Once operations are established, permit requirements and the Environmental Management Plan are reviewed to ensure they have been followed and mitigation requirements met.

The process concludes with an assessment: How good was the plan? Was it cost effective? What should be done differently? Partly a critique, this step is also the first stage of continuous improvement and planning for future operations.

Figure 1 Anadarko Petroleum Corporation's Environmental, Health, and Safety management system incorporated into its four project development phases.

1.2 PROPOSED PROJECT

This project refers to the drilling of a minimum of 4 exploratory wells offshore in water depths greater than 200m within Area 1 in the Rovuma Basin (Figure 2).

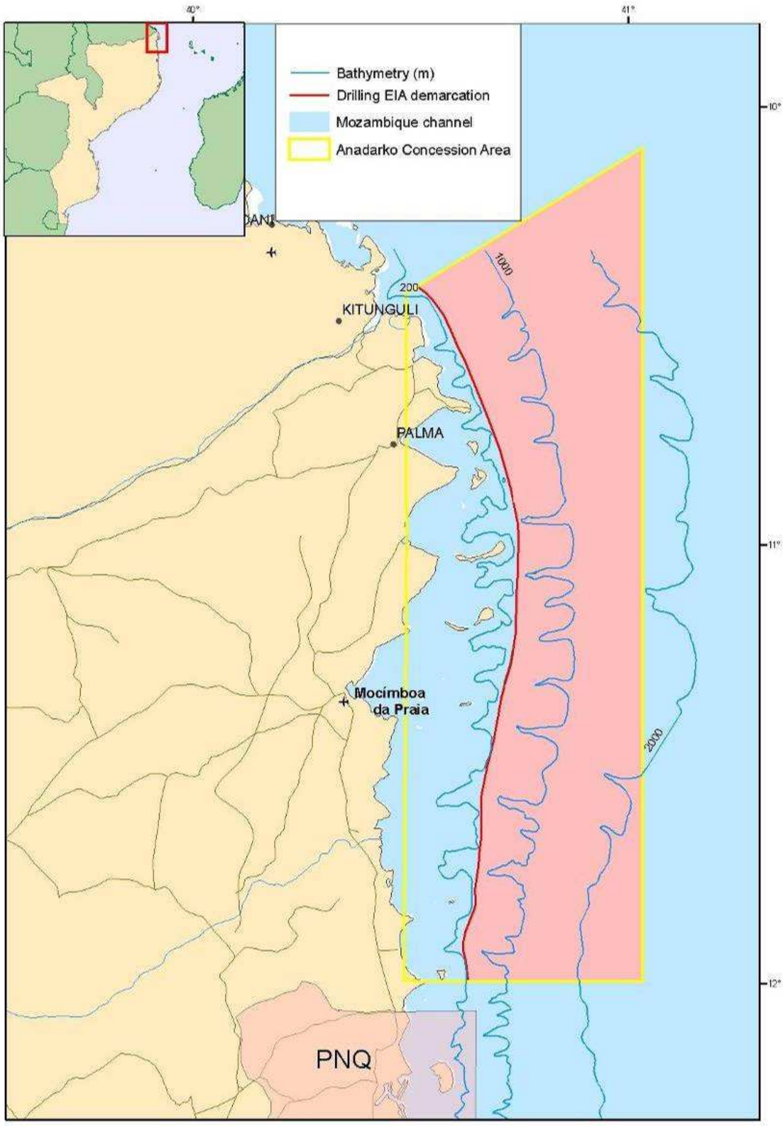

Figure 2. Offshore Drilling Area in the AMA1 Concession Area in the Rovuma Basin

The exploratory drilling is proposed to occur within the limits of Area 1 offshore, in water depths greater than 200m. However, the exact location of the wells will only be determined after the results of the seismic activity are available. The seismic survey was completed in May 2008 and the results are expected by the 4Q of 2008.

The drilling operation is a short-term activity. A drilling rig will be brought from international waters to Area 1 and will be responsible for the well drilling. Each well will take up to 2 months to drill. After drilling operations are complete, a Remote-control Operated Vehicle (ROV) will be used to see whether the site is left in a safe and environmentally sound manner during decommissioning, i.e. guarantee that no unnecessary infrastructure or debris from the activity is left on site.

The operations will be coordinated from the AMA1 office in Pemba and most vessel supplies/support services will commence from and terminate at Pemba Port. Wastes from the drilling rig shall also be transferred (where necessary) to shore via Pemba Port for appropriate disposal.

A detailed program of abandonment and decommissioning shall be developed in line with the applicable Mozambique Petroleum Regulations/Environmental Guidelines and issued based on results from drilling and evaluation.

1.3 PURPOSE OF THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The purpose of the EIA is to evaluate potential impacts to the physical, biological and social environments of northern Cabo Delgado province in Mozambique, resulting from the proposed deepwater drilling operations.

In Mozambique, the EIA process is a legal requirement under the Environmental Law 20/97 and it is defined and governed by the Regulation on the Environmental Impact Assessment Process (Decree No. 45/2004) and the General Directive for Environmental Impact Studies (Ministerial Diploma nº 129/2006). Under these regulations, MICOA has classified the proposed drilling operations as a Category A activity, which is subject to the EIA process.

1.4 TERMS OF REFERENCE

As indicated above, the proposed drilling operations have been classified as a Category A activity, which is subject to the EIA process. Critical factors in the Category A activity classification related to this project include the following:

- The activity will take place close to or possibly in a sensitive ecosystem (in this case, the Quirimbas Archipelago). The project area lies in the East African Marine Ecoregion, as defined by the World Wildlife Fund (WWF). The Quirimbas Archipelago stretches a distance of approximately 400 km from the Tanzanian border at the mouth of the Rovuma River southward to Pemba, the capital of Cabo Delgado Province. The Archipelago comprises 32 islands, banks, and reefs. Inshore of these islands is a rich complex of mangroves, patch reefs, seagrass, and sand/mud flat habitats.
- The activity may cause potential impacts to local communities (especially artisanal fisheries) and tourism; and
- The activity is related to petroleum exploration. Specific regulations in Decree No. 45/2004 for petroleum-related operations require the identification, assessment, and mitigation of potential environmental impacts from exploration activities associated with petroleum operations.

In accordance with Decree No. 45/2004, the project was approved by MICOA on 18 January 2008. Later, a Pre-Viability Report Scope Definition Study and Terms of

Reference (EPDA and TOR) were submitted to MICOA on 6 May 2008 and approved on 2 July 2008. Appendix 1 contains the TOR and Appendix 2, the letter of approval of the EPDA and TOR by MICOA.

The EIA process considered the following potential impacts:

- Reduction in air quality due to project emissions and due to a hydrocarbon release or fire/explosion
- Impacts from the discharge of drilling muds and cuttings in the marine environment (including water turbidity, smothering effects, etc)
- Impacts from deck drainage, bilge water and sewage discharge in the the marine environment
- Impacts from solid waste discharge in the marine environment
- Reduction in water quality due to the disposal of produced water
- Effects of pre-drilling assessment on deepwater benthic macrofauna
- Effects of drilling on deepwater benthic macrofauna, including mooring anchors and chains (if applicable)
- Impacts due to the introduction of invasive species in ballast water
- Noise impacts
- Increased vulnerability of fauna attracted to the rig´s lighting/Flare
- Social conflicts due to the presence of foreign workers
- Increased revenue due to the presence of the crew in Pemba and possibly in the islands
- Loss of access to fishing grounds due to the exclusion zone (artisanal and commercial fisheries)
- Temporary catch decrease due to fish displacement (artisanal and commercial fisheries)
- Damage to trawl nets caused by surface structures remaining after well suspension/abandonment
- Reduction in revenue due to a perceived decline in tourist potential (includes discussion about visual impacts, increased air traffic and impacts on recreational offshore sport-fishing activities and whale watching)
- Interference with maritime traffic
- Impacts from hydrocarbon spills

These issues emerged from the stakeholder engagement and the EIA team's assessments.

The present EIS is based primarily upon an extensive review of published literature already available for Area 1. The main reports reviewed were the EIA Report prepared for AMA1 prior to the seismic survey, which was also prepared by Impacto Lda in a joint venture with CSA International, and the EIA Report for Area 4 prepared for Eni East Africa by Impacto. The relevant specialists studies prepared for each of the above have been updated.

The affected environment for this impact assessment encompasses the following three elements:

- Physical environment – meteorology/climate; air quality, oceanography (wind, currents, waves, and tides); geology, sediments, and water quality;
- Biological environment – macrobenthic communities, inshore habitats (coral reefs, mangroves and seagrass beds), fisheries, marine birds, marine turtles, marine mammals, migration pathways; and
- Socioeconomic environment – artisanal fisheries, commercial fisheries, shipping routes, coastal industries and tourism industry.

Based on the Consultant's knowledge of the area, additional fieldwork was not deemed necessary. However, short visits to the project area were carried out to update the information about the socio-economy, tourism industry and artisanal fisheries.

The information on drilling operations and the general Oil Spill Contingency Plan as well as Oil Trajectories were also reviewed by specialists.

The impact assessment process started with a procedure to identify the activities from the project description detailed in Chapter 3 that could interact with the environment. In parallel to that procedure, an identification focused on the key environmental and social features from the baseline information detailed in Chapter 5 was undertaken, aimed at identifying the key biological, physical and human components of the project area.

The potential positive and negative changes resulting from the defined project activities were then predicted for the study area throughout the entire project lifecycle. These predicted changes (impacts) were then evaluated using a significance ranking process.

For the impact identification of this project, professional judgement and the use of a matrix were the techniques used, whereas the impact evaluation was conducted using internationally accepted criteria (Bojórquez – Tapia, *et al*., 1998) as well as the Decree 45/2004.

A set of relevant Mozambican laws, regulations, policies, conventions and other environmental and petroleum industry related legal documents was prepared based on the Legal Framework prepared for the aforementioned seismic EIA. In addition, international protocols, laws and conventions adhered to by Mozambique have been identified and described. Finally, relevant international drilling operations guidelines and Anadarko's EHS policy were also reviewed.

Two rounds of public consultation meetings took place in Cabo Delgado Province; the first one to present the EPDA and ToR (01 – 03 of April 2008) and the second one to present the Draft EIA (09 – 11 of September 2008). Refer to Section 5.1.2 and Volume III of this report.

According to Decree 45/2004, the EIA Report should contain as a minimum the following information:

- Abbreviations and acronyms
- Non - Technical Summary
- Introduction

- Description of the proposed project
- Description of the implementation area
- Outline of the legislation, regulations and administrative organization
- An analysis of alternatives
- Description of the environmental impacts over the proposed project area and proposal for mitigation measures
- Environmental Management and Monitoring Plan
- List of people /institutions contacted
- Bibliography/References

A Public Consultation Report has been produced as a separate document (Volume III).

1.5 ENVIRONMENTAL CONSULTANTS

AMA1 has selected Projectos e Estudos de Impacto Ambiental Limitada (IMPACTO) to conduct this EIA. IMPACTO has extensive experience in conducting impact assessment studies for oil and gas exploration and development in Mozambique.

The EIA was prepared by a multidisciplinary team which comprised the following specialists:

Lead Consultants

- Mr. António Emílio Leite Couto – Project Manager/Public Consultation and Institutional Specialist
- Ms. Uke Overvest – Team Leader/EIA Specialist

Project Scientists

Emídio André	Fisheries Biologist
Almeida Guissamulo	Coordinator for Biophysical Studies
Horácio Francisco Gervásio	Artisanal Fisheries Specialist
James Wilson	Commercial Fisheries Specialist
Johan Van der Walt	Tourism
António Mubango Hoguane	Oceanographer
Rune Woie	Drilling Operations Specialist
Mike Oberholzer	Oil Spill Specialist
Lucinda Cruz	Legal expert
Carlota Quilambo	Public Consultation Assistant
Naíca Costa	GIS Specialist
Juan Ramon Miguelez	Quality Assurance and Control

1.6 STRUCTURE AND CONTENT OF THIS VOLUME

As indicated above, this report comprises 3 Volumes; namely:

- Volume I – Non - technical Summary (this document);
- Volume II – Part A: EIS and Part B: Environmental Management Plan (EMP); e
- Volume III – Public Participation Report.

This specific volume is comprised of two parts: A – Environmental Impact Study and B – Environmental Management and Monitoring Plan.

Part A – Environmental Impact Study

This volume is organized into the following parts and sections:

Section 1.0 **Introduction** – Explains the purpose of the EIA process, identifies the project, describes AMA1 and its parent company APC, identifies the environmental consulting team, presents the Terms of Reference and summarizes how the EIA is structured and finally, it indicates report availability.

Section 2.0 **Legal and Regulatory Framework** – Describes the legal and regulatory framework for petroleum resource development in Mozambique and other relevant Mozambican environmental legislation and decrees; identifies relevant international conventions; summarizes international health, safety and environmental guidelines for the drilling industry and provides the APC Environmental, Health and Safety Policy.

Section 3.0 **Project Description** – A detailed description of the proposed drilling project, including the survey area, safety zone, survey vessel and equipment to be used, the drilling and testing operations, support operations and summarises the resource use, emissions, discharges and waste. At the end of this section, an Environmental Aspects Register is presented.

Section 4.0 **Alternatives Considered** – It discusses the alternatives considered, including the “no action” alternative, project location and project technologies.

Section 5.0 **Environmental Baseline** – Presents the information gathering methodology and describes the existing biophysical and socioeconomic conditions in the Rovuma Offshore Area 1 concession block. It also discusses existing impacts in the area and presents the key environmental components.

Section 6.0 **Environmental Impact Assessment** – Describes impact criteria and the methodology employed to assess the significance of identified potential impacts and discusses the potential impacts.

Section 7.0 **Mitigation Measures and Residual Impacts –** This section presents mitigation measures to avoid or minimize such impacts and/or enhance the positive impacts and describes and discusses residual impacts, after mitigation, showing their significance rates (before and after mitigation).

Section 8.0 **Conclusions and Recommendations** – Draws conclusions based on the assessment of impacts and recommended mitigation measures.

Section 9.0 **Literature Cited** – Lists the literature that was used to produce the EIA report.

Part B – Environmental Management Plan

Section 1.0 **Introduction** – Describes the purpose and format of the EMP and environmental obligations and policies.

Section 2.0 **Scope of the EMP** – Provides the scope of the EMP.

Section 3.0 **Relevant legislation and standards** – Summarises the relevant national and international legislations and standards.

Section 4.0 **Government entities with responsibilities for environmental management and maritime safety -** Indicates the main entities for inter-institutional liaison and coordination during this project.

Section 5.0 **Basic Principles for the Environmental Management Plan** – indicates the basic principles to be adopted by AMA1 for environmental management.

Section 6.0 **Obligations and Responsibilities in Environmental Management** – presents the main obligations and responsibilities for AMA1, the contractor and additional recommended staff.

Section 7.0 **Monitoring -** proposes a monitoring programme to determine the effectiveness of mitigation measures applied to the exploration drilling activities.

Section 8.0 **Independent Auditors** – refers to MICOA´s responsibility in auditing the activity and the possibility for AMA1 to hire an independent auditor.

Section 9.0 **Implementation of the EMP** – Presents a matrix summarising the environmental impacts, mitigation and monitoring requirements and responsibilities for compliance with the EMP

Section 10.0 **Communication Plan -** This Plan summarizes the communication procedures AMA1 will establish to inform stakeholders on the location and timing of the drilling operations. It also includes the lines of communication in case of an emergency.

Section 11.0 **Emergency Response Plan and Oil Spill Contingency Plan** – Refers to additional measures to be implemented to avoid or minimize the risk of accidents and incidents during the project, as well as response capabilities in the event of a spill. Only framework documents will be submitted as these will be updated once well locations are known.

Section 12.0 **Waste Management Plan** – Refers to the waste management procedures, indicating the different recommeded handling and disposal procedures.

1.7 REPORT AVAILABILITY

Electronic copies of all the documents produced throughout EIA process are available in English and Portuguese and can be downloaded from the AMA1 website (http://www.anadarko.com/mozambique).

For more information about the project, please contact the Public Participation Office as follows:

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Cell (Impacto): +258 82 304 6650
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E-mail: cquilambo@impacto.co.mz

2.0 LEGAL AND REGULATORY FRAMEWORK, COMPANY COMMITMENTS AND INTERNATIONAL STANDARDS

2.1. COMPETENT AUTHORITIES

2.1.1 Ministry for the Coordination of Environmental Affairs (MICOA)

The Ministry for the Coordination of Environmental Affairs (MICOA) is responsible for coordinating all environmental activities at national level in order to promote the management, preservation and rational use of the country's natural resources as well to propose environmental policies and strategies for integration in sectoral development plans. The Ministry is to promote the sustainable development of the country through the steering of the implementation of the country's environmental policy[2].

In order to implement the above mentioned activities, the Ministry for the Coordination of Environmental Affairs presents the following structure:

a) General Inspection;
b) National Directorate of Environmental Management;
c) National Directorate of Land Planning and Organization;
d) National Directorate of Environmental Impact Assessment;
e) National Directorate for Environmental Promotion;
f) National Directorate for Planning and Studies;
g) Directorate of Human Resources;
h) Directorate of Administration and Finances;
i) Department of International Cooperation
j) Judicial Office;
k) Minister's Office.

The Ministry for the Coordination of Environmental Affairs has as its subordinate institutions:

a) Centre for Sustainable Development for Coastal Areas (CDS-ZONAS COSTEIRAS);
b) Centre for Sustainable Development of Urban Areas (CDS-ZONAS URBANAS);
c) Centre for Sustainable Development of Natural Resources (CDS-RECURSOS NATURAIS

The relevant directorates for Environmental Impact Assessment studies are:

1. National Directorate of Environmental Management
2. National Directorate for Environmental Impact Assessment.

The duties of the National Directorate for Environmental Management are:

[2] See Presidential Decree No. 6/95 of 10th November published in the Boletim da República No. 48, 1st Series, Supplement, of 29th November 1995

a) To propose policies, plans and standards for the correct use of the environmental components and environment control quality;
b) To promote global and integrated air, water, soils and other environmental components quality program;
c) To propose the establishment of environmental quality standards and to promote its implementation;
d) To participate in the definition of sustainable development indicators;
e) To promote environmental conservation actions, aiming in particular, to preserve biodiversity, sustainable management of sensitive or protection areas and the rehabilitation of degraded areas;
f) To promote the integrated and sustainable management of urban and coastal areas.

However, the duties of the National Directorate for Environmental Impact Assessment are:

a) To propose adequate legislation to guide the implementation and environmental management of potentially degrading activities for the environment;
b) To conduct environmental licensing of potentially degrading activities for the environment;
c) To conceive and implement pilot-projects for the evaluation of cumulative environmental impacts in the main economic development areas;
d) To manage and coordinate the environmental impact assessment process;
e) To prepare and issue general and specific guidelines on the environmental impact assessment process;
f) To act, in collaboration with public and private entities interested and the civil society for the analysis of environmental studies in the scope of the environmental impact assessment;
g) To promote the monitoring of environmental impacts and environmental audits to ventures that can cause harm to the environment;
h) To approve the specific terms of reference presented by the proponents of the development activities that will serve to guide the environmental impact studies;
i) To register and keep a record of professionals and consulting companies qualified to conduct environmental impact studies and environmental audits;
j) To conduct strategic environmental evaluation, of policies, plans and programs.

It is important to note that the National Directorate for Environmental Impact Assessment, apart from managing and coordinating the Environmental Impact Assessment process, is also responsible for monitoring the environmental impacts as well as environmental audits.

2.1.2 National Petroleum Institute (INP)

The National Petroleum Institute (INP) is the regulatory body for hydrocarbon research, production and transportation activities[3].

[3] The National Petroleum Institute was created by Decree No. 25/2004 of 20th August, published in the Boletim da República No. 33, 1st Series, of 20th August 2004

The National Petroleum Institute is a legal entity governed by public law, with administrative, financial and patrimonial autonomy that performs its competences based on exemption, technical capacity and impartiality.

The INP is based in Maputo, with delegations in the provinces, including one in Cabo Delgado (Pemba).

In the scope of the research activity, the INP has the following competencies:

a) To evaluate and update the knowledge of petroleum potential in the national territory;

b) To develop actions to promote investment in petroleum surveying;

c) To participate in the definition of the contract, minimum work obligations of the title holders of the contracts and concessions.

Without judgment of other powers awarded by law and other applicable standards, the NPI, in the scope of its competences and attributions, must inspect the locations, buildings and facilities where petroleum operations are conducted and must also observe the execution of petroleum operations and inspect all assets, registry and data in the possession of the operator.

The INP has as main bodies:

a) The Board of Directors
b) The Supervisory Board
c) The Governing Board

The Board of Directors will create support and technical consultation bodies or any others, permanent or temporary, needed for the operation of the INP. The mandates of the members of the Board of Directors, including the Chairman are 5 (five) years, renewable.

It is based on these statutes that the INP is responsible for the supervision and monitoring of all aspects of seismic exploration and must ensure that the proponent complies with the proposed Environmental Management Plan (EMP).

2.1.3 National Maritime Institute (INAMAR)

INAMAR – National Maritime Institute is the institution commonly known and designated by Maritime Authority and it is created to replace SAFMAR – National Administration and Maritime Supervision Service (terminated by Decree No. 32/2004 of the Cabinet dated 18th August 2004, in its Article 8) that was created by Decree No. 34/94 dated 1st September and that had been performing the role of Maritime Authority in the Republic of Mozambique.

INAMAR, is a public institution with legal administrative and financial autonomy created by the Government of the Republic of Mozambique through Decree No. 32/2004[4] as the "Maritime Regulatory Authority" (article 1 of Decree No. 32/2004), in

[4] The Decree 32/2004 of 18th August is published in the Boletim da República No. 33, 1st Series, of 18th August 2004

accordance to Article 30 of Law No. 4/96 dated 4th January 1996: Law of the Sea, in its Chapter VII on Maritime Administration.

INAMAR's responsibility is to address maritime safety, protection of ships and port facilities, maritime transportation, agency and stowing, maritime personnel, preservation of marine environment and maritime administration (Article 3 of Decree No. 32/2004 of the Cabinet).

INAMAR's duties (Article 4 of Decree No. 32/2004) are:

a) To exercise maritime authority in the maritime jurisdiction areas, lakes and rivers and on the public maritime domain;

b) To promote the establishment and maintenance of maritime safety conditions for the execution of maritime activities;

c) To promote and encourage efficiency and competition through economic and specific regulation in the interest of the users and service providers.

Among the competences of INAMAR, the following are worth highlighting:

- To apply and ensure the compliance of national legislation on maritime safety and international conventions on maritime issues the country has ratified;
- To supervise compliance with legislation, regulations and safety procedures in maritime infra-structures and to support maritime navigation;
- To certify, supervise and license maritime equipment and material;
- To promote actions to prevent and fight against maritime pollution;
- To participate, in coordination with other relevant authorities, in search and rescue activities;

In the context of hydrocarbon research activities, special attention must be given to paragraphs 2 (Maritime safety), 4 (maritime transportation, agency and stowing), 6 (preservation of the marine environment) and 7 (maritime administration) of Article 3 of the Organic Statute, regarding the specific competences of INAMAR that detail the mandate of INAMAR as a Maritime Authority.

2.1.4 National Hydrography and Navigation Institute (INAHINA)

The National Hydrography and Navigation Institute (INAHINA in Portuguese) has the following competences:

- Responsible for safety of maritime navigation, through emission and dissemination of "Notice to Mariners" for maritime navigation in the waters under the jurisdiction of the Republic of Mozambique (Line (d) of Article 5 of the Organic Statute of INAHINA integrated in Decree No. 27/2004 dated 2nd August, from the Council of Ministers)[5];

[5] *Aviso aos Navegantes* is an Information Newsletter on any changes to safety in navigation in waters under national jurisdiction.

- Responsible for preparation and sale of nautical publications such as charts, navigation routes, lists of lighthouses, tide tables, among others *(Decree No. 27/2004 dated 20th August, from the Council of Ministers)*;

- Responsible for the operation and maintenance of Navigation Aids (Lighthouses, Beacons, Buoys,and other signals) in the waters under the jurisdiction of the Republic of Mozambique *(Decree No. 27/2004 dated 20th August, from the Council of Ministers)*;

2.2 LEGAL FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT IN MOZAMBIQUE

2.2.1 Overall Environmental Management

The key elements for environmental management in Mozambique are the following:

- The National Environmental Management Program;
- The Environmental Law (Law No. 20/97);
- EIA Regulations, including the General Directives for Environmental Impact Assessment (Ministerial Diploma No. 129/2006) and for the Public Participation Process in the Environmental Impact Assessment (Ministerial Diploma No. 130/2006);
- Regulations on Environmental Quality and Effluents Emission Standards (Decree 45/2004);
- Regulations for the Environmental Audit Process (Decree 32/2003).

*Environmental management in the context of the petroleum industry is defined through the Petroleum Law (*Law *No. 3/2001) and the Regulation on Petroleum Operations (Decree 24/2004) as well by the Regulations for the Prevention and Protection of the Marine and Coastal Environment (Decree 45/2006).*

The Law of the Sea (Law No. 4/96) adds a certain level to the protection of marine ecosystems in relation to marine pollution.

The protection of certain marine species is regulated by the Forestry and Wildlife Law (Law No. 10/99) and the Regulations on Recreational and Sport Fishery Decree No. 51/99.

2.2.1.1 National Environmental Management Program (NEMP)

The National Environmental Management Program (NEMP), approved by the Council of Ministers in 1995, seeks to promote and implement sound environmental policy. Although the NEMP was approved on 1995 it still used to guide environmental management strategies and policies in Mozambique.

The NEMP represents the master plan for the environment in Mozambique and contains a National Environment Policy, Framework Environmental Legislation and Environmental Strategy.

The NEMP consists of Sectoral Plans, for the medium and long term, which is intended to lead to sustainable development in Mozambique. Three policy areas are defined as

- rural
- coastal
- urban

In coastal areas, mangrove degradation, coastal and marine pollution and erosion are the main issues to be addressed under the program.

The Ministry for the Coordination of Environmental Affairs (MICOA) has been given the authority to oversee the implementation of the NEMP. To this effect, environmental rules and regulations have been devised. In this regard MICOA is tasked with the responsibility to evaluate policies of other ministries as well as to promote and implement sound environmental policy

The implementation of the NEMP requires a range of actions at all levels and across sectors. In accordance with the NEMP, MICOA, in close co-ordination with other ministries, private and civil groups and works towards the following:

- Development of inter-sectoral policies for sustainable development;
- Development and promotion of integrated resource-use planning;
- Promotion of sector legislation and of establishment of norms and criteria for environmental protection and sustainable use of the countries' natural resources; and
- Creating conditions for law enforcement and environmental monitoring.

2.2.1.2 The Framework Environment Law

The Framework Environmental Law was passed by the Mozambican Parliament in July 1997[6].

This law acknowledges the responsibility of the Government of Mozambique in the promotion and implementation of the National Environmental Management Program.

The aim of this law is to provide a legal framework for the use and correct management of the environment and its components such that it assures sustainable development.

The Environmental Law is applicable to all public or private activities, which may influence the environment either directly or indirectly.[7]

The salient features of the Law include the following:

- With regard to liability, those who pollute, or in any way degrade the environment, are always under obligation to rehabilitate it or to compensate for the resulting damage.[8]

[6] Law No. 20/97, Boletim da República No. 40, 1st Series, 3rd Supplement, of 7th October 1997
[7] Article 3, of the Environmental Law.
[8] Idem, paragraph (g).

- The Law forbids pollution from the production stage up to that of the depositing in the soil, subsoil, water or atmosphere of any polluting substances, or any other form of degradation of the environment, which fall outside the limits stipulated by the law.[9]
- The law also forbids, explicitly, the importation of dangerous residues or dangerous waste, except for that laid down in specific legislation.[10]
- Projects and operations that are likely to have a negative impact on the environment are required to be subject to an Environmental Impact Assessment by independent assessors.

It also forbids all activities that may threaten the conservation, reproduction, quality and quantity of biological resources, especially those in danger of extinction.[11]

Licensing of activities that are liable to cause significant environmental impacts shall be required. The issuance of an environmental license shall be based upon an environmental impact assessment.

In order to protect the environmental components that have a recognized ecological and socio-economic value, environmental protection zones can be created. These protected zones may be national, regional or local and may cover land areas, lakes, rivers, marine waters and other distinctive nature zones.

To ensure the effective co-ordination and integration of sectoral policies and plans related to environmental management at the highest level, a National Commission for Sustainable Development (NCSD), linked to the Council of Ministers, has been created by a provision in the Framework Environmental Law.

2.2.1.3 Environmental Impact Assessment Regulations

According to current Mozambican legislation (Framework Environmental Law No 20/97 and the Environmental Impact Assessment Regulations – Decree No 45/2004 of 29th September 2004 [12]), the granting of an Environmental License is a prerequisite to a range of development activities (defined in the Regulations, Annexes I, II and III). Once the Environmental License has been granted, the Proponent can begin the project implementation.

The EIA Regulations define three project categories (A, B and C) on basis of which the extent of the environmental assessment is determined by MICOA (Figure 3). Maximum periods allocated for report revision/approval by MICOA are indicated in red. Three categories of project are defined by the new Regulations (Article 3):

- Category A: Activities presented in Annex 1 are considered to have significant adverse impacts on the environment and are subject to an EIA;
- Category B: Activities listed in Annex II are those for which potential environmental impacts are less adverse than those of Category A projects and are subject to a Simplified Environmental Assessment (SEA); and

[9] Article 9 of the Environmental Law.
[10] Idem.
[11] Article 12 of the Environmental Law
[12] The Decree N.º 45/2004 of 29th September is published in the Boletim da República No. 39, 1st Series, Supplement, of 29th September 2004

- Category C: Activities listed in Annex III are exempt from an EIA and SEA but still require observance of good management practices.

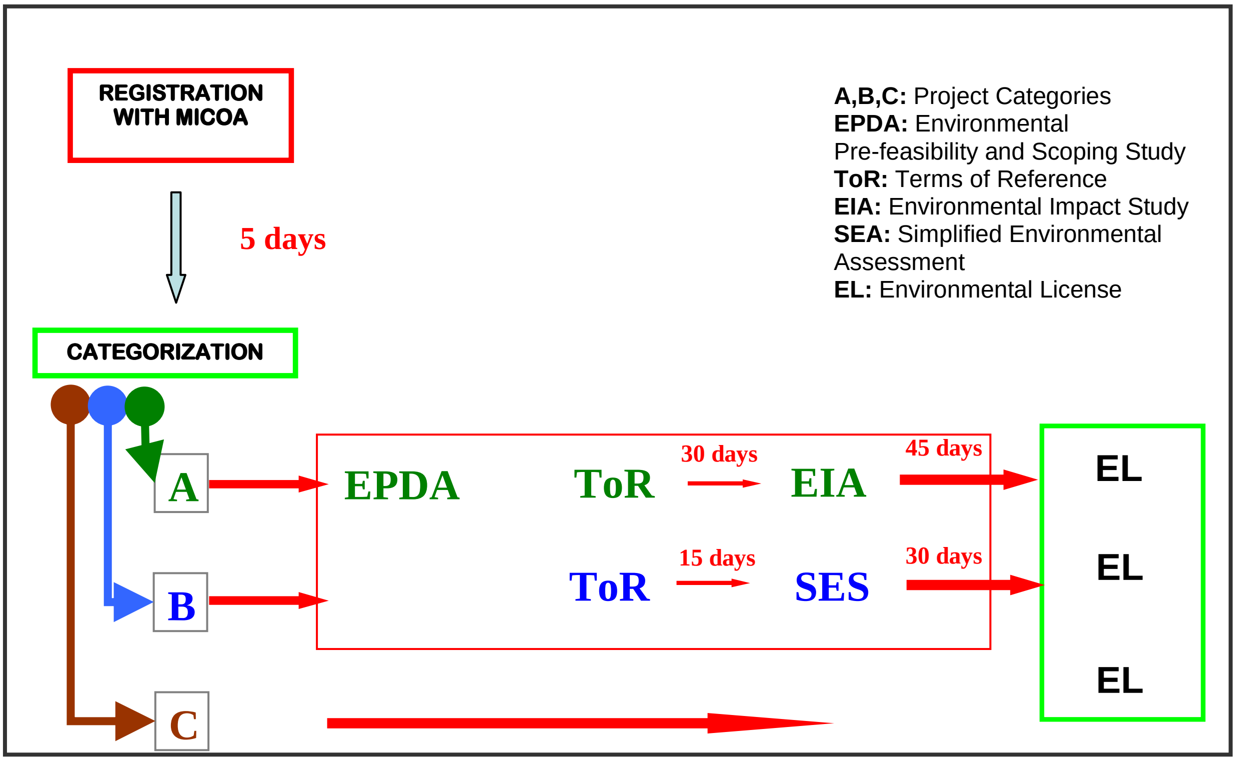


Figure 3 EIA process flow diagram

In accordance with EIA Regulations, there are three distinct steps to carrying out an EIA for a Category A Project:

1. Registering the EIA with MICOA ("Instrução do processo");
2. Preparation of an Environmental Pre-feasibility and Scope Definition Study (EPDA) ("Estudo de Pré-viabilidade Ambiental e Definição de Âmbito") and Terms of Reference for the EIS;
3. The EIS Study, *per se* (including the Impact Assessment and the Public Consultation).

Registration of the EIA

In the first instance the proponent must register the project with MICOA in order for the project to be classified (Category A, B or C).

The documentation for registering the EIA with MICOA is as follows:

- Descriptive Memoir;
- Description of the activity;
- Justification for the Activity;
- Legal framework;

- Summary bio-physical and socio-economic description of the area;
- Resource use in the area;
- Information about the environment in the area of the proposed activity;
- Information about the EIA steps, i.e. production and submission of the Terms of Reference (TOR), EPDA (Environmental Pre-feasibility and Scoping Study (EPDA); and
- Preliminary Environmental Information Form (available at the National Directorate for Environmental Impact Assessment).

Environmental Pre-feasibility and Scoping Study (EPDA) and TOR

Upon confirmation from MICOA that a project is classified as a Category A the proponent must prepare an Environmental Pre-feasibility and Scoping Study Report and prepare TOR for the EIS.

The EPDA Report contains as a minimal the following information:

- Non-technical Summary, including the main issues addressed, as well as conclusions and recommendations;
- Identification and address of the Proponent and the multi-disciplinary team responsible for conducting the EIS;
- The limits of the indirect influence area of the activity and land use patterns in the direct and indirect influence areas;
- Description of the activity and the anticipated actions, as well as the respective alternatives in planning, implementation and operation (or deactivation, in case of temporary activities);
- Biophysical and socio-economic description of the area;
- Identification and evaluation of any potential fatal flaws of the activity;
- Identification and description of the issues to be addressed in detail in the EIS; and
- Detailed Terms of Reference for the EIS in accordance with the EIA Regulations.

Environmental Impact Assessment

Upon approval of the EPDA and TOR for the EIS by MICOA, the proponent may proceed with the EIA, *per se*.

The minimum contents of an EIA Report include the following:

- Abbreviations and acronyms;
- Executive Summary;
- Introduction;
- Description of the proposed project and its social and economic integration;
- Description of the implementation area;
- Outline of the legislation, regulations and administrative organization;
- Approaches and techniques utilized for collection of information and analysis of the impacts;
- Consultation with the stakeholders;
- Description of the environmental impacts over the proposed project area;
- Proposal for mitigation methods;

- List of people/institution contacted; and
- Bibliography/References.

The Ministerial Diploma 129/2006 of 19th July[13] detailed various aspects of the content and procedures of the EIA.

Public Consultation

Public Consultation is an integral part of the EIA process for projects classified as Category A as laid out in Article 14 of the EIA Regulations:

> “Public participation from the phase of the conception of the activity until of the EIA Report is the responsibility of the proponent.”

An invitation for any public meeting shall be made public 15 days before it takes place using the means deemed adequate for its advertisement. All interested or affected parties, directly or indirectly, are entitled to take part in the EIA process. All technical reports produced within the scope of the EIA shall be made available for public consultation.

The final EIR Report submitted to MICOA shall include a Public Consultation Report.

The Guidelines for Public Participation are further defined in the General Directive for the Public Participation Process in the Environmental Impact Assessment Process (Ministerial Diploma No. 130/2006 published in the Boletim da República I Serie – No. 29 of the 19 July 2006).

2.2.1.4 Regulations on Environmental Quality and Effluents Emission Standards

The Decree 18/2004 of 2nd June[14] establishes environmental quality and emission effluents standards in order to ensure an effective control and monitoring of the quality of the environment in terms of the provisions of Article 10 of the 1997 Framework Environmental Law.

The purpose of the Regulation is to establish the standards of environmental quality and of effluents emission, aiming at the control and maintenance of the admissible levels of concentration of pollutants in the environmental components.

Article 3 states that the provisions of this Regulation are applicable to all public and private activities that directly or indirectly may influence on the environmental components.

Jurisdictional responsibility for enforcing the Regulation lies with MICOA (Article 4).

Article 12 (water quality parameters) defines water quality for recreational purposes (swimming, water skiing, and diving):

[13] The Ministerial Diploma 129/2006 published in the Boletim da República No. 29, 1st Series, of the 19th July 2006
[14] The Decree 18/2004 of 2nd June is published in the Boletim da República No. 22, 1st Series, Supplement of the 2nd June 2004

- Null of chlorine, odor, taste and turbidity;
- Total bacteria <1,000/100 ml; and
- Coliforms <100/100 ml.

Article 16 refers to the discharge of industrial liquid pollutants or effluents into the marine environment stating that “the discharge of effluents into the ocean shall obey the standards established in Appendix V of the Regulation.”

2.2.1.5 Regulations for the Environmental Audit Process

This regulation was approved by the Council of Ministers by Decree 32/2003 on the 12th of August 2003[15], with the purpose of establishing parameters to carry out environmental audits.

These regulations apply to all public or private activities, which, during their implementation, may have a direct or indirect impact on the environment.

Article 4 refers to the scope of Environmental Audits:

- The impacts caused by routine activities on the environment;
- The accident risks and contingency plans for the evacuation and protection of workers and the populations in the project’s area of influence;
- Degree of compliance of development activities, with the established parameters, for its implementation, in the process of environmental licensing and its compliance to the regulations and standards in practice;
- The actual or potential levels of pollution or environmental degradation resulting from the implementation of development activities;
- The conditions of operation and maintenance of equipment and systems to control pollution;
- The measures to be taken into consideration to restore the environment and protect public health;
- The capacity building of the people responsible for the operation and maintenance of systems, routines, installations, and equipments to protect the environment and public health;
- The management and conservation of energy sources, raw material, water;
- Re-use, recycling, reduction, transport, and elimination of residues;
- Noise and vibration inside and out of the installations;
- Selection of new methods of production and alteration of existing methods, even of the industrial process and systems of continuous monitoring for the reduction of the pollutants levels; and
- The measures to prevent and limit environmental accidents.

Article 10 refers to the contents of an Environmental Audit Report:

- Introduction and project/activity background;
- The methodology;
- Executive summary, assessment of compliance between the environmental management plan and the findings;
- Assessment of the results based on the recommendations from previous audits;

[15] Decree 32/2003 is published in the Boletim da República No. 34, 1st Series of 20th August 2003

- Description of the identified non-compliances and summary of the audit findings and analysis; and
- Conclusions and recommendations.

It is the responsibility of MICOA to promote Environmental Audits and ensure that audits are carried out for activities requiring auditing. Environmental auditors must be registered with MICOA.

2.2.2 Environmental Management in Relation to the Petroleum Industry

2.2.2.1 Petroleum Law No. 3/2001, of 21st February 2001

This regulation was approved by the Council of Ministers by Decree 32/2003 on the 12th of August 2003[16], with the purpose of establishing parameters to carry out environmental audits.

These regulations apply to all public or private activities, which, during their implementation, may have a direct or indirect impact on the environment.

Article 4 refers to the scope of Environmental Audits:

- The impacts caused by routine activities on the environment;
- The accident risks and contingency plans for the evacuation and protection of workers and the populations in the project's area of influence;
- Degree of compliance of development activities, with the established parameters, for its implementation, in the process of environmental licensing and its compliance to the regulations and standards in practice;
- The actual or potential levels of pollution or environmental degradation resulting from the implementation of development activities;
- The conditions of operation and maintenance of equipment and systems to control pollution;
- The measures to be taken into consideration to restore the environment and protect public health;
- The capacity building of the people responsible for the operation and maintenance of systems, routines, installations, and equipments to protect the environment and public health;
- The management and conservation of energy sources, raw material, water;
- Re-use, recycling, reduction, transport, and elimination of residues;
- Noise and vibration inside and out of the installations;
- Selection of new methods of production and alteration of existing methods, even of the industrial process and systems of continuous monitoring for the reduction of the pollutants levels; and
- The measures to prevent and limit environmental accidents.

Article 10 refers to the contents of an Environmental Audit Report:

[16] Decree 32/2003 is published in the Boletim da República No. 34, 1st Series of 20th August 2003

- Introduction and project/activity background;
- The methodology;
- Executive summary, assessment of compliance between the environmental management plan and the findings;
- Assessment of the results based on the recommendations from previous audits;
- Description of the identified non-compliances and summary of the audit findings and analysis; and
- Conclusions and recommendations.

It is the responsibility of MICOA to promote Environmental Audits and ensure that audits are carried out for activities requiring auditing. Environmental auditors must be registered with MICOA.

2.2.2.2 Petroleum Operations Regulation Decree No. 24/2004, of 20 August

The Petroleum Operations Regulations[17] were approved in August 2004 in order to define the types, terms and conditions of contracts, the petroleum operations' practices, including the management of resources, safety, health and environmental protection, as well as the submittal by the holders of rights to conduct petroleum operations of plans, reports, data, samples and other information.

Petroleum Operations are carried on the basis of a concession contract, which may be of survey, exploration and production, or construction and operation of an oil or gas pipeline (Article 3, General Conditions).

In the case a discovery is commercially developed, Article 30 establishes that the Operator must prepare a Development Plan, programming the Development and Production of the corresponding Petroleum Deposits for a period of two years as of the date of the Declaration of Commerciality. The Development Plan must include the Environmental Impact Assessment (j).

Article 75 provides the general requirements for drilling and other well operations:

1. Drilling and well activities shall at all times be carried out in a safe and proper manner, i.e.:
    a) Measures shall be taken to ensure regularity and prevent the interruption of operations;
    b) Operating and maintenance procedures shall take due consideration of relevant equipment specifications such as their pre-determined operating and maintenance limits;
    c) Operational measures shall be taken to prevent fires, explosions, pollution, or any sort of damages;
    d) Well casing shall be conceived and developed so as to render the well under control at all times;
    e) Safety equipment for drilling shall be installed in accordance with the requirements of the planned activities and with these Regulations;

[17] The Petroleum Operations Regulation Decree No. 24/2004 is published in the Boletim da República No. 33, 1st Series, 2nd Supplement, of the 20th of August 2004

f) The ground or seabed shall be examined prior to drilling or prior to the installation or setting up of well facilities so as to ensure that the external environment will not cause damage to existing facilities;

2. The Operator shall:
   a) Establish plans and procedures for drilling and simultaneous operations on wells;
   b) Identify, by means of risk analysis, situations where well control may be lost or other hazardous situations that may occur as a result of simultaneous activities;
   c) Establish the operational limits applicable to drilling and well activities undertaken within the same facility;
   d) In accordance with the established procedures, shut down wells in areas where falling objects are capable of causing damages thereto.
3. Prior to drilling and well activities, the Operator shall:
   a) Develop an Emergency Plan for the cases of a Blow out of oil, gas or water, and that identifies suitable locations for drilling of a relief well;

   b) Develop a plan for the mobilization and organization of personnel in the event of a blowout. This shall also include all the equipment and services which are required for the drilling of the exploratory well and a potential relief well, as well as for the control of an erupting relief well, including possible direct intervention.

Article 77 provides Operation Requirements, including:

a) In accordance with safety and operational criteria, oil based and synthetic oil based drilling fluids shall only be used when such is required;
b) Fluid volumes shall be verified prior to, during and subsequent to the removal of equipment from the well. Procedures shall be established to remove the unintentional influx of fluids from the well, as well as to maintain pressure control in the event of their loss;
c) Formation testing including drilling, hydraulic fracturing, acid treatment or other physical or chemical treatment of the well shall be done according to requirements in these Regulations and with best practices of the Petroleum Industry;
d) Well control equipment shall be periodically tested and examined under pressure so as to verify that its barrier functions;
e) Prior to temporary or permanent plugging of a well is carried out, the zones with flow potential shall be located so as to prevent the eruption of hydrocarbons and other formation fluids.

Article 82 refers to hazardous material management:

a) Transport, storage and use of hazardous material shall take place in a controlled manner and in accordance with national legislation, as well as internationally accepted rules and principles, for which purpose documented rules and procedures of their handling shall be made available;
b) The danger of chemical exposure involving health hazards shall be minimized in the storage, use, handling and disposal of chemicals, as well as in work operations or processes which produce chemical substances. Chemicals hazardous to health shall be classified, labelled and identified in accordance with internationally accepted standards;
c) If chemicals are moved into other containers or appliances, it must be ensured that the contents are labelled and clearly identified so as to allow the identification of their contents by personnel, of which hazards are connected with the use of such chemicals, and of which safety precautions should be

taken. Prior to the use of chemicals hazardous to health, a table of instructions, regarding the applicable safety rules of such substances, shall be available at the work site;

d) Personnel shall wear individual protective equipment against risks which may not be otherwise avoided or limited to an acceptable extent. Use of radioactive substances shall be restricted on a need of use basis.

Article 86 provides general Emergency and Contingency Requirements, which include:

a) The Operator shall be prepared to handle accidents and emergencies which may lead to loss of life, injuries, pollution or major damage to property;
b) The Operator shall take the necessary measures to prevent or minimize harmful effects of accidents and to restore the environment in accordance with a Contingency Plan which shall identify the potential accident events and consequences of such events.

Article 87 refers that the Operator shall submit to the National Petroleum Institute a Contingency Plan for handling accidents and hazardous situations which may occur during Petroleum Operations and provides the contents of such a plan. It also states that the National Petroleum Institute shall be notified prior to the carrying out of emergency exercises and shall receive a report on such emergency exercises.

Article 88 indicates that the National Petroleum Institute may require the installation of emergency equipment such as fire-fighting equipment, oil barriers, vehicles, standby boats or aircrafts near or at the facilities or at major equipments involved in Petroleum Operations and stipulate the operational requirements of each of such equipment under these circumstances.

Article 90 of the Regulations deals specifically with the environment and requires the operators to comply with the following requirements:

- Environmental impact assessments, including impact reduction measures, shall be carried out in all areas which may be affected by Petroleum Operations.
- Registration of all environmental aspects influenced by the Petroleum Operations shall be created and maintained for all phases.
- The Operator shall prevent:
  - Accidents and material damage resultant from its activities and from the facilities' operation;
  - Damage or risk of damage to third parties' personnel and assets;
  - Damage to animals, vegetation, marine life and monuments;
  - Sea pollution and of water fountains discovered in the course of Petroleum Operations;
  - Air pollution; and
  - Damage in petroleum reservoirs.
- The Operator shall monitor and reduce the effect of all operational and accidental discharge, handling of waste and pollution emissions into the air, sea, lakes, rivers, and soil. Operational discharges shall be within the limits defined by the entity with authority over environmental matters.
- The Operator shall inform the National Petroleum Institute of the amount of operational and accidental discharges, leakages and waste and such information shall be made public.

- The Operator shall take remedial measures and repair damage to the environment when the Petroleum Operations are carried out endanger the physical safety of persons or property, or cause pollution or other environmental damage harmful to persons, animals, marine life, monuments or vegetation.
- Preferential treatment shall be given to materials and chemicals least dangerous to health and of greater safety so as to minimize the risk to persons, to the environment and to the facilities. The recycling of materials and chemicals shall be duly taken into account.
- The operator shall take due consideration of the health of personnel, as well as of the qualification and requirements applicable to medical staff. Health related aspects shall include, *inter alia*, the following:
  - Health service;
  - State of readiness in respect of health care and health services;
  - Transport of sick and injured personnel;
  - Hygienic aspects; and
  - Supply of drinkable water, catering and distribution of food supplies.
- A system of safety delegates and a work environment committee for each facility shall be established.

2.2.3 Maritime Protection

2.2.3.1. The Law of the Sea

The Law of the Sea (Law No. 4/96 of 4th January 1996[18]) covers mainly aspects related to maritime traffic, but also refers to activities concerning the conditions of security and the control of the pollution of the marine environment.

The Law applies to:

a) The sea and all waterways and the corresponding bed and subsoil under maritime jurisdiction, in accordance to the terms of the applicable law, as well as the public domain adjacent to those waters;
b) To all vessels and other maritime objects, including cables, pipelines, facilities and maritime structures under Mozambican jurisdiction;
c) To all national vessels, wherever their location;
d) To all entities, personal, individual or collective somehow connected to vessels or with navigation in Mozambique;
e) To all maritime activities taking place within the limits of specific jurisdiction applicable to fishing activities and others.

As regards the area adjacent to territorial sea:

1. The area adjacent to territorial sea is defined as the strip of sea adjacent to territorial sea that extends up to 24 nautical miles as of the baseline.

2. In the area adjacent to territorial sea, the State exercises the necessary control for:

[18] The Law No. 4/96 is published in the Boletim da República No. 1, 1st Series, of the 4th of January 1996

a) Prevent breaching of customs, tax, migration and sanitary laws and regulations for the protection and conservation of the maritime environment, in force in the Mozambican territory;
b) Prevent infractions against laws and regulations referred to in the previous line.

As regards the Exclusive Economic Zone:

The exclusive economic zone of the Republic of Mozambique encompasses the strip of sea adjacent to territorial sea up to 200 nautical miles as of the baseline where the territorial sea is measured.

Article 11 refers to the sovereign rights in the exclusive economic zone. The jurisdiction of the State over the exclusive economic zone will be exercised in accordance to the terms of the present law, as regards:

a) Scientific maritime research;
b) Protection and preservation of the maritime environment.

The regulatory measures (Article 33) include:

a) All issues regarding safety of commercial vessels, investigation of accidents or maritime events in Mozambican jurisdictional waters
b) Control of maritime traffic, as well as pilotage and towing in Mozambican waters;
c) Issues regarding maritime pollution;
d) Issues regarding maritime commerce and industry.

It is also the responsibility of the Government to regulate and administrate all sea use activities within the Mozambican jurisdiction waters, in accordance to international laws, namely:

a) Scientific maritime research;
b) Exploration and use of all natural marine resources, living and otherwise;
c) Protection and preservation of maritime environment;
d) Protection of archaeological objects in the sea;
e) Maritime sports and maritime recreational activities;
f) General management of territorial sea, adjacent area; exclusive economic zone and Mozambican continental platform.

The law defines the constitution of maritime courts whose jurisdiction covers port areas, construction and rehabilitation areas. The constitution of such courts is planned for Maputo, Beira, Quelimane, Nacala, Inhambane and Pemba.

2.2.3.2. Prevention of Pollution and Protection of the Marine and Coastal Environment

Decree 45/2006 of 30 November[19] approved the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment.

The first chapters of this Regulation transpose general provisions included in several Conventions on the subject-matter into the domestic legal order, adjusting them to the Mozambican reality. Among these are the International Convention for the Prevention of Pollution from Ships (MARPOL 1973/1978), the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention) and the International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 – OPRC 90.

As established in its article 1, the objective of this Regulation is to determine the appropriate measures to prevent and limit pollution resulting from illegal discharges carried out by ships, platforms or by land-based sources, off the Mozambican coast as well as the establishment of legal bases for the protection and conservation of the maritime, lacustrine and fluvial public domain areas, of beaches and of fragile ecosystems.

The Regulation applies to all national or foreign natural or legal persons, performing activities susceptible of causing negative impacts on the environment, in maritime, lacustrine and fluvial public domain areas, including all fragile ecosystems bordering the coast and inland waters.
In addition, the Regulation applies to discharges of harmful or dangerous substances by ships, in ports, harbour facilities, emission facilities along the coast, platforms or by other land-based sources, namely:

a) In inland waterways, including ports and wetlands;
b) In the territorial waters of the Mozambican State;
c) In the Mozambique Channel, when used for international navigation subject to the transit passage regime, established in Part III, Section 2, of the Convention of the Law of the Sea, ratified by Resolution 21/96, of 26th November, insofar as the Mozambican State exercises jurisdiction over the Channel;
d) In the exclusive economic zone, established in agreement with international law; and
e) In the international waters.

The regulation also applies to all domestic and foreign ships navigating the jurisdictional waters of the Republic of Mozambique as well as to facilities situated off the Mozambican coast, regarding any discharge or dumping occurred under its terms.
Regarding the classification of harmful or dangerous substances, the Regulation refers to the waste management legislation in force [20].

Heading II of this Regulation deals with ships and platforms.
In the scope of pollution prevention and control systems, the Regulation stipulates that all ports, port facilities, platforms, emission facilities along the coast as well as their support facilites, have the obligation to have adequate facilities or means for the collection and treatment of the various types of waste and for pollution control at their

[19] Decree 45/2006 is published in the *Boletim da República* N.º 48, 1st Series, Supplement of 30th November 2006
[20] Article 3 of the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment

disposal. Their owners must prepare a procedures manual for the management of the various types of waste produced by or deriving from the movement and storage of oil and harmful or dangerous substances. This procedures manual shall be approved by the entity supervising the area of the environment. The owners must also have contigency plans available for fighting oil pollution and pollution by harmful or dangerous substances[21].

Whenever possible,[22] ships have the obligation to dispose of all waste produced onboard while at the port prior to putting to sea. The Regulation also stipulates the obligation to provide a waste record book[23].

In Chapter II (articles 11 to 14), the Regulation deals with issues related to the transport of oil, hydrocarbons and harmful or dangerous substances, stipulating obligatory Record Books and the data that should be entered, and the obligation to inform about their onboard location as well as the data that the packing of harmful or dangerous substances should provide.

Chapter III (articles 15 to 25) deals with aspects related to oil and harmful or dangerous substance discharges, prohibiting their occurrence in waters of national jurisdiction, and defines the exceptions to this prohibition.

Article 20 indicates that the discharge of solid waste from the drilling activities are subject to specific regulations from MICOA in Coordination with INAMAR and the Ministry of Mineral Resources. These regulations have still not been prepared.

Furthermore, in Chapter III the obligation is laid down to communicate incidents occurred in ports, ships, platforms and support facilities liable to cause pollution of waters of national jurisdiction.

Chapter IV (articles 26 to 32) defines the competences of the maritime authority to avoid pollution, among which the possibility to demand that the ship master and/or owner:

a) Carry out transshipment to another ship available or discharge to a specific part of the same ship or to a port depot, within a given time frame;
b) Move the ship under his command to a specific location;
c) Retain the ship at a given location, until a contrary order is given according to the ship's specific conditions and its current position;
d) Abstain from any unloading or transshipment of hydrocarbon or part of it until a contrary order is given by the maritime authority;
e) Carry out operations for sinking or destroying the ship or its load or part of it, in agreement with Government decisions;
f) Follow a given route, in the event that the ship is navigating in territorial waters or in the contiguous zone;
g) Seek to obtain help from one or more vessels adequate to support the maritime authority in the measures that turn out to be necessary;
h) Take other measures in relation to the ship or its load to impede the hydrocarbon discharge or the continuation of this discharge.

[21] Articles 5, 6 and 7 of the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment
[22] Article 8 of the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment
[23] Article 9 of the Regulation for the Prevention of Pollution and Protection of the Marine and Coastal Environment

Regarding facilities' masters, the maritime authority may demand the suspension of the facilities' operation or that the above-mentioned measures are taken.

Chapter V (articles 33 to 42) deals with the investigation of incidents, sanctions and compensation for damages.
In addition to the pecuniary sanctions, the Regulation stipulates other punitive measures, particularly the seizure of the ship and the product's destruction or rendering it unusable.

Heading III (articles 43 a 86) of this Regulation deals with the prevention of marine and coastal pollution by land-based sources.

The Regulation has an Annex, consisting of a reference summary of the 73/78 Marpol Convention Rules with respect to oil and harmful liquid spills.

2.2.4 Protection of Marine Species

A certain level of protection is given to selected marine species by way of two laws: 1) the Forestry and Wildlife Law and Regulations, and 2) the Recreational and Sport Fishery Decree. The Forestry and Wildlife Law and Regulations also provide for the creation of national parks and reserves. Currently, there are no marine protected areas in the AMA concession area although the Quirimbas National Park is located 7.5 km south of southern limit of the drilling area but a small portion of the proposed buffer zone overlaps with AMA1 Concession Area.

Additionally, a very small portion of the Proposed Rovuma National Reserve occur within the AMA1 Concession area. This area of overlap lays beyond the 200m bathymetric line where the proposed wells will be drilled.

2.2.4.1 Forestry and Wildlife Law

The Forestry and Wildlife Law was passed in 1999[24] replacing the out-dated laws promulgated in 1965 (the Forestry Laws) and 1978 (the Wildlife Laws).

Article 6 states that the faunal heritage comprises all wildlife occurring in Mozambique and will be classified on the basis of its rarity and economic and socio-cultural value; these species will be officially listed and protected by law.

Article 10 recognizes three types of protected zones for the conservation of biodiversity and fragile ecosystem:

- National Parks;
- National Reserves; and
- Historical – cultural use zones.

[24] Law No. 10/99 of 7th July published in the Boletim da República No. 27, 1st Series, 4th Supplement, of the 12th July 1999.

National Parks are total protection zones for the protection, conservation and management of vegetation and wildlife as well as the protection of sites of special scientific, cultural or aesthetic interest and for recreation that are representative of the national heritage. National Reserves are for the protection of rare species of fauna and flora, endemics, species threatened with extinction.

The National Directorate for Conservation Areas (DNAC in Portuguese)) under the Ministry of Tourism (MITUR) is responsible for the administration of the conservation areas.

2.2.4.2 The Forestry and Wildlife Regulation

The Forestry and Wildlife Regulation (Decree No. 12/2002[25]) was passed by the Government in June 2002.

Article 43 states that "animals listed in Annex II of the Regulations are considered to be protected under the present Regulation."

The protected marine species listed in Annex II are

- dugongs (*Dugong dugon*)
- marine turtles (all species)
- sea gulls (all species)
- pelicans (all species)

2.2.4.3 The Recreational and Sport Fishery Decree

The Recreational and Sport Fishery Decree No. 51/99[26] provides a list of protected marine species, including marine mammals (dugongs, whales, and dolphins), marine turtles, and five species of fish, two species of bivalves, and two species of gastropods, as shown in **Table 1**.

Table 1 List of protected species included in Annex II of Recreational and Sport Fishery Decree

Common Name	Scientific Name
Fishes	
Brindle bass	*Ephinephelus lanceolatus*
Seventy-four	*Polyleganus undulosus*
Potato bass	*Ephinephelus tukula*
Red steenbras	*Petrus nupestris*
White shark	*Nebrius concolor*
Reptiles	
Marine turtles	All species

[25] The Decree No. 12/2002 is published in the Boletim da República No. 22, 1st Series, 2nd Supplement of 6th June 2002 altered by Decree No. 11/2003 published in the Boletim da República No. 13, 1st Series, of 26th March 2003
[26] The Decree No. 51/99 is published in the Boletim da República No. 34, 1st Series, 4th Supplement, of 31st August 1999

Common Name	Scientific Name
Mammals	
Dugong	*Dugong dugon*
Whales	All species
Dolphins	All species
Bivalves	
Giant clam	*Tridacna gigante*
Scaled clam	*Tridacna squamosa*
Gastropods	
Giant clam	*Cassis cormuta*
Horned helmet	*Charonia tritonis*

2.2.5 National Policies and Strategies

Relevant national policies and strategies include:

- National Strategy and Action Plan for the Conservation of Biodiversity; and
- Tourism Policy and Implementation Strategy.

2.2.5.1 National Strategy and Action Plan for the Conservation of Biodiversity

National Strategy and Action Plan for the Conservation of Biological Diversity for Mozambique formulated by MICOA was passed by the Council of Ministers in August 2003.

The overall goal of the National Strategy and Action Plan for Biodiversity Conservation is to provide guidelines and define priority actions to be implemented by various economic sectors in order to guarantee sustainable development.

The areas for action identified in the Strategy are as follows:

- Identification and analysis of biological diversity components and their relationship within ecosystems, as well as an analysis on the processes and activities that might have an adverse impact on them.

- To determine the conservation status of species in Mozambique and to identify and implement appropriate conservation measures for threatened and endemic species.

- Determine the extent of indigenous cattle breeding species in the country, their conservation status and implement appropriate preservation measures.

- To determine the conservation status of ecosystems and habitats in Mozambique and to identify and implement appropriate conservation measures and ecosystem management with an emphasis on fragile ecosystems.

- To establish and manage a representative system of areas for protection.

- Development and strengthening of *ex-situ* potential for national conservation of the components of biological diversity, with the purpose of supporting and complementing *in-situ* conservation.

- Recuperation and rehabilitation of degraded ecosystems and where applicable, develop management plans for the recovery of species.

- Restrict the introduction and propagation of alien species that cause damage to the indigenous biological diversity and establish mitigation and eradication measures of alien species that might affect the ecosystems, habitats and indigenous species.

- To promote sustainable and integrated use of forestry resources (timber and non timber products), whilst guaranteeing that all parties involved in the exploration have benefits, with an emphasis on the local community.

- To guarantee the sustainable use of agricultural resources with the purpose of improving the quality of life of the Mozambican rural population. To avoid aspects related to the loss of specific and genetic variability of main agricultural crops.

- To guarantee the rational use of wildlife, in order to contribute to the well being of the rural population and the country's development.

- To promote the sustainable use of fishing resources for the benefit of the population and economic prosperity, as well as for the conservation of resources and maintenance of the biological diversity.

- To promote the integrated management of hydrological basins, guaranteeing the minimum amount of flow necessary for the prosperity of the ecosystems adjacent to rivers

- To guarantee that industrial and tourism development occurs in accordance with the sustainable use of biological diversity.

2.2.5.2 Tourism Policy and Implementation Strategy

The objectives of tourism are laid out in Tourism Policy and Implementation Strategy (TPIS) approved by the Resolution No. 14 of the 4th of April 2003[27]. Tourism objectives are established to balance economic interests with socio –cultural and environmental considerations. The overall objectives of the tourism policy are to

- develop and position Mozambique as a world-class destination;
- contribute to employment creation economic growth and poverty alleviation;
- develop sustainable and responsible tourism;
- participate in the conservation and protection of biodiversity;
- preserve cultural values and national pride; and
- enhance the quality of life for all the people of Mozambique.

[27] The Resolution No. 14/2003 is published in the Boletim da República No. 18, 1st Series, of the 4th April 2003

With regards to the environment the main environmental objectives related to the development of tourism, in Mozambique are to

- ensure that tourism and the environment are mutually supportive;
- promote a proactive approach by all tourism stakeholders to develop, market and manage the sector in a responsible and integrated manner;
- prioritize the preservation of the quality and sustainability of biodiversity;
- contribute to the rehabilitation, conservation and protection of eco-systems and natural heritage;
- promote the development of natural resources, especially those that possess an ecological and historical value in a recreational, aesthetic and/or socio-cultural way; and
- make Mozambique a prominent player in responsible environmental practices.

The realization of the objectives defined in the policy leads to the establishment of the priority areas for intervention and action.

The identification of areas with high biological value such as Transfrontier Conservation Areas (TFCAs) are considered as a priority for both tourism development and conservation. The TFCAs identified in the TPIS are shown in Figure 4.

Note: Despite the fact that they are considered a priority in Mozambique, the term Transfrontier Conservation Area has no legal basis in Mozambique. It is used to refer to a large area that contains a core conservation area for where biodiversity protection and where land use and natural uses practices will be compatible with biodiversity conservation.

The Government recognizes the necessity to prioritize areas for development of tourism - Priority Areas for Tourism Investment (PATI).

These areas (PATI’s) represent areas of focus for the Government in terms of investment promotion, prioritization in resources allocation for the development of tourism, human resources infrastructure provision and environmental protection. The approach to tourism development within PATI’s will be in line with international practices with regard to responsible tourism development and the promotion the PATI’s will form the core of the strategy aimed at maximizing the results for tourism development. The location of the PATI’s is shown in Figure 5.

Note: The Priority Area for Tourism Investment (PATI) area is a geographical area that has a high potential for tourism development. It does not imply that other activities are prohibited in the area.

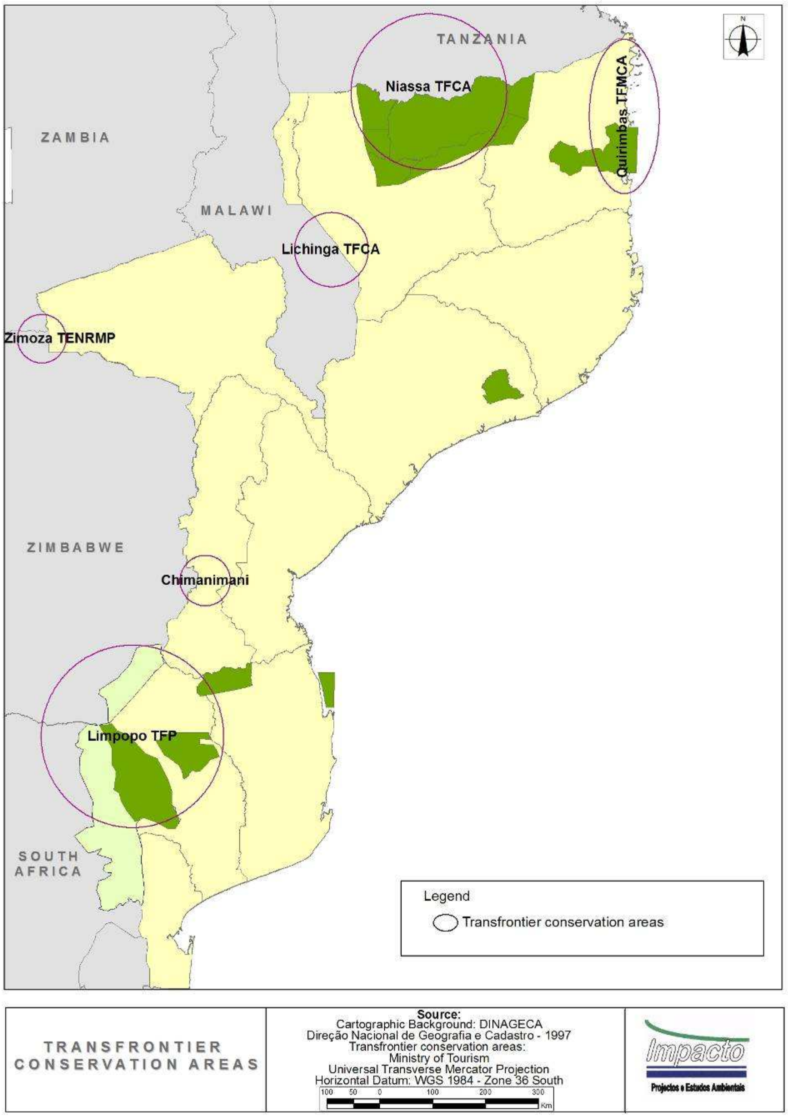


Figure 4 Location of the Transfrontier Conservation Areas in Mozambique

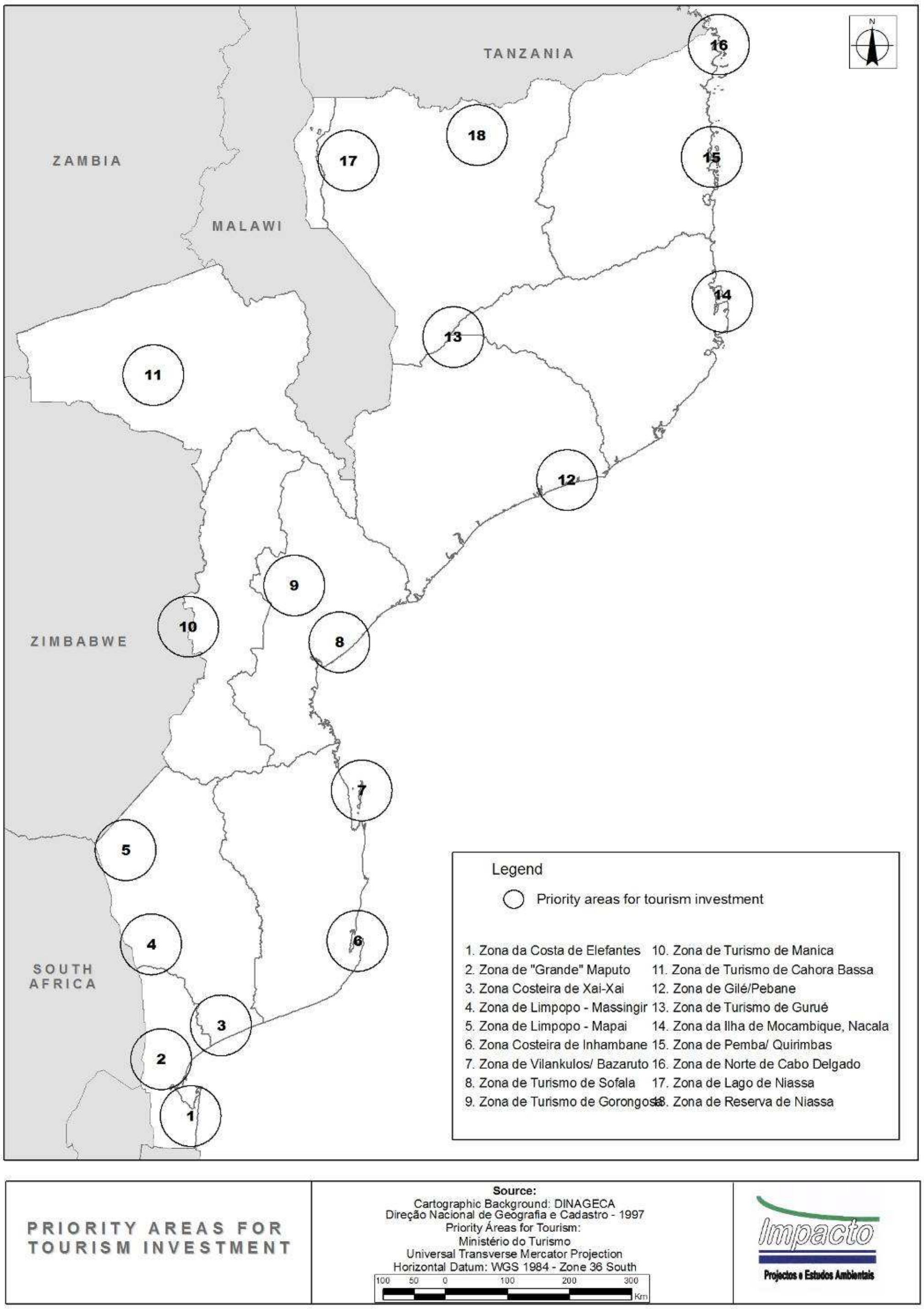


Figure 5 Location of the Priority Areas for Tourism Investment

2.3 INTERNATIONAL FRAMEWORK

The Government of Mozambique (GOM) has signed and ratified several International conventions regarding environmental management.

2.3.1 The Nairobi Convention

The Nairobi convention formally known as the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region was concluded in 1985 in Nairobi.

The Nairobi Convention was adopted on June 21st, 1985, with two Protocols and an Action Plan under the UNEP Regional Seas Program. The Convention is directed towards marine and coastal environmental management from the perspective of the eastern African reality and requirements. Key components of the Nairobi Convention include the following:

Article 5: Pollution from Ships

The Contracting Parties must take all necessary measures to prevent, reduce and fight pollution in the Convention area caused by discharges from vessels and also ensure the effective implementation of internationally established applicable laws and standards.

Article 6: Pollution caused by Dumping of Wastes

The Contracting Parties must take all adequate measures to prevent, reduce and fight pollution in the Convention area caused by the dumping of residues and others into the sea from vessels, planes, or other man-made structures taking the internationally applicable laws and standards and recommended practices and procedures into consideration.

Article 8: Pollution from Activities on the Seabed

The Contracting Parties must take all adequate measures to prevent, reduce and fight pollution in the area of the Convention resulting from, directly or indirectly, the exploration and excavation of the sea bed and its subsoil.

Article 10: Special Protection Areas

The Contracting Parties must, individually or together, take the adequate measures to protect and preserve rare or fragile ecosystems as well as rare, extinct or endangered species of wild fauna and flora and corresponding habitats within the Convention area. In this context, the Contracting Parties must, in their jurisdiction areas, establish protected areas, such as parks and reserves and regulate, and when needed and in accordance to the rules of international law, forbid activities that can cause harmful effects in the species, ecosystems and biological processes in these protected areas. The establishment of these areas must not affect the rights of other Contracting Parties and third States and, in particular, of other legitimate maritime users.

Article 11: Cooperation to fight against pollution in cases of emergency

1. The Contracting Parties must cooperate in taking all necessary measures to address pollution related emergencies in the Convention Area and to reduce or eliminate pollution or the threat of pollution. In this context, the Contracting Parties must, individually or together, develop and promote contingency plans to address incidents involving pollution or the threat of pollution in the Convention Area.

2. When one of the Contracting Parties is made aware of a case in which the Convention area is in eminent danger of being polluted or has been polluted, it must immediately notify the other States likely to be affected by that pollution, as well as relevant international organizations. Apart from that, it must inform, as soon as possible, those other States and the Organization of any measures taken to minimize or reduce pollution or the threat of pollution.

Article 13: Environmental Impact Study

As part of their environmental management policies, the Contracting Parties must, in cooperation with relevant regional and international organizations, develop, if necessary, technical guidelines and others to support the planning of its major development projects in order to prevent or minimize harmful impacts in the Convention area.

Each one of the Contracting Parties must evaluate, within its capacities, the potential environmental effects of major projects that can cause substantial pollution or harmful and significant changes in the Convention Area.

The work programme (2002-2003) was developed by the Contracting Parties in Maputo, Mozambique, from 5th to 7th December 2001 and includes:

Protection of endangered species

- The Contracting Parties must take actions for the conservation of marine turtles in the Convention area including joining the Convention for the Conservation of Migratory Wildlife Species and participate in conservation and management activities for marine turtles in the Indian Ocean.

- The Contracting Parties must reaffirm the need to maintain the status of the Indian Ocean as a sanctuary for the protection of endangered marine mammals in the region and make an appeal for the renewal of the Indian Ocean Sanctuary created in 1979.

- The Contracting Parties must ask regional and international organizations to facilitate the development of a regional initiative to protect the dugong, involving all the countries in the region.

Protection of coral reefs and associated ecosystems

- To appeal to all the parties to adhere to the International Coral Reefs Initiative.
- The Contracting Parties must establish national bodies to coordinate the activities in coral reefs in each country and to develop national action plans for coral reefs, when needed, in particular the creation of a working committee for coral reefs.

The fourth meeting of the Contracting Parties for the Nairobi Convention was held in Antananarivo, Madagascar, from 6th to 8th July 2004. Two new areas of interest were included in the work programme between 2004 and 2007:

1) Pollution from maritime sources (different from land sources of pollution) and the development and improvement of national contingency plans in cases of marine pollution emergency.

2) The environmental, economic and public health impacts related to ballast waters, one of the four major threats to oceans after the invasion of aquatic species. All the participants agreed that the ballast waters issues would be relevant for the Nairobi Convention and should be integrated in the work programme.

The Contracting Parties may enter into bilateral or multilateral agreements, including regional or sub-regional agreements, for the protection and management of the marine and coastal environment of the Convention Area.

The Contracting Parties shall co-operate, directly or with the assistance of competent regional and international organizations, in scientific research, monitoring, and the exchange of data and other scientific information.

To this end, the Parties shall develop and co-ordinate natural resources in the Convention Area and shall establish, in co-operation with competent regional and international organizations, a regional network of national research centres and institutes to ensure compatible results.

The Contracting Parties shall take all appropriate measures to ensure the strictest protection of to endangered wild fauna species which are listed in an Annex II.

The following countries are the original signatories: the Comoro Islands; Reunion/France/European Union; Kenya, Madagascar; Seychelles and Somalia. Mozambique and Tanzania participated in the Conference but did not sign the Convention. Mauritius was invited but did not attend. The latter three countries have subsequently signed the Convention.

The Nairobi Convention has been reviewed and several amendments have been made. The Signatories are now firmly committed to the implementation of the Action Plan. The administration has recently been restructured and comprises the Chair (main secretariat - held by Seychelles) and three vice chairs viz. Kenya (follow-up secretariat), Mauritius (fund-raising) and Tanzania (development of programme).

2.3.2 International Convention for the Prevention of Pollution from Ships (MARPOL, 1973/1978)

The International Convention for the Prevention of Marine Pollution from Ships 1973 as modified by the Protocol of 1978 relating thereto (MARPOL 73/78) was ratified by Mozambique in 2003 by the Resolution No. 5/2003 of 18th February[28].

This International Convention come into force on 2nd October 1983. The 1983 Convention initially comprised two annexes: Annex I (Regulations for the Prevention of Pollution by Oil Regulations) and Annex II (Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk).

Since 1983 four additional annexes have been the Convention currently comprises includes six technical Annexes aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations (Table 2).

Table 2 Annexes to MARPOL 1973/1975

Annex I	Regulation for the Prevention of Pollution by Oil
Annex II	Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk
Annex III	Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form
Annex IV	Prevention of Pollution by Sewage from Ships
Annex V	Prevention of Pollution by Garbage from Ships
Annex VI	Prevention of Air Pollution from Ships (entry into force 19 May 2005)

Parties must accept Annexes I and II, but the other Annexes are voluntary. Mozambique has ratified Annexes III, IV, and V, but still has to ratify Annex VI (Prevention of Air Pollution from Ships).

Annex I: Prevention of pollution by oil.

Entry into force: 2nd October 1983. Revised Annex I entered into force 1st January 2007.

Annex 1 of MARPOL mainly pertains to oil pollution from oil tankers. However, Chapter II, Regulation 9 states that discharges into the sea of oil or oily mixture from ships shall be prohibited except when the following conditions satisfy:

"…from a ship of 400 tons gross tonnage and above other than an oil tanker and from machinery space bilges excluding cargo pump-room bilges of an oil tanker unless mixed with oil cargo.

- the ship is not within a special area;
- the ship is more than 12 nautical miles from the nearest land;
- the ship is proceeding en route;

[28] The International Convention for the Prevention of Marine Pollution from Ships is published in the Boletim da República No. 7, 1st Series, 3rd Supplement, of 25th February 2003.

- the oil content of the effluent is less than 100 parts per million; and
- the ship has in operation an oil discharge monitoring and control system, oil-water separating equipment, oil filtering equipment or other installation."

Annex II: Control of pollution by noxious liquid substances.

Entry into force: 6th April 1987 (Revised Annex II entered into force 1st January 2007).

Annex II details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk.

Some 250 substances were evaluated and included in the list appended to the Convention. The discharge of their residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with.

In any case, no discharge of residues containing noxious substances is permitted within 12 miles of the nearest land.

Annex III: Prevention of pollution by harmful substances in packaged form.

Entry into force: 1st July 1992.

Annex III is the first of MARPOL optional annexes and contains general requirements for the issuing of detailed standards on packing, marking, labeling, documentation, stowage, quantity limitations, exceptions and notifications for preventing pollution by harmful substances.

Annex IV: Prevention of Pollution by Residual Waters from Ships

Entry into force: 27th September 2003

Annex IV defines, in detail, how to handle or preserve residues on the ship and the circumstances in which discharge into the ocean can be allowed. It requires the Convention Parties to provide for adequate containers to hold the residues and includes a model of an International Certificate for the Prevention of Pollution from Sewage that can be issued by the national navigation authority for ships under its jurisdiction.

The Annex is applied to ships that make international trips. It is applied to all new ships with 400 tons and higher and new vessels with less than 400 tons that are certified to take more than 15 people. It will be applied to existing vessels of 400 tons and higher and new vessels with less than 400 tons but that are certified to take more than 15 people, five years after its entry into force.

The discharge of residues into the ocean is forbidden, except when the ship has an operation approved device for treatment of residue or when it is discharging disinfected residues and in small amounts, using an approved system at more than three nautical miles from the nearest coast; or discharging non-disinfected and un-fragmented residues, at more than 12 nautical miles from the nearest coast.

Annex V: Prevention of pollution by garbage from ships.

Entry into force: 31st December 1988.

This deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of. The requirements are much stricter in a number of "special areas" but perhaps the most important feature of the Annex is the complete ban imposed on the dumping into the sea of all forms of plastic.

Under Annex V of the Convention, garbage includes all kinds of food, domestic and operational waste, excluding fresh fish, generated during the normal operation of the vessel and liable to be disposed of continuously or periodically.

Annex VI: Prevention of Air Pollution from Ships.

Adoption: September 1997.

Entry into force: 19th May 2005.

As Mozambique does not have specific standards for this type of project or for pollution from ships, it is recommended that this Annex is adopted.

The regulations in this annex set limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibit deliberate emissions of ozone depleting substances.

Sulphur Oxides:

Annex VI IMO of MARPOL 73/78, that entered into force on 19th May 2005, limits the sulphur content of heavy oils to a maximum of 4.5 % m/m globally and a maximum of 1.5 % m/m in SOx Emission Control Areas (SECAs)[29]. In alternative, if the ship is equipped with an approved cleaning system for subsequent treatment of exhaustion gases or any other technical method that is verifiable and that reduces SOx emissions to a maximum of 6.0 g/kWh measured as $S0_2$[30].

NOx Emissions:

The limits of NOx emissions are established for diesel engines that vary from 9.8 to 17 g/kWh depending on the engine's maximum operating speed, as Table 3 shows**.**

[29] m/m = per mass (1% m/m means that the mass of the substance is 1% of the total mass of the solution or mix)

[30] g/kWh = grams per kilowatt-hour

Table 3 Annex VI MARPOL NOx Emission Limits

Engine Speed (n, rpm[31])	NOx, g/kWh
n < 130 rpm	17.0
130 rpm ≤ n < 2000 rpm	$45 \cdot n^{-0.2}$
n ≥ 2000 rpm	9.8

More technical details on NOx emissions, such as methods to control emissions, are included in the mandatory “Technical NOx Code”, that was adapted under the coverage of “Resolution 2”.

Other air pollutants:

Annex VI forbids the deliberate emission of substances that can harm the ozone layer, including halon and chlorofluorocarbons (CFCs). New facilities that contain substances that harm the ozone layer are forbidden in all ships. But the new facilities that contain hydro-chlorofluorocarbons (HCFCs) are allowed up to 1st January 2020.

The Annex also forbids the on-board incineration of certain products, such as contaminated packaging materials and polychlorinated Biphenyl (PCBs).

2.3.3 International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 – OPRC 90

Mozambique joined the International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 – OPRC 90 through Resolution 6/2003 of 18th February[32].

The International Convention on Oil Pollution Preparedness, Response and Cooperation, signed in 1990 and effective since 13th May 1995, stipulates that States Parties to this Convention adopt a series of measures laid down in the Convention so as to be prepared for the combat and cooperation against marine pollution. Especially relevant for the study under discussion are the provisions of articles 6 and 3 of the Convention.

Article 6 determines that each Party shall have «a national system for responding promptly and effectively to oil pollution incidents». The same article also lays down the main aspects of the contents of such a national system.

Article 3 of the Convention determines that each State Party shall require that «operators of offshore units under its jurisdiction have oil pollution emergency plans, which are co-ordinated with the national system established in accordance with article 6 and approved in accordance with procedures established by the competent national authority».

[31] rpm = rotations per minute
[32] This Resolution is published in the *Boletim da República* No. 7, 1st Series, 3rd Supplement, of 25th February 2003

Article 4 lays down the procedures to be adopted with respect to reporting oil pollution:

1. Each Party shall:

a) Require masters or other persons having charge of ships flying its flag and persons having charge of offshore units under its jurisdiction to report without delay any event on their ship or offshore unit involving a discharge or probable discharge of oil:

i) in the case of a ship, to the nearest coastal State;

ii) in the case of an offshore unit, to the coastal State to whose jurisdiction the unit is subject;

b) Require masters or other persons having charge of ships flying its flag and persons having charge of offshore units under its jurisdiction to report without delay any observed event at sea involving a discharge of oil or the presence of oil:

i) in the case of a ship, to the nearest coastal State;

ii) in the case of an offshore unit, to the coastal State to whose jurisdiction the unit is subject;

c) Require persons having charge of sea ports and oil handling facilities under its jurisdiction to report without delay any event involving a discharge or probable discharge of oil or the presence of oil to the competent national authority;
d) Instruct its maritime inspection vessels or aircraft and other appropriate services or officials to report without delay any observed event at sea or at a sea port or oil handling facility involving a discharge of oil or the presence of oil to the competent national authority or, as the case may be, to the nearest coastal State;
e) Request the pilots of civil aircraft to report without delay any observed event at sea involving a discharge of oil or the presence of oil to the nearest coastal State.

2.3.4 United Nations Convention on the Law of the Sea and the Agreement relating to the Implementation of Part XI of the Convention

Mozambique joined the United Nations Convention on the Law of the Sea and the Agreement relating to the Implementation of Part XI of the Convention through Resolution 21/96 of 26th November[33]. The United Nations Convention on the Law of the Sea was adopted in 1982 and is in force since 1994.

It is one of the most important international treaties regarding sea regulation, since the large majority of its provisions are accepted by almost all countries, even if they have not ratified the Convention.

As its name already indicates, the United Nations Convention on the Law of the Sea covers a broad spectrum of issues with respect to the "Law" of the Sea. The articles directly dealing with marine pollution deserve special attention.

Article 1, paragraph 4 gives the definition of "pollution of the marine environment": «it means the introduction by man, directly or indirectly, of substances or energy into the

[33] Resolution 21/96 is published in the *Boletim da República* No. 47, 1st Series, 6th Supplement of 28th November 1996

marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities».

Paragraph 5 of the same article 1 refers to "dumping", defining it as:

> i) any deliberate disposal of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea;
> ii) any deliberate disposal of vessels, aircraft, platforms or other man-made structures at sea;».

Part XII of the Convention, covering articles 192 to 237, deals with the Protection and Preservation of the Marine Environment.

Article 192 establishes the obligation of the States to protect and preserve the marine environment and article 194 assigned the right to States, and particularly the coastal States, to take all measures necessary to prevent, reduce and control pollution of the marine environment, irrespective of its source, using to this end the most viable means at their disposal and in conformity with their possibilities.

Article 194 is especially important because it defines in general the measures that can and should be taken by the States to protect and preserve the marine environment, as well the possible sources of pollution.

2.3.5 Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation, 1988

This Convention was adopted on 10th March 1988 and came into force on 1st March 1992.

Mozambique acceded to this convention in 2003. This Convention requires governments to take measures to prevent unlawful acts which threaten the safety of ships and the security of their passengers and crews.

The Protocol for the Suppression of Unlawful Acts Against the Safety of Fixed Platforms Located on the Continental Shelf extends the requirements of the Convention to fixed platforms such as those engaged in the exploitation of offshore oil and gas.

2.3.6 Additional International Conventions

Mozambique is also party to several additional international environmental conventions, including:

- Vienna Convention for the Protection of the Ozone Layer, 1985 ratified by Mozambique by the Resolution No. 8/93 of 8th December[34].

[34] The Resolution No. 8/93 is published in the Boletim da República No. 49, 1st Series, 2nd Supplement, of 8th December 1993

This convention commits governments to take appropriate measures to protect human health and the environment against adverse effects resulting from depletion of the ozone layer. Cooperative research and information exchange are encouraged to better understand and assess the effects of ozone layer modification on human health and the environment.

- Agenda 21 of the United Nations Conference on Environment and Development (UNCED), 1992. Agenda 21 is a comprehensive plan of action to be taken globally, nationally, and locally by organizations of the United Nations System, governments, and major groups to reduce human impacts on the environment. Chapter 17 of Agenda 21 addresses protection of the oceans, and Section 17:30 calls for states to assess the need for additional measures to control degradation of the marine environment from sea-based activities, including activities associated with oil and gas platforms.

- Framework Convention on Climate Change (FCCC), 1992 ratified by Mozambique by the Resolution No. 1/94 of 24th August 1994[35].
  The FCCC's goal is the stabilization of greenhouse gas concentrations in the atmosphere consistent with sustainable development and at levels and on a time scale that would prevent dangerous anthropogenic interference with the climate system. Governments should take precautionary measures to anticipate and prevent or minimize the causes of climate change and mitigate its adverse effects.

- Convention on Biological Diversity, 1992 ratified by Mozambique by the Resolution No. 2/94 of 24th August[36].
  In support of conserving biological diversity, governments commit to integrating conservation and sustainable use of biological resources into national decision-making, establishing a system of protected areas, and requiring environmental impact assessments of proposed projects that may adversely affect biological diversity.

- Convention on the Conservation of Migratory Species of Wild Animals (1979) and the Memorandum of Understanding Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa (1999).

Mozambique is also party to the international agreements on climate change-Kyoto Protocol[37], desertification[38], endangered species[39], hazardous wastes[40], and wetlands[41].

[35] The Resolution No. 1/94 is published in the Boletim da República No. 34, 1st Series, 2nd Supplement, of 24th August 1994
[36] The Resolution No. 2/94 is published in the Boletim da República No. 34, 1st Series, 3rd Supplement, of 24th August 1994
[37] Ratified by the Resolution No. 10/2004 of 28th July published in the Boletim da República No. 30, 1st Series, Supplement, of 28th July of 2004
[38] Ratified by the Resolution No. 20/96 of 26th November, published in the Boletim da República No. 47, 1st Series, 5th Supplement, of 28th November 1996
[39] Ratified by the Resolution No. 20/81 of 30th December, published in the Boletim da República No. 52, 1st Series, Supplement, of 30th December 1981
[40] Basel and Bamako Conventions ratified respectively by the Resolutions 18/96 and 19/96 both of 26th November, both published in the Boletim da República No. 47, 1st Series, 5th Supplement of 28th November 1996
[41] Ratified by the Resolution No. 45/2003 of 5th November, published in the Boletim da República No. 45, 1st Series, 2nd Supplement of 5th November 2003

Finally, Mozambique is signatory to various international instruments important for activities taking place at sea. The most important are:

- **COLREG Convention 72** – IMO Convention on Collision Regulations;
- **GMDSS** – Global Maritime Distress Signaling System;
- **INMARSAT Convention 76 & INMARSAT OA 76** – **IMO & ITU** Conventions on International Maritime Satellite System;
- **SAR Convention 79** – IMO Convention on Search and Rescue;
- **SOLAS Convention 74** – IMO International Convention on Safety of Life at Sea
- **STCW Convention 78** – IMO Convention on Standards of Training, Certification and Watch keeping for Seafarers.

2.4 APC ENVIRONMENTAL, HEALTH, AND SAFETY POLICY

Anadarko Petroleum Corporation (APC)'s EHS policy (it is included in the Environmental Management Plan) emphasizes the company's commitment to managing and operating its worldwide assets in a manner consistent with its core values in order to protect the health and safety of people and the environment, as well as comply with applicable EHS laws, regulations, and internal EHS principles. The EHS policy applies to all employees of APC and its subsidiaries, including AMA1. Key elements of the policy include the following:

- Design and execution – APC shall incorporate the protection of human health and safety (along with methods to mitigate community impact) and be responsible for the minimization of waste and the reduction of emissions in all phases of operations, including planning and design. Ongoing compliance activities shall include appropriate monitoring, incident investigations, and the evaluation of concerns raised by management or employees to continuously improve EHS performance.
- Training and Communication – APC shall train officers and employees in EHS-compliance policies and procedures in a manner appropriate for the position of the individual or group. Appropriate information regarding means of compliance shall be prepared and distributed to directors, officers, and employees. Officers, managers, and supervisors shall demonstrate their support by regularly communicating this Policy to their direct reports and ensure appropriate training is provided. Communication of EHS requirements, expectations, hazards, and measurements shall be made during new-employee orientation and on-assignment to a new position or location. Ongoing communication will include regularly scheduled site safety meetings, shift/tour handover briefings, written alerts, orientation and induction briefings, or refresher training. Contractors and visitors shall be informed of appropriate EHS requirements.
- Auditing – Corporate EHS shall conduct periodic audits of APC's operations to assess risk areas and determine whether employees are abiding by the Policy, EHS principles, and programs and procedures adopted hereunder. Audit results will be reviewed, any incidents of non-compliance addressed, and necessary changes to the EHS compliance system implemented.

EHS considerations and an active concern for local laws and customs are integrated into every aspect of APC's business. EHS goals are maintained through a strict system of internal management and accountability that begins with senior management personnel and extends down to individual employees and contractors. The EHS management system ensures APC maintains consistently high EHS standards wherever it operates.

2.5. INTERNATIONAL GUIDELINES

2.5.1 International Association of Drilling Contractors (IADC)

This guide is designed to supplement company Health Safety and Environmental programs and operating procedures. It is based on experience and careful study over many years. Practicability has been substantiated by the adoption of the safe operating procedures by many drilling contractors and government regulatory bodies. It gives the drilling contractor a basis on which to build a Health, Safety and Environmental program.

Of particular interest for the present project are chapters 12, related to Offshore Safety, covering aspects such as medical evacuation to rough weather procedures; and chapter 14, related to the Protection of the Environment covering air emissions, waste management, spill prevention and control amongst others.

The guidelines also cover aspects related to Fire Prevention and Control, Personal Protective Equipment and Emergency Action Plan(s). These aspects are also addressed in the Mozambican Regulations for Petroleum Operations.

2.5.2 International Association for Oil and Gas Producers (OGP)

The OGP has been producing many documents and guidelines over the past few years to help its members to develop best practices in Health, Safety and Environment. Of special importance for the project are:

- Environmental Aspects of the use and disposal of non aqueous drilling fluids associated with offshore oil & gas operations – it provides a comprehensive synopsis of what is known around the world about the environmental impacts of this discharge;

- Environmental management in oil and gas exploration and production – It provides an overview of the environmental issues and the technical and management approaches to achieving high environmental performance in the activities necessary for oil and gas exploration and production around the world;

- Guidelines for the development and application of Health, Safety and Environmental Management Systems – it describes the main elements necessary to develop, implement and maintain a Health, Safety and Environmental Management System by the operators;

- Exploration and Production (E&P) Waste Management Guidelines – it provides a general description of waste management principles; an identification and overview of E&P activities and associated wastes; and options of waste reduction, recycling, treatment and responsible disposal; and

- Key questions in managing social issues in Oil & Gas Projects – it provides a tool to help with social planning issues and are targeted to: project management, by helping to identify questions that may be important in their leadership role; and business and project teams, by helping in the identification of questions that may be important in project development and management.

3.0 PROJECT DESCRIPTION

3.1 OVERVIEW

The purpose of exploration drilling is to determine if the subsurface geological structures contain hydrocarbons (oil and gas) in commercial quantities. Drilling activities are typically initiated after a seismic survey has been conducted. Maps created using the seismic survey results allow geoscientists to determine the best prospects for hydrocarbon accumulation. AMA1 is currently undertaking the analysis of the results from the seismic activities conducted from January to May 2008.

AMA1 proposes to conduct drilling operations within the limits of Area 1 offshore in water depths greater than 200m, once the results from the seismic activities are available. AMA1 is required to drill a minimum of seven wells, with a minimum of four in water depths greater than 200m, as part of the work commitment of the EPC contract granted by the Republic of Mozambique.

The drilling operation is a short-term activity. A drilling rig will be brought from international waters to Area 1 and will be responsible for the well drilling. Each well will take up to 2 months to drill. The depths of the wells will depend on the outcome of the seismic results.

After drilling operations are complete, a remote-control operated vehicle (ROV) is placed on the seabed to record the characteristics of the well location in order to guarantee that no unnecessary structure from the activity is left behind.

Independent of type, the rig is self-contained with a highly trained and specialized crew. The drilling rig will accommodate two drilling shifts working on a 12-hour rotating basis, as well as daily operational and maintenance staff requirements.

3.2 SURVEY AREA

The proposed activities will be conducted in the area delimited by the northern, eastern and southern borders of the Area 1 concession. The western border will be defined by a vertical projection of a line that joins the most eastern points of the 200m bathymetry line. Because the results from the seismic activities are not ready yet and therefore, the exact well locations are not known, the description of the survey area will cover the whole area beyond the 200m bathymetric depths.

Once the well locations are known, the relevant addendums shall be produced for each site.The types and quantities of the studies will be determined on a case-by-case basis.

Definition of the area of influence

Due to the nature of the project, the direct area of influence only covers a small area around each drilling site. Impacts such as noise and vibration caused by the drilling rig will only spread within a small area around the drilling site.

The indirect area of influence, however, includes the whole of the Rovuma Block, and the route between the Pemba Port and the drilling site(s). Potential impacts can occur, not from the drilling activity itself, but from the support infrastructure and activities necessary for the drilling unit to operate. This support includes supply vessels, shore based sources of supplies, storage areas, and helicopter operations (weekly crew changes will be carried out using a helicopter).

An issue of concern is the potential for spills both from the drilling rig and support vessels. Major events from drilling rigs (ie, “blow outs) are extremely unlikely when using the appropriate equipment and operational procedure. Nonetheless, oil trajectory models have been employed to identify likely paths of possible pollution in the event of accidents both on the central drilling vessel and from support vessels. These models will provide more detailed oil trajectories once the well locations are known.

3.3 SAFETY ZONE

The specific type of rig to be used remains to be determined, i.e. (i) dynamically positioned rig or (ii) moored rig. It is recommended that while the drilling vessel is operational, an area of 500m of safety radius be maintained around the drilling site, regardless of the type of rig.

3.4 TENTATIVE SCHEDULE OF THE MINIMUM 4 DEEPWATER WELLS

The tentative schedule of the minimum 4 deepwater wells is as follows:

- Move rig to deepwater location in Q1, 2009 for 1st campaign
- Spud 1st well, drill and evaluate well – 2 months
- Drill 2nd well immediately after the first well (depending on rig share arrangement)
- Evaluate results for up to 6 months (meanwhile prepare for 2nd deepwater drilling campaign)
- Move rig to deepwater location in from Q4, 2009 to early 2010 for 2nd campaign
- Spud 3rd well, drill and evaluate well – 2 months
- Drill 4th well immediately after the third well (depending on rig share arrangement)
- Evaluate results for up to 6 months

3.5 DRILLING RIG TYPE AND SPECIFICATIONS

Two types of rigs are capable of operating in the deep water environment. However, rig availability will ultimately dictate what rig will be utilized. The selected rig will be equipped for operations in up to 2,200m of water; it will possess a very high variable load capacity, it will carry up to a 15,000 psi blowout preventer (BOP) system, and will be equipped with a remotely operated vehicle (ROV).

Rig selection for the deepwater portion of the block is limited to the following 2 options:

- Dynamically positioned rigs
- Moored rigs

Dynamically positioned drilling rig: This will be the operator's first choice of rig type. This rig could either be ship-shaped or a column-shaped semi-submersible rig capable of drilling in water depths of up to 3,000m. Vessels are usually self-propelled and wellsite positioning is maintained dynamically using GPS satellites. Typical rig specifications are shown in table below.

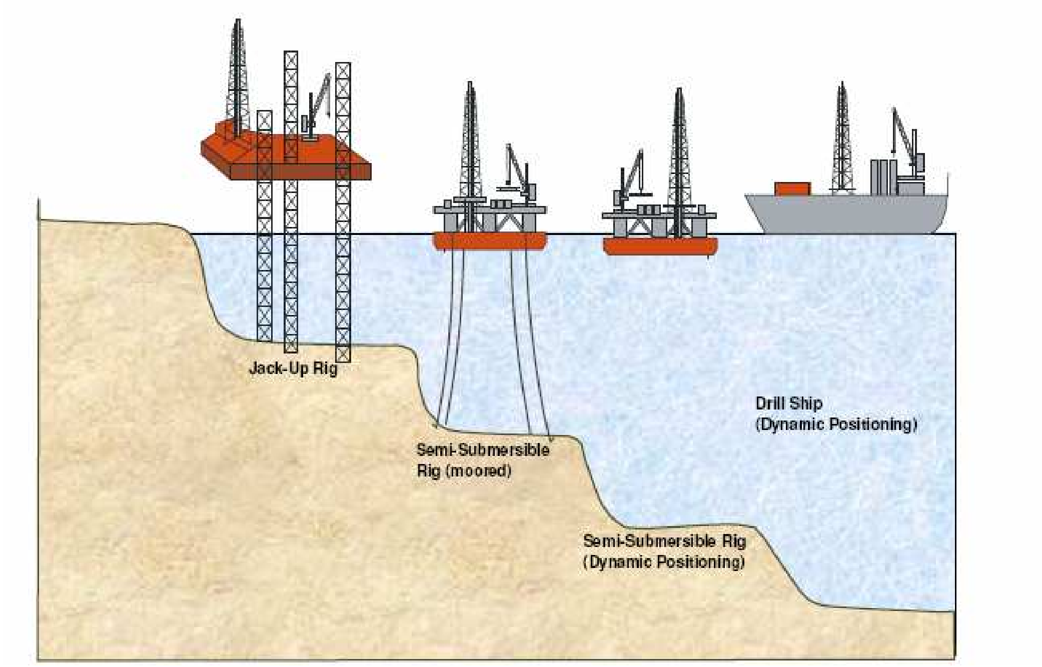
Table 4 Typical dynamically positioned drilling rig specifications

Capacities	Variable deck load: 15,000 MT
	Quarters: 100 – 130 people
	Water depth: 800 - 3,000 m
Drilling Equipment	Derrick: 1.0 - 2 mm lb
	Mudpumps: 3 x 2200 hp (typical)
	Top Drive: 750 t hoisting capacity (typical)
Other Equipment	Mooring type: DP3
	BOP system: up to 15,000 psi
	Drawworks: 1,500,000 lbs hoisting capacity (typical)

The drill-ship or semi-submersible is equipped with a moonpool or opening on the deck that is open to the sea. A derrick or mast is mounted on the deck over the moonpool, and drilling operations are conducted through the opening.

The rig is dynamically positioned, which means that it uses a system to automatically maintain the rig's position and heading with its own propellers and thrusters. This allows operations at sea where mooring or anchoring is not feasible due to deep water, congestion on the sea bottom (pipelines, templates), or other problems. Dynamic positioning is often used in the offshore oil industry (e.g., in the North Sea, Persian Gulf, Gulf of Mexico, and Brazil). Since no anchoring is taking place with a dynamically positioned drilling rig, there will be no direct impact to the seafloor from positioning the rig.

Moored drilling rig: this could either be ship-shaped or a column-shaped semi-submersible rig capable of drilling in water depths of up to 2,200m. Vessels are usually towed to location. The rig is maintained on location through a system of moored lines anchored to the sea floor. The surface area directly impacted by the positioning of the vessel is limited to the area where the anchor lines make contact with the seafloor. Typically rig specifications are similar to the dynamically positioned rigs.



Source: ERM 2006

Figure 6 Examples of drilling rigs (moored and dynamically positioning)

3.6 PRELIMINARY ACTIVITIES

Mobilization

The rigs will be mobilized to site either under tow by a vessel or under own propulsion in open navigable seaways. At this time, it is not anticipated that the vessel will come in to any of the ports in Mozambique except if needed to clear customs.

Supplies to the rig will be primarily routed through the AMA1 supply base at Pemba. Typical supplies include fuel, water, food, drilling fluid chemicals, oil well cement and chemicals, well tangibles (piping, wellheads), equipment, tools and other items. Some supplies may be delivered directly to the rig.

Site preparation

A shallow hazard study will be carried out for each possible well location. The purpose of the proposed work is to provide a pre-drilling assessment of shallow geohazards at proposed well location.

The geohazards assessment will be based on 3-D exploration seismic data. This will be limited to the seafloor and shallow geologic section. Depth of investigation would apply to only the top hole section (extend to 1.5 seconds TWT below the seafloor).

Before drilling commences, a remotely operated vehicle (ROV) will be launched from the drilling vessel to scan +/- 500m area around the location at the seabed. The main objective is to scan for the presence of chemosynthetic life and potential obstructions. This will ensure minimal impact to the environment and drilling operations.

3.7 DRILLING AND TESTING PROCEDURES

3.7.1. Drilling Procedures

The drilling process is characterized by the application of weight to and rotation of the drill bit, and by the circulation of fluid around the drill bit. Figure 7 illustrates the main features of a drilling rig.

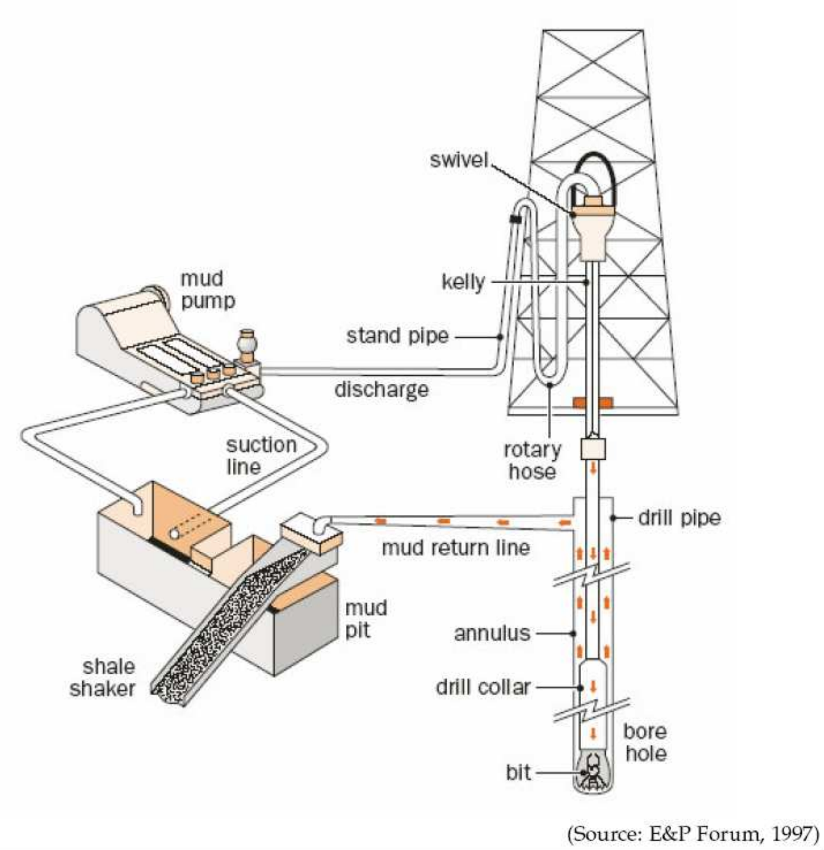
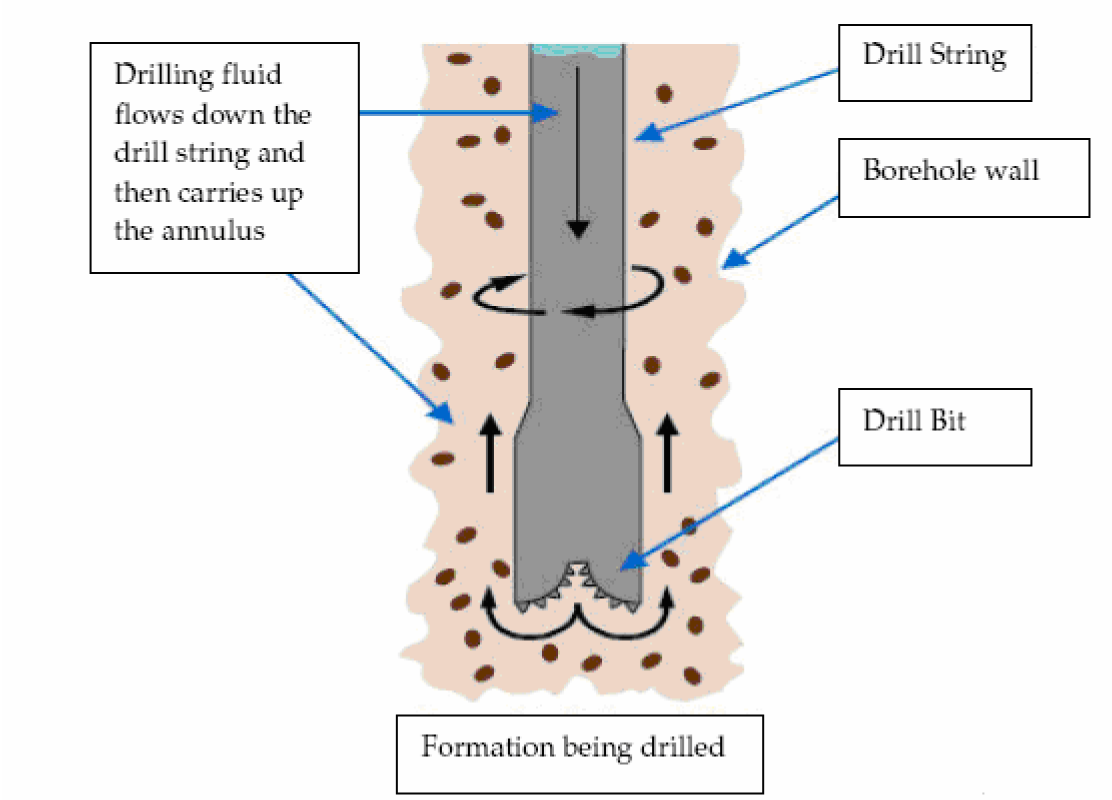


Figure 7 Main features of a drilling rig

The drilling process consists of the following steps:

Drill pipes are fitted together with a drill bit at the bottom end. This is known as the drill string. The drill string is lowered from the derrick into the bore hole. Once the bit reaches the bottom of the borehole, weight and rotation are applied. Once drilling commences, drilling fluid or mud continuously circulates down the drill pipe and back to the surface equipment. Drilling mud is used for maintaining the hydrostatic pressure on the fluid column and thus composition is changed through the process. The drilling fluid is also used for removing the cuttings from the bottom of the well, lubricating the drilling bit and piping, and stabilizing the wellbore.

The following shows the fluid circulation system around the drill bit.



Source: OGP 2003

Figure 8 Circulation of fluids in the drill bit

Once the cuttings and drilling mud reach the surface, they are separated in order to recirculate the drilling mud. Drill cuttings are 'cleaned' by passing them through a solids control device. The function of this device is to separate the cuttings from the drilling mud. At the end of the cleaning process the maximum amount of mud remaining on the drill cuttings is generally less than 6.9%.

There are several technologies used to remove the solids from the drilling mud. Typically, solid control devices consist of the following components:

- Shale Shakers (remove the larger fragments);
- Degasser (removes any gas);
- Desanders (removes sand particles);

- Desilters (removes silt particles);

The following additional equipment will be available if low toxicity synthetic/mineral oil based mud is used

- Cuttings dryer (cleans cuttings of residual oil before discharging to the sea)
- Centrifuge (recovers fine, light solids and weighting materials such as barite)

So-called “casing” of the well is carried out to isolate portions of the well so as to protect the aquifers of groundwater, as well as to provide a support structure to the well itself. In addition, “casing” also serves to guarantee safety and efficiency during drilling operations. It is accomplished by placing a string of casing pipe in the well and then setting it in place by pumping specially designed cement between the outside of the casing pipe and the well bore wall. After a string of casing is in place, a smaller drill bit is then used to drill a narrower well section. The process of drilling then continues until the desired depth is reached.

Figure 9 below shows the liquid cement used for setting casing.

Figure 9 Liquid cement used for setting casing

3.7.2 Drilling Program

The proposed exploration wells will be drilled to a total depth (TD) of +/- 5500m including water and drilled depth. A full suite of wireline logging (WLL) tool will be run in each of the borehole sections. The following lists the major operational steps.

1. Move in and rig up rig
2. Set transponders and position rig;
3. Pick up 36-inch casing and 26-inch drilling assembly;
4. Run in hole to mudline at +/- 1700 m ss and jet in 36-inch casing to +/- 1800 m ss;
5. Release tool and drill 26-inch hole to +/- 1,200 m bml. Pull out of hole;
6. Run and cement 20-inch surface casing;
7. Run and test blow out preventor (BOP) and riser;

8. Drill 17-1/2-inch hole to +/- 2,300 m bml. Pull out of hole; (Note: a 12-1/4" pilot hole may be drilled first if hole section is to be evaluated. After evaluation hole will be opened to 17-1/2").
9. Run and cement 13-3/8" casing
10. Drill 12-1/4" hole to +/- 3,800 m bml.
11. Run open hole logs as per geologic program. 9-5/8-inch casing is available to run as production casing, if the potential of commercial volumes of hydrocarbons exists. Plug and abandon well;
12. Pull BOPs and perform remotely operated vehicle survey of seabed;
13. Recover transponders and release rig
14. Contingency liners (16" and 11-3/4") will be available to use in situations of abnormal pore pressures and hole stability problems.

The above highlights expected operations using a dynamically positioned rig. For moored rigs, rig positioning will include additional time for running and setting drag embedded anchors. The mooring lines would have to be retrieved at the end of drilling operations. Figure 10 shows the planned drilling program.

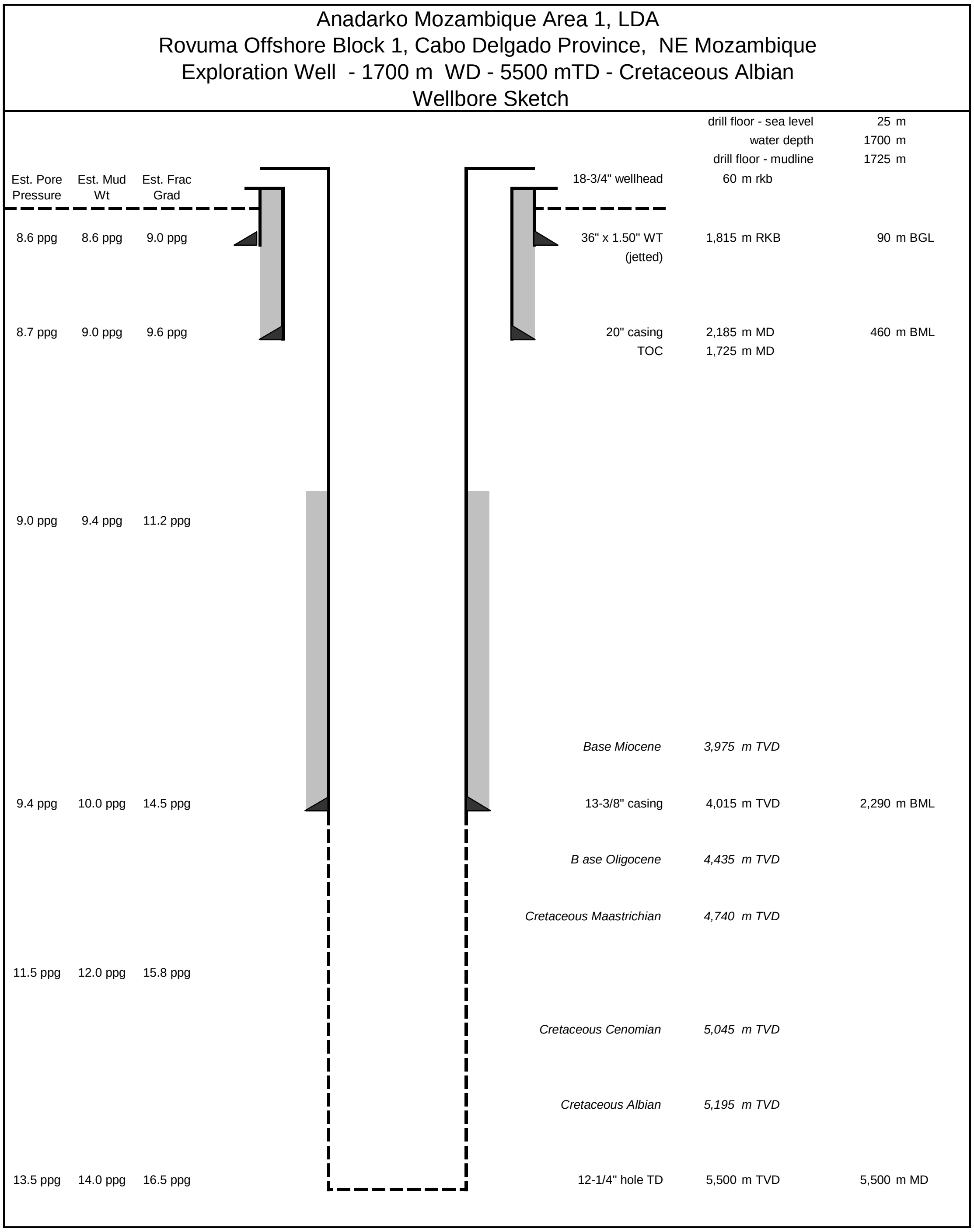


Figure 10 Tentative Drilling Program

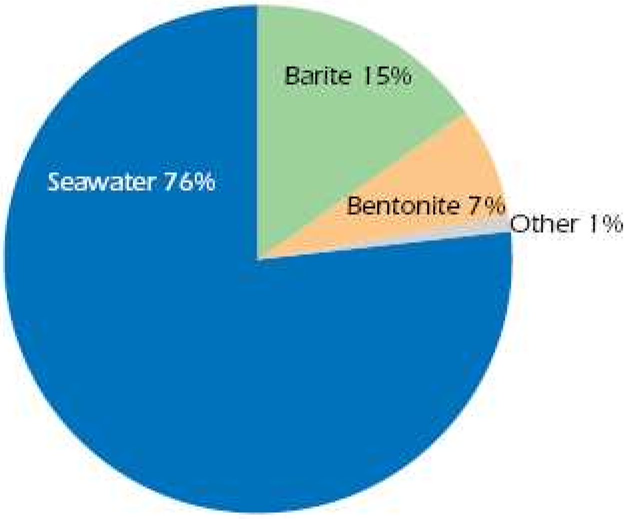
3.7.3 Drilling Fluid system

The use of specifically designed drilling fluid (or drilling mud) has crucial functions in the drilling process: suspension of drilling cuttings, pressure control, stabilization of the borehole walls, lubrication and cooling of the drill bit, among others.

There are two types of drilling mud: Water Based Mud (WBM) and Non Aqueous Drilling Fluids (NADF), which can be oil-based (OBM) or synthetic-based (SBM).

The selection of drilling fluids that may be used is related with the waste management aspects of the project. No drilling fluids can be selected in isolation of the required waste treatment and disposal requirements (CIS Oil & Gas, 2008).

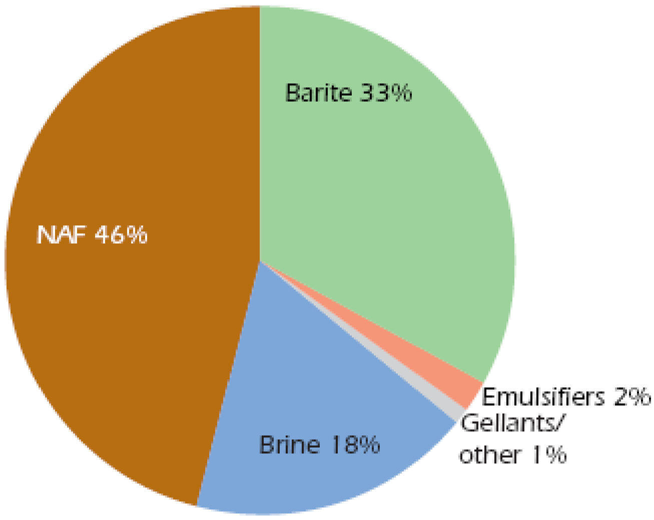
WBM consist of water mixed with bentonite clay and barium sulphate (barite) to control mud density and thus, hydrostatic head. Others substances are added to gain the desired drilling properties. These additives include thinners (eg lignosulphonate, or anionic polymers), filtration control agents (polymers such as carboxymethyl cellulose or starch) and lubrication agents (eg polyglycols) and numerous other compounds for specific functions. WBF composition depends on the density of the fluid. (OGP, 2003)



Source: OGP, 2003

Figure 11 WBM composition

Non-aqueous fluids have been used for many years in drilling for oil and gas. Typical synthetic base fluids include internal olefins, alpha olefins, polyalphaolefins, paraffins, esters and blends of these materials. These fluids offer improved lubricity, thermal stability, and well-bore integrity. (Environmental Performance, Shell Chemicals 2006).



Source: OGP, 2003

Figure 12 NADF composition

In addition to delivering high drilling performance, these fluids can be an important component of an environmentally sound drilling operation. For some of these fluids, drilled cuttings removed by the solids control equipment can be safely discharged into the marine environment because of their enhanced environmental properties. (Environmental Performance, Shell Chemicals 2006).

The use of water-based mud (WBM) and/or synthetic-based mud (SBM) as non-aqueous drilling fluid is expected for this program.

In most applications, water-Based-Muds are the most environmentally friendly fluids and can be discharged to the sea under deep water circumstances. However at greater wellbore depths they lose efficiency and the best option is to use Synthetic-Based-Muds. SBM systems are not discharged to sea and are retained aboard the drilling vessel.

Mozambican legislation, in Article 77 of Decree 24/2004 (Regulation of Petroleum Operations), regulates the use of synthetic-based drilling fluids, restricting its use to "only when necessary and according to operational and safety criteria".

The main advantage in using NADFs during exploratory drilling is related to the unknown nature of the formation and its potential for collapsing. NADF help stabilize the borehole by minimizing the interaction of clays present in the formation that react to water causing wellbore failure. NADF do not penetrate the formation as much as the WBM, helping creating a protective barrier around the wall of the borehole. The following figure shows an example of drilling mud.

Figure 13 Drilling mud in the respective reservoir

The NADF that will be used during the proposed drilling activities belong to group III, which include non-aqueous fluids with low to negligible aromatic content. These fluids are characterized by PAH contents less than 0.001% and total aromatic contents less than 0.5%. Group III includes synthetic based fluids which are produced by chemical reactions of relatively pure compounds and can include synthetic hydrocarbons (olefins, paraffins, and esters). Base fluids derived from highly processed mineral oils using special refining and/or separation processes (paraffins, enhanced mineral oil based fluid (EMBF), etc) are also included. In some cases, fluids are blended to attain particular drilling performance conditions (OGP, 2003)

The top hole section of the well (36" structural pipe jetting and 26" hole) will be drilled with seawater with the regular sweeping of cuttings with high viscous fluid (prepared with mainly pre-hydrated bentonite). The returns from the wellbore are collected at the seabed since the well is drilled with no riser at this stage. The high viscosity fluid is again pumped when the well is drilled to section depth, to clean the hole of cuttings, before running the 20" casing.

As soon as the BOP is in place and the riser connected, beyond the 20'' casing depth, the selected mud system shall be employed for drilling the well to TD. The mud management plan to be employed will rely on the high specification solids control equipment aboard the rig.

3.7.4 Well Control Equipment

The blowout preventer (BOP) provides a mechanical means of shutting the well in the event of drilling into over-pressured zones. This equipment is installed on top of the well head at the seabed and ensures the well integrity and pressure control during the drilling operations.

3.7.5 Equipment and Resource Use

3.7.5.1 Equipment

The equipment necessary to conduct exploration drilling includes mud pumps, centrifuges, cement units, and drill pipes, among others. The following figures show some of the equipment used in drilling.

Figure 14 Drill pipes

Figure 15 Pipes used for casing

Most of the resources necessary for drilling will be obtained from the international market. Local participation is expected to be more in providing on land support services, such as the supply of basic provisions for the drillship and support vessels.

3.7.5.2 Resource use

The drilling program will use the following resources:

Table 5 Resources to be used during the drilling program

Resource	Estimated Quantity
Water required for drilling	5,000 barrels of sea water
Drilling Muds/fluids	Total volume of well x 1.25
Sanitary and domestic water use (combined)	193litres/day/man
Fuel	35t/day (dynamically positioned rig)/ 12t/day (moored rig)
Various fluids chemicals (additives), including[42]:	Round-up values
Bentonite	59 units (of 1 MT each)
Guar Gum	440 units (25 Kg each)
Caustic soda	28 units (25 Kg each)
Soda Ash	40 units (25 Kg each)
VG Plus	120 units (25 Kg each)
SUREMUL	216 units (55 Kg each)
SUREWET	52 units (55 Kg each)
Lime	920 units (25 Kg each)
ECOTROL RD	280 units (25 Kg each)
Mosspar H	6,160 units (1 BBL each)
$CACl_2$	139 units (1 MT each)
Barite	1,256 units (1,000 Kg each)
Ultracap Plus	510 units (25 Kg each)
ULTRAFREE	412 units (55 GA each)
ULTRAHIB	412 units (55 GA each)
M-I PAC UL	400 units (25 Kg each)
FLO-TROL	560 units (25 Kg each)
ALPHASOL SUPREME	1,560 units (50 LB each)
SALT PVD	530 units (1MT each)
SUPRAVIS	320 units (10 Kg each)

Chemical additives such as barite will be used to prepare the drilling mud. The rig and some of the equipment movers on the rig run on marine diesel.

Consumption of diesel during the drilling mode, when the rig is dynamically positioned, is estimated at 35t/day. A third of this volume is used if the rig is a moored type.

Barite (barium sulfate, $BaSO_4$) is one of the major components of both WBM and SBM drilling fluid systems. It is a natural mineral used to increase the density of the drilling mud.

Some of the potential additives of the drilling muds are described in Table 6 below.

[42] Details of the types and quantities of chemical additives used for either WBM or SBM are included in Appendix 3. Note that types and quantities are a function of the rig type.

Table 6 Potential Drilling Fluid Additives

Additive	Composition	Function
Barite (Barium Sulphate)	Barite, crystalline silica, mica	Weighting agent Control mud density and thus, hydrostatic head
Bentonite	Natural mineral clay *e.g.*, bentonite, crystalline silica, tridymite, gypsum.	viscosifier, lubricant
Caustic Soda	Sodium hydroxide	pH modifier
Lime	Calcium hydroxide	pH modifier
SUPRAVIS	Biopolymer	Viscosifier
VG PLUS (Hyphen)	Organophilic clay	Viscosifier
SUREWET	Fatty acids	Emulsifier
SUREMUL	Polyamide, Hydrocarbon mixture and forms of ethanol	Emulsifier
Guar Gum	Carbohydrate polymer	Viscosifier Fluid Loss reducer
Soda Ash	Sodium carbonate	pH control, removes calcium, flocculant
Salt	Sodium chloride	Inhibitor
Mosspar H	Isoparaffinic solvent	Solvent

3.7.6 Required Personnel

All rigs are self-contained with a highly trained and specialized crew. The rigs used for drilling the wells will be sourced from the global international market. This may limit opportunities for local participation to on-shore support services such as supply base services, catering, and other basic provisions.

Accommodation is supplied on the drill vessel which will cater for 2 drilling shifts working on a 12 hour basis, as well as for daily operational and maintenance staff requirements. All other supporting drilling technical services will also be accommodated on board. The total work force on the drilling vessel will depend on the specific vessel's accommodation capacity but it likely to range between 100 to 130 people.

3.7.7 Project Generated Wastes

The proposed exploration drilling campaign will result in the generation of certain quantities of solid and liquid wastes. Anadarko recognizes the need to minimize waste generation in the course of the proposed project and to handle such wastes in accordance with Mozambican Law, industry and international best practices, and also in line with Anadarko's policies on health, safety and environment.

3.7.7.1 Solid Wastes

The waste items that could be generated during the proposed project include solid wastes (drilling cuttings, used drums, filters, used batteries, lumber and packing materials, waste rags, rubbish/garbage, etc).

The rig will have a mandatory Waste Management Plan. The Plan specifies procedures for waste collection, storage, processing and disposal, including the on-board use of equipment. This Waste management Plan shall be submitted to INP and MICOA prior to the beginning of the activities. This will be in line with the Mozambican and international legal requirements (Refer to Section 2 of this report).

Each type of waste will be dealt with appropriately, according to type of waste, best possible disposal method and existing waste management capacity onboard and onshore. Kitchen waste can be discharged at sea according to MARPOL 73/78 Requirements.

The ship may also have a compactor for processing domestic waste. The compactors minimize the storage of waste for subsequent transfer to the continent. Other waste may be stored separately in waste skips and returned to the mainland for disposal, in accordance with MARPOL 73/78. Used oil will be contained and disposed of at an appropriate location, as per requirements of the Waste Management Plan to be submitted to MICOA before the beginning of the operations.

Pemba as all the other cities only has a general waste facility where all types of waste are dumped without any sort of segregation. Maputo is the only province with a hazardous waste facility site, managed by Enviroserv.

The Port to which the wastes will be taken shall offer facilities for their reception and disposal. Alternatively, an agent could receive and dispose of the waste.

3.7.7.2 Liquid Wastes

The liquid wastes (drilling muds/fluids, cooking oils, deck drainage, gray water, chemicals, used solvents, used oil, sanitary waste water, etc). During well testing some formation water will also be produced.

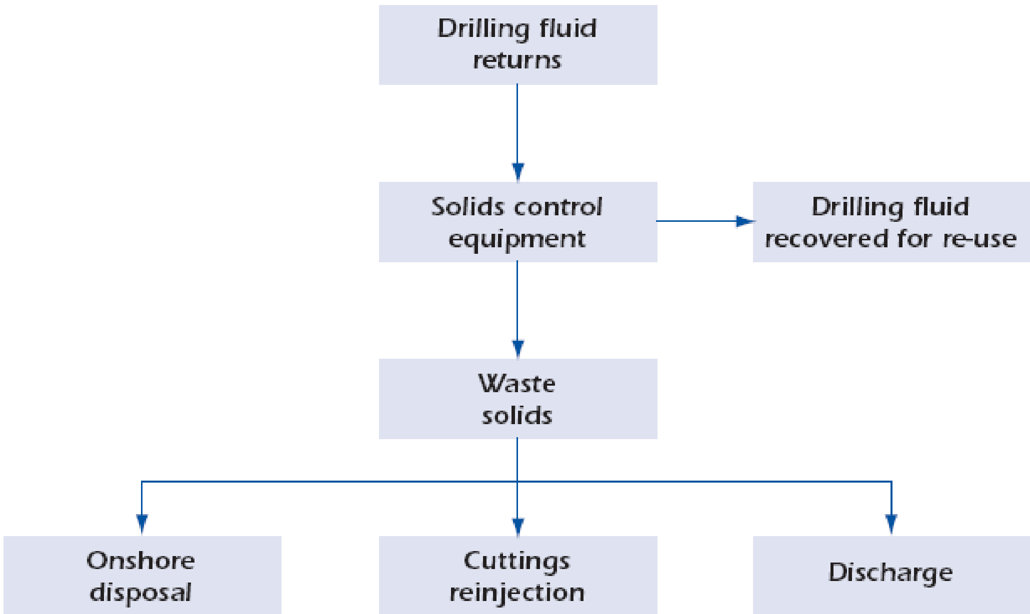
The drilling vessel will have a closed drainage system, so that it will be possible to collect all the water derived from the various components of the vessel such as rainwater and wash water. Run-off from locations on the rig such as active work areas, areas where potentially oily equipment is exposed to rain and soapy wash water will be collected in this closed drainage system. Run-off water and rainwater areas which are not subject to such potential contamination will be drained directly into the sea. Control measures will include:

- All the closed drainage systems will be equipped with oil and lubricant separators; and all used oil coming from the engines will be stored in drums and subsequently transported for disposal at an appropriate site.
- Potentially contaminated drainage water will be collected and equally transported for disposal at an appropriate site.

Under certain circumstances, some wastes can be discharged at sea in deep waters away from any sensitive marine habitats. These include the drilling cuttings and drilling fluid (water based), cement and cement additives, deck drainage and sewage.

The drill vessel may be equipped with a small sewerage treatment station and the final waste is discarded on the high seas in accordance with the MARPOL requirements (not closer than 12 nautical miles (21,6km) from land). MARPOL´s Annex IV requires that sewage discharges from ships be treated and disinfected and that the effluent must not produce visible floating solids in, nor cause discoloration of, the surrounding water. The treatment system must provide primary settling, chlorination and dechlorination. The treated effluent can then be discharged into the sea, as is practice aboard ocean-going vessels. The discharge depth is variable, depending on the draught of the rig at the time, but it should not be less than 5m below the surface.

As part of the drilling process, drill cuttings are brought to the surface with drilling fluid for processing. It is at this stage that drill cuttings are removed from the fluid, become waste and processing and disposal begins (Figure 16). On the drilling rig, solids control equipment removes unwanted solids from the drilling fluid to provide the maximum practical recovery of drilling fluid for re-use. Disposal options for the waste solids include offshore discharge, offshore re-injection, and onshore disposal.



Source: OGP,2003

Figure 16 Schematic Flow Chart Showing Separation of Cuttings from Drilling Fluids and Options for Drill Cuttings Disposal

The drilling cuttings are generally inert but may contribute with small amounts of trace metals and/or hydrocarbons to receiving waters. The bulk constituents of cement are non-toxic and no cementing chemicals will be released into the environment as they will remain in a closed system downhole.

3.7.7.3 Air Emissions

The main emissions to the atmosphere from the drilling rig will be from the exhausts fitted to the diesel power generators. These generators will be operational 24h a day. Emissions from the generators will comprise of combustion products such as CO_2 and water vapour, with lower concentrations of NOx, SO_2, unburned hydrocarbons and particulates.

3.7.7.4 Noise emissions

The drilling rig will produce low-frequency noise. The ships used in these activities produce more noise than the fixed platforms. This is due to the larger surface area in contact with the water, which produces greater vibration into the water column (Hurley and Ellis (2004), referenced in ERM (2006). According to findings of recent studies conducted by other exploration companies in Mozambique, this noise spectrum may range between 0.5 and 1.2 kHz, with tonal reception levels between 119 and 127 dB (ERM, 2006).

Noise will also be produced by the supply vessel. The sources of noise will be from the vessel engines, and during vessel manoeuvre alongside the anchored ship.

Table 7 below presents a general summary of the main emissions, discharges and wastes.

Table 7 Summary of emissions, discharges and wastes

Emission/Discharge/Waste	**Estimated Quantity**
a) Emissions	
NOx	305 kg/hr
CO	70kg/h
SOx	105 kg/hr
Total HC	9 kg/hr
b) Discharges	
Drilling cuttings	663 cubic meter
Drilling muds (WBM only)	1591
Deck drainage	6bblitres/day
Sanitary waste water	193litres/day/man
c) Wastes	
* Solid	
Common trash	1.5 ton/month
Used batteries	35 kg/month
Paper	0.5 tons/month
Plastic tanks	42 (1200litres)
Plastic/steel drums	50 (220 litres)
Oily cuttings	15.5 tons/month
* Liquid	
Drilling muds (NABM or SBM)	9 tons/month
Oily sludge	1.8 m3 /week.

3.7.9 Testing Operations

When the target zone has been reached, so-called “production tests” can be carried out. In general, this zone is reached during the last few days of drilling. The small quantities of hydrocarbons that are liberated during the testing procedures will be eliminated through flaring (for gas) or burning (in case of liquid hydrocarbons). Small samples will be collected to do other tests such as quality tests of the material found.

3.7.9.1 Geophysical Logging Program

A geophysical logging program is a survey of geophysical properties in the well bore or in the formations surrounding the well bore. It is a test conducted within the borehole, either during the drilling or before or after the casing is set. The tool is run through the hole and the data is collected either in the tool or simultaneously recorded at the computer at the rig floor.

3.7.9.2 Well testing – Drill Stem Tests

Drill stem test is a procedure for testing a formation through drill pipe. It is often defined as a temporary completion of a well to determine the fluid content of a reservoir and its ability to produce. Formation fluid is recovered in the drill pipe through temporary relief of backpressure imposed on the formation. Hydrostatic, flowing and shut-in pressures are recorded versus time.

The test is conducted to measure or estimate the production rate of the formation, and the place in the borehole where the test would be conducted is normally isolated from the rest of the formation by either packers or casing.

3.8 ABANDONMENT PROCEDURES

After the drilling activities have ended, the well will be properly sealed/plugged and abandoned.

A detailed program of abandonment and decommissioning shall be developed in line with the applicable Mozambique Petroleum Regulations/Environmental Guidelines and issued based on results from drilling and evaluation. In all cases, the well shall be isolated hydraulically with minimum two pressure barriers. Also, heavy mud will be displaced in hole to balance the riser. Article 77 of Decree 24/2004 (Regulation of Petroleum Operations), stipulates in subsection 7 that before the wells are sealed, the potential flow zones should be localized to prevent the eruption of hydrocarbons and other drilling fluids.

The notional sequence of operations for abandonment is as follows:

1. Run in hole with drill pipe stinger
2. Circulate Bottom’s Up
3. Set cement plug in open hole
4. Pull stinger above cement plug and circulate bottom’s up

5. Set cement plug across casing shoe
6. Pull stinger above cement plug and circulate bottom's up
7. Pull out of hole stinger and rack back
8. RIH with bit to top of cement
9. Tag cement and circulate bottom's up
10. Displace Mud to retain riser margin
11. Pull out of hole with bit
12. Run in hole Bridge Plug on drill pipe
13. Set Bridge Plug
14. Unlatch running tool and displace mud in hole with sea water
15. Pull out of hole bridge plug running tool
16. Retrieve Wear Bushing running tool
17. Run in hole drill pipe stinger
18. Set surface cement plug
19. Pull out of hole 3½" stinger
20. Unlatch BOP stack and recover riser
21. Run Corrosion Cap and install on well head
22. Transponders with ROV
23. Offloading operations & move rig off location

When any portion of the well is suspended above the seafloor, a "cage" is placed above the well head (Figure 17) to protect fishing nets of tangling.

When a well is abandoned it is plugged with cement and the wellhead and steel casings of the well just above the seabed surface are severed (Figure 18).

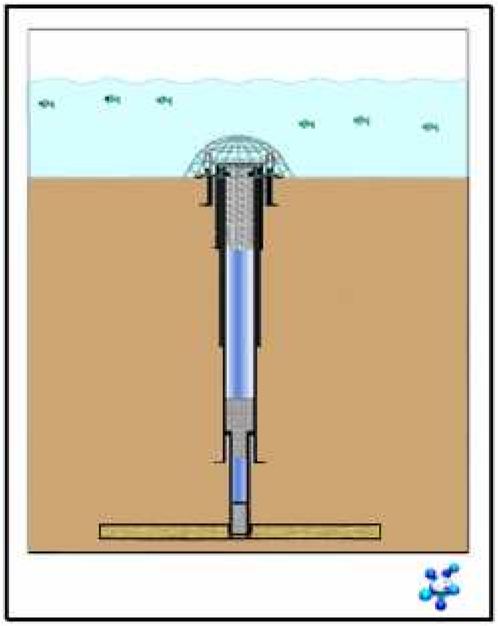


Figure 17 Suspended well schematic. Source: adapted from ERM, 2006

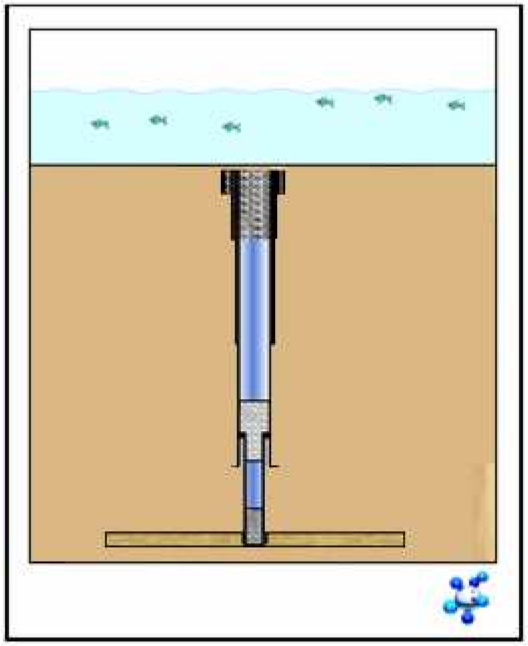


Figure 18 Abandoned well schematic. Source: adapted from ERM, 2006

3.9 SUPPORT OPERATIONS

Offshore drilling vessels need support in terms of food, water, fuel, equipment, and material supplies. These will be supplied by supply and support vessels.

Drilling operations will be coordinated by Anadarko from its office in Pemba, Cabo Delgado. However, the day to day drilling activities will be managed at the drilling location by a drilling supervisor.

The proposed campaign shall be coordinated from the Anadarko office in Pemba and most vessel supplies/support services shall commence from and terminate at Pemba Port. Wastes from the drilling rig shall also be transferred, when necessary, to shore via Pemba port for appropriate disposal.

A helicopter will also transfer the crew flying to Pemba from Pemba Airport to the drilling vessel and back and allow for weekly crew changes. These will be infrequent and only 2 or 3 flights per week are expected.

3.10 ENVIRONMENTAL ASPECT REGISTER

An environmental aspect is an element of an organisation’s activities, products or services that can interact with the environment in a manner that is positive or negative. The environmental aspects may affect the physical or socio-economic environment in adverse or beneficial ways. Some impacts are experienced within the program area, and others can result in changes beyond the program area. As described in this EIA, the environmental aspects of the proposed drilling program, listed in Table 8 below, have been used to identify and evaluate the significance of potential impacts and to develop appropriate mitigation recommendations.

Table 8 Environmental Aspects

Project Component	Environmental Aspect
Equipment Mobilization	Vessel movements along the access route
Site Preparation	Pre-drilling assessment of shallow geohazards
Drilling Program	Personnel accommodation and management
	Drilling
	Well evaluation
	Waste (solid, liquid, gaseous) Management
Decommissioning	Well abandonment
	Demobilization (move rig off location)
Non-routine Events	Leaks and spills
	Blowout
	Fire and explosions
	Collision with other vessels

4.0 ALTERNATIVES CONSIDERED

The project consists in the drilling a minimum of 4 wells in water depths greater than 200m within the AMA1 offshore area.

According to the Mozambican EIA legislation, an analysis of alternatives is required. This report assesses two types of alternatives: a) No action and b) Project alternatives, including the project location and project technologies (rig and drilling fluids alternatives).

4.1. NO ACTION

Should the "No Action" alternative be accepted, opportunities to find hydrocarbons in Mozambique would be limited, as well as the possibility to reduce the country's dependence from other countries and increase the economic benefits in one of the poorest countries in the world.

Additionally, in case the "No Action" alternative is accepted, the project will not be able to take place in the Cabo Delgado Province and could be transferred to other regions in the Country or beyond borders. This option is not recommended for the following reasons:

Contractual reasons

- AMA1 signed an Exploration and Production Concession (EPC) contract with the Government of the Republic of Mozambique for Offshore Area 1 (Area 1) in the Rovuma Basin and it will represent a failure in meeting the requirements of the above mentioned contract;
- The EPC contract between AMA1 and the Republic of Mozambique requires AMA1 to prospect for petroleum resources in the Rovuma Offshore Area 1 within 5 years;
- AMA1 is currently undertaking the analysis of the results from the seismic activities conducted from January to May 2008 and is committed to drill a minimum of seven wells, with a minimum of four in water depths greater than 200m (this project);

Environmental and socio-economic reasons

- Similar experiences in the country (Inhambane and Sofala) have shown that impacts are localized and can be mitigated;
- Cabo Delgado Province needs projects that can improve the socio-economic conditions and allow for their multiplying effects to take place in order to develop the province;
- The Country needs investments that can stimulate its economic development and thus improving the quality of life for its inhabitants;
- Possibility for long term technology and knowledge transfer, bringing economical development and improving the quality of life for its inhabitants;
- Possibility to generate revenues for the country, adding to the Gross National Product, generate foreign exchange and create job opportunities;

- No fatal flaws (i.e., irreversible negative impacts that would render the project unfeasible) have been found as a result of the environmental analysis conducted both for the seismic and drilling projects.

The positive only impact of choosing the “No Action” alternative is that there will be no impacts on the marine environment and no subsequent negative impacts on artisanal and commercial fishing activities or tourist activities.

4.2. PROJECT ALTERNATIVES

4.2.1. Project location

The area where the drilling will take place is located within the Concession Area granted to AMA1 by the Mozambican Government as part of the Exploration and Production (EPC) Contract, which is limited to Area 1.

In projects of this nature, the site location is given after detailed geological studies and the well location is determined by a probability of existence of reserves at a specific site and results from seismic activities, within the Concession Area. Therefore, it is very difficult to consider geographical alternatives. Furthermore, because the project takes place in deep waters, the difference between one location and another is not expected to be significant.

4.2.2. Project technologies

There are various project technologies that can be considered but this section will only look at two types due to their importance from the environmental point of view.

4.2.2.1 Rig Selection

Rig selection for deepwater drilling is limited to the following 2 options (i) Dynamically positioned rigs and (ii) Moored rigs.

The dynamically positioned drilling rig will be the operator’s first choice of rig type. This rig could either be ship-shaped or a column-shaped semi-submersible rig capable of drilling in water depths of up to 3,000m. These vessels are usually self-propelled and wellsite positioning is maintained dynamically using GPS satellites, allowing operations at sea where mooring or anchoring is not feasible due to various reasons including those described in Section 3.5 above. The main environmental advantage of using this type of rig is that since no anchoring is taking place, there will be no direct impact to the seafloor, and therefore to the benthic communities, from positioning the rig.

Moored drilling rigs are either ship-shaped or column-shaped semi-submersibles capable of drilling in water depths of up to 2,200 m. The rig is maintained on location through a system of moored lines anchored to the sea floor and the surface area directly impacted by the positioning of the vessel is limited to the area where the anchor lines make contact with the seafloor, covering a radius of about 3 – 4 times the water depth around the rig at sea bottom.

Although the dynamically positioned drilling rig is the best option and operator's first choice of rig, rig availability will ultimately dictate rig selection in the AMA1 block. For either case, the necessary mitigation measures will be included in the report.

4.2.2.2 Drilling Fluids (Muds) Selection

There are two types of drilling muds: Water-Based Mud (WBM) and Non Aqueous Drilling Fluids (NADFs), which can be oil-based (OBM) or synthetic-based (SBM).

The use of water-based mud (WBM) and/or synthetic-based mud (SBM) as non aqueous drilling fluid is expected for this program. Oil based muds will not be used and are not discussed in this report.

WBM consist of water mixed with bentonite clay and barium sulphate (barite) to control mud density and thus, hydrostatic head. Others substances are added to gain the desired drilling properties. These additives include thinners (eg lignosulphonate, or anionic polymers), filtration control agents (polymers such as carboxymethyl cellulose or starch) and lubrication agents (eg polyglycols) and numerous other compounds for specific functions.

Non-aqueous drilling fluids (NADF) have been used for many years in drilling for oil and gas. Typical SBM include internal olefins, alpha olefins, polyalphaolefins, paraffins, esters and blends of these materials.

The NADF that will be used belong to group III non aqueous fluids which correspond to the most recent internationally used and are the most acceptable from an environmental point of view as it has very low to negligible aromatic content.

Conventional water-based muds (WBM) offer the benefits of environmental compliance, attractive logistics, and a relatively low unit cost but consistently fail to approach the drilling performance of NADFs. In other words, WBMs are the most environmentally friendly fluids, however at greater depths they lose efficiency and the best alternative is the Synthetic-Based-Muds (SBM).

SBM (and OBM) have many inherent advantages over WBM, including temperature stability, tolerance to contamination, and corrosion protection, making OBM and SBM the technical choice for drilling demanding wells. These fluids are also preferred over WBM in most applications for their ability to drill a gauge hole, thereby minimizing drilling problems.

WBMs are usually discharged to the environment (with no recovery) whereas SBMs are generally recovered onboard the drill vessel, on account of cost and environmental considerations.

4.3. PROJECT ALTERNATIVES ASSESSMENT

Based on the discussion above, whereby several socio-economic benefits have been indicated and taking into account the absence of fatal flaws, it is clear that the "No Action" alternative should rejected, i.e. the project should be allowed proceed. Although at the temporary exploratory phase (this phase), there are some economic benefits, allowing the project to go ahead would stimulate long-term technology and knowledge transfer, bringing economical development and improving the quality of life for its inhabitants. In a success scenario (commercial oil/gas quantities are discovered), the ensuing production will generate significant revenues for the country, add to the Gross National Product, generate foreign exchange and create job opportunities.

For the reasons explained above in 4.2.1, in projects of this nature, it is very difficult to consider geographical alternatives. However, because the project takes place in deep waters, the difference between one location and another is not expected to be significant. In any case, this report provides the relevant recommendations to minimize environmental and social impacts.

With regard to project technologies, the types of rig and drilling fluid system alternatives to be used have been discussed.

Although it is clear that the rig selection will be dictated by rig availability, it is clear that the type with the least environmental impacts is the dynamically positioned drilling rig since no anchoring is taking place and therefore no direct impact to the seafloor and to the benthic communities, from positioning the rig. This will be the operator's first choice of rig.

With regards to drilling muds, two types have been assessed: WBM and SBMs.

WBMs are considered to be the most environmentally friendly fluids and should be preferably used. However because at greater depths they lose efficiency the best alternative are the SBMs. Should SBMs be required, alternatives that are low in toxicity, biodegradable and non-accumulative, should be used.

Mozambican legislation, in Article 77 of Decree 24/2004 (Regulation of Petroleum Operations), regulates the use of synthetic-based drilling fluids, restricting its use to "only when necessary and according to operational and safety criteria".

In conclusion, the project should be allowed to proceed with the best project technologies possible.

5.0 ENVIRONMENTAL BASELINE

5.1 INFORMATION GATHERING METHODOLOGY

The affected environment for this impact assessment encompasses the following three elements:

- Physical environment – meteorology/climate; air quality, oceanography (wind, currents, waves, and tides); geology, sediments, and water quality;
- Biological environment – macrobenthic communities, inshore habitats (coral reefs, mangroves and seagrass beds), fisheries, marine birds, marine turtles, marine mammals, migration pathways; and
- Socioeconomic environment – artisanal fisheries, commercial fisheries, shipping routes, coastal industries and tourism industry.

The EIS, primarily an extensive review of published literature already available for Area 1, is included in the EIA Report for the seismic survey (prepared by Impacto Lda in a joint venture with CSA International) and in the EIA Report for Area 4 (prepared for ENI by Impacto). The relevant specialists studies prepared for each of the above have been updated based on desktop studies.

Socio-economy, tourism industry and artisanal fisheries information was updated through brief visits to the project area.

5.1.1 Physical and Biological Studies

5.1.1.1 Physical Studies

The physical study was based essentially on literature review of the studies conducted on the area for different purposes including previous EIA and other reports and articles. In addition results from a combined environmental and marine physical processes (NORWECOM model) were used to simulate the oceanic currents.

5.1.1.2 Biological Studies

Biological studies were carried out for the Seismic EIA. No further surveys have been conducted. Therefore, most of the information regarding biological baseline information was included in the Seismic EIA for Area 1. For these reasons, physical and biological specialist studies are not included in this EIA in a separate volume, but mostly incorporated in the EIA.

5.1.1.2.1 Marine mammal and sea turtle survey

This study was carried out based on review and update of existing information from previous specialist reports prepared for the EIS for the offshore seismic survey proposed by Eni East Africa S.p.A in partnership with Empresa Nacional de

Hidrocarbonetos, EP (ENH) and Galp Energia for Area 4 of the Rovuma Basin and the EIS for a deepwater seismic survey proposed by Anadarko Moçambique Área 1, Lda (AMA1) and Empresa Nacional de Hidrocarbonetos, EP (ENH) in Rovuma Offshore Area 1.

5.1.1.2.2 Representative Marine habitats survey

Based on observations made during the aerial survey of marine mammals and sea turtles, three representative areas within the Quirimbas Archipelago were selected for a marine habitats survey, which were conducted in March 2007.

5.1.1.2.3 Fisheries study

This study was carried out based on review and update of existing information. New information was taken from the Dr. Fridtjof Nansen survey undertaken in December 2007.

5.1.2 Socio-economic Studies

5.1.2.1 Socio-economy and tourism

In order to understand and quantify the potential socio-economic effects on tourism and fisheries at the level of detail required for the Social Impact Assessment (SIA), two baseline studies were conducted for the EIA prepared for the seismic project in 2007, namely, a Tourism Baseline Study[43] (TBS) and a Fisheries Baseline Study (FBS).

For the present EIA´s SIA, only desktop studies were conducted since a significant amount of baseline information already existed from previous studies conducted for AMA1 and other concessionaires. However, during a visit to Pemba, the consultant gathered current information from tourism operators in order to update the existing baseline data

5.1.2.3 Artisanal fisheries

As with the other components, the EIA Report prepared for AMA1 prior to the seismic survey was reviewed and updated[44].

The primary data revision involved the re-collection of both qualitative and quantitative information on-site or electronically, and constituted:

- Literature review (general and specific).

[43] Due to the limited extent of tourism activities in the northern part of the Cabo Delgado Province, the tourism baseline is limited and, therefore, it is not presented as a separate document, but wholly included in the SIA.
[44] The fisheries baseline study is not presented as a separate document, but wholly included in the SIA.

- Population and fisheries census review,
- Specific quantitative and qualitative data about the industrial development in the area. This revision was done at national, *provincial* and *district* levels. Information on industrial statistics, development policy and strategic plans was collected from Industry and Trade sector at National, province and district levels.
- Discussions about the most critical issues related to fisheries dynamics were conducted at district and local levels. This exercise focused issues related to the participants perceptions related to the probable impacts from the both previews seismic and the planned drilling projects.
- Focus Groups and individual semi-structured interviews were re-conducted in the areas where artisanal fishery is more dynamic, such as Palma-sede, Vamize and Mocimboa da Praia-sede. In these areas two types of focus groups were conducted. One with groups composed by fishers who participated in the previous study (EIA-July-2007), to confirm if changes occurred in the area (Refer to Table 9 below for names of fishing centres and dates of interviews). Maps, diagrams and other tools which were produced together with them during the previews studies were re-printed and reviewed. The second type of focus groups included people who were not involved in the previous studies and these was made as control group to measure the quality and consistence of the information provided by the other groups.
- Stakeholders (*men and women, owners and staff/employees*), were selected according to the type of fishing gear used, the type of service provided, experience in fishing activities, and availability to participate in the Focus Groups. Individual semi-structured interviews were held to clarify certain aspects requiring further discussion after the Focus Groups. Thus a total of eight Focus Group discussions were held, involving 13 of the 40 fishing centers involved in the previous study. Issues and topics covered during the Focus Group discussions included:

    - History of fishing activities in the area.
    - Role of fishing activities.
    - Fishing stakeholders and their roles.
    - Social and political structures.
    - Income from the fishing sector.
        - Movement of fishers and fishing areas.
        - Fish markets, demand and supply.

Table 9 Places and fishing centres where focus groups and interviews were held as part of this project

District	Number of Focus Groups	Number of fishing centres involved	Places where focus groups and interviews were held		
			Village were focus groups and interviews took place	Representatives of Fishing centres involved in the discussions	Dates
	(a)	(b)	c	d	e
Palma	5	8	Palma-sede	Makongo**	9/05/08
			Kilava	Kilava**, India**,	9/05/08
			Palma-sede	Muhoa, Quelimane,	9/05/08
			Palma-sede	Palma-sede & Maganja da costa	10/05/08
			Vamize	Vamize**	10/05/08
Mocimboa da Praia	3	5	Milamba-sede	Milamba-sede Pamunga*, Luchete,	10/05/08
			Zalala	Zalala	10/05/08
TOTAL	8	13	Zalala	Muechanga*	10/05/08

*fishers from Muichanga island living at Zalala fishing centre
** fishing centres included in the previous study

5.1.2.4 Commercial fisheries

The work has been developed on the basis of publicly available data and no original research or fieldwork has been undertaken.

5.1.2.5 Maritime traffic (Navigation)

The study[45] was carried out using information obtained from interviews with several entities in Public Institutions, International Organizations as well as those from Public and Private Companies. The interviews were conducted directly whenever possible (person-to-person) and by use of information & communication technologies such as telephone, internet and fax.

Websites of several institutions, organizations and companies linked to the subject under study were also visited.

[45] The Maritime Traffic study is not presented as a separate document, but wholly included in the EIA.

5.1.2.6 Public Participation

The main goal of the public consultation process is to raise concerns and obtain suggestions for the added benefit of the Interested and Affected Parties (I&APs), organizations, or individuals. This process provides an opportunity for the I&APs to comment on the results of the EIA and serve as a forum to express concerns, opinions, and comments on any issue that is considered relevant for inclusion in the EIA. The public consultation process also establishes a communication channel between the public, the consultants, and the developer for the duration of the EIA process.

Phases of the Public Consultation Process

The public consultation process consists of two fundamental phases: i) scope definition and ii) impact assessment.

i) Public Consultation during the Scope definition phase

The aim of the scope definition phase is to present the Draft Environmental Pre-Viability and Scope Definition Report (EPSDR) and Terms of Reference. At this stage one public meeting was held in Pemba and two small meetings for the Administrator and District Consultative Council were undertaken in Mocimboa da Praia and Palma. The meetings were conducted during the first week of April 2008 (Refer to Public Participation Report).

After the meetings a preliminary version of the Issues and Response Report was prepared which was updated after the second round of public consultation meetings to present the EIA.

ii) Public Consultation during the Impact Assessment Phase

Meetings were held to present and explain the results of the EIA and gather concerns and suggestions for the EIA.

Before the meetings there was a 2 week period for the I&APs and relevant authorities to review the findings of the draft EIA. After the meetings, another 2 week period was provided for the I&APs to present any further comments. The reports were verbally presented to the I&APs, as follows:

- Through a public meeting in Pemba; and
- Through meetings in Mocímboa da Praia and Palma.

There was an effort to ensure that local fishermen can understand and have the opportunity to make comments on the results of the EIA. As during the scope definition phase, explanations were brief with visual aids.

After the meetings the Issues and Response Report was updated (Refer to the Public Participation Report in Volume III).

Identification of Interested and Affected Parties

The I&APs database was developed by consulting previous databases for similar projects in Cabo Delgado and validated through a data survey in the affected districts. At the same time, the project was disseminated through the Tourism Association of Cabo Delgado, travel agencies operating in Cabo Delgado Province, and a survey of economic activities in the area with a particular focus on small-scale fishing. The database includes the following (Also refer to the Public Participation Report in Volume III):

- National and provincial government and elements from the District Consultative Councils;
- Representatives from the local fishing industry and local non-industrial (artisanal) fishing;
- Representatives from the tourism industry;
- Environmental groups and NGOs; and
- Research organizations

The involvement of the civil society was as follows:

- For the City of Pemba, an invitation was made through *Jornal Notícias* and announcements on the provincial broadcasting station (*Rádio Moçambique* in Pemba), invitation letters to those that are in the database created for this purpose, and electronic invitations. The target group comprised the provincial government, tour operators, and universities based in Cabo Delgado.

- For the district offices, an invitation was made to the District Consultative Council through a letter addressed to the District Administrator and through the Provincial Secretariat.

Moreover, there were also newspaper ads (*Jornal Notícias*) and radio advertisements inviting I&APs to participate. Currently, the list of people interested in the process comprises a wide range of individuals and organizations.

Opportunities for public involvement

For the first round of public meetings, a simple presentation about the proposed project and the EIA process has been prepared as a basis for the participation of the I&APs in the EIA.

For the second round, a non-technical summary of the EIA was produced, including the drilling project, the baseline environmental information, the major potential impacts and the relevant mitigation measures. The EIA reports, in Portuguese and English were placed in the Anadarko´s website.

The general public was able to communicate their opinions and concerns through the following means:

- Written comments from I&APs on comment sheets attached to the BID and non-technical summary;
- Individual or small-group meetings with owners of tourism resorts; and
- Public meeting held Pemba.
- Meetings held in Mocimboa da Praia and Palma with the Administrators and District Consultative Council

All comments received were documented in an updated version of the IRR. Any necessary changes to the EIA and specialist studies were made based on the comments received from the I&APs and relevant authorities. A Public Participation Report is included in Volume III of this report.

5.1.3 Additional reviews

The information on drilling operations, the general Oil Spill Contingency Plan and the results of the Oil Spill Trajectories were also reviewed by specialists.

Drilling information

A 3rd party review of the information about the drilling operations has been carried out and a report produced.

Oil Spill Contingency Plan

In this regard, a 3rd party review of the Oil Spill Contingency Plan (OSCP) prepared by Anadarko Petroleum Corporation for the proposed Anadarko operations in Mozambique was undertaken. This is a generalised plan which could form the frame work for a more comprehensive plan.

5.2 THE PHYSICAL ENVIRONMENT

This chapter was be supported mostly by the information gathered during the EIS for the Seismic project in Area 1. However, whenever it was possible, updated information was be included. In addition results from a combined environmental and marine physical process (NORWECOM model) were used to simulate the oceanic currents.

The description of the physical environment is divided into six subsections:

- Climate and meteorology
- Cyclones
- Tidal range
- Circulation
- Bathymetry, including bottom topography and features (available information)
- Temperature, salinity and oxygen

5.2.1 Climate and Meteorology

Since the project area lies in the northern region of Mozambique, the climate description will be based on data gathered from Pemba, Mocimboa da Praia and Macomia meteorological stations.

The climate of the study area is strongly influenced by the Intertropical Convergence Zone (ITCZ)[46]. In January the ITCZ is located at about 15°S and the East African coast Equator is under the influence of northeasterly winds.[47] In July the ITCZ is situated at about 15°N and most of East Africa is u nder the influence of southeasterly and southerly winds.[48] Thus, the area is characterised by two distinct seasons: a wet season running from November to March, and a dry season between April and October.

During the wet season the mean temperatures vary between 25° and 27° C, and between 87% and 91% of the total annual rainfall (900-1000 mm) falls during this period. In the dry season there is very little precipitation and the mean temperatures vary between 22° to 25° C.

The following graphics illustrate the temperature and precipitation data measured in Pemba (Figure 19), Macomia (Figure 20) and Mocimboa da Praia (Figure 21).

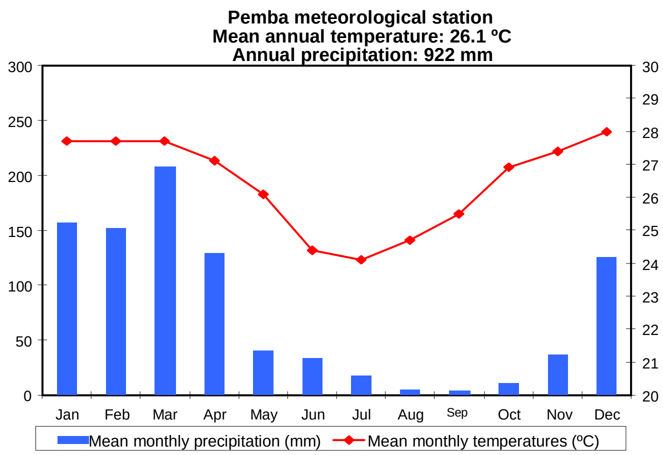


Figure 19 Climate data for Pemba

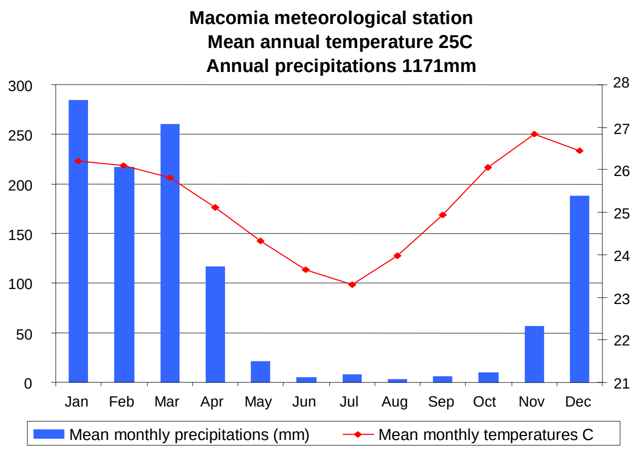


Figure 20 Climate data for Macomia

46 The ITCZ is an area of low pressure that forms where the Northeast Trade Winds meet the Southeast Trade Winds near the equator. As these winds converge, moist air is forced upward causing water vapor to condense and cool resulting in heavy precipitation.

47 South of the Equator, the winds may become more north-westerly due to the effect of the earth's rotation.

48 These seasonal wind regimes are known as monsoons

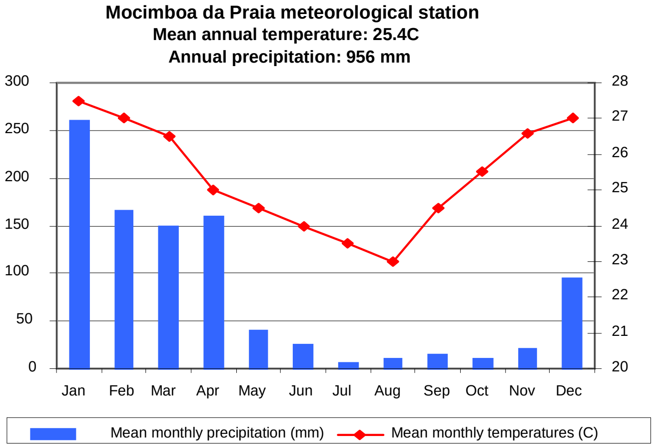


Figure 21 Climate data for Mocimboa da Praia

The winds in the northern part of Mozambique are influenced by the monsoon system with NE winds during the southern summer and SW winds during the southern winter. Central and Southern Mozambique are dominated by the SE trade winds (Sætre and Silva, 1982, Figure 22). The winds are usually weak except during cyclones when the speed could exceed 100 km hr^{-1}.

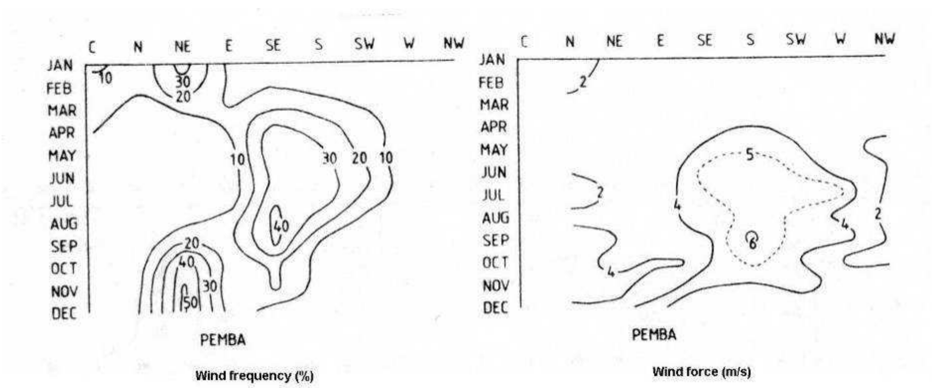


Figure 22 Mean monthly frequency (left) and force (left) of the winds observed in Pemba Meteorological Station

The analysis of the wind behaviour in the study area distinguishes four periods with determinant characteristics, during the months of January (middle of the wet season), April, July (middle of the dry season) and September.

In January, winds are recorded from the north (27%), being the northwest winds predominant (51%) (See Figure 23). During this month, winds with average velocities varying between 5 and 10km/h are common (Figure 24).

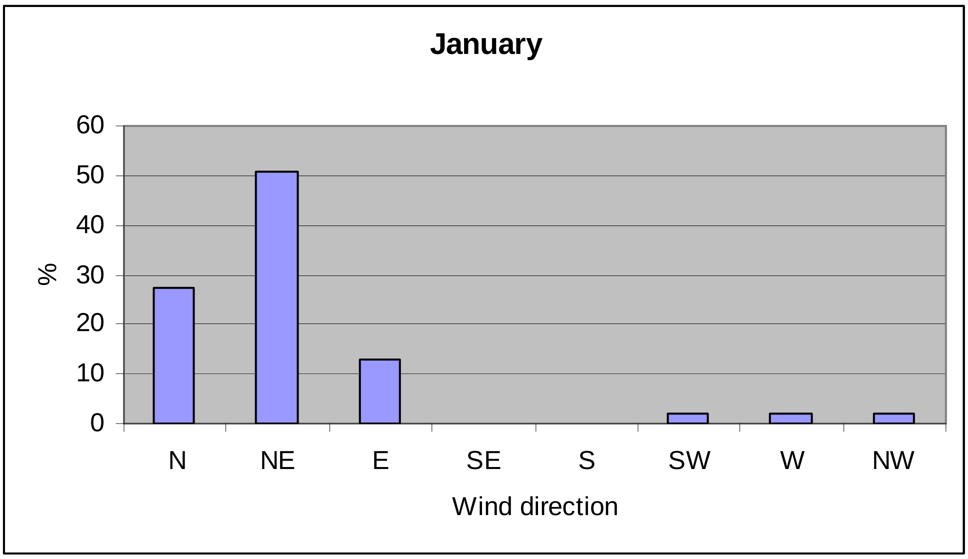


Figure 23 Wind direction – January (1962-2006)

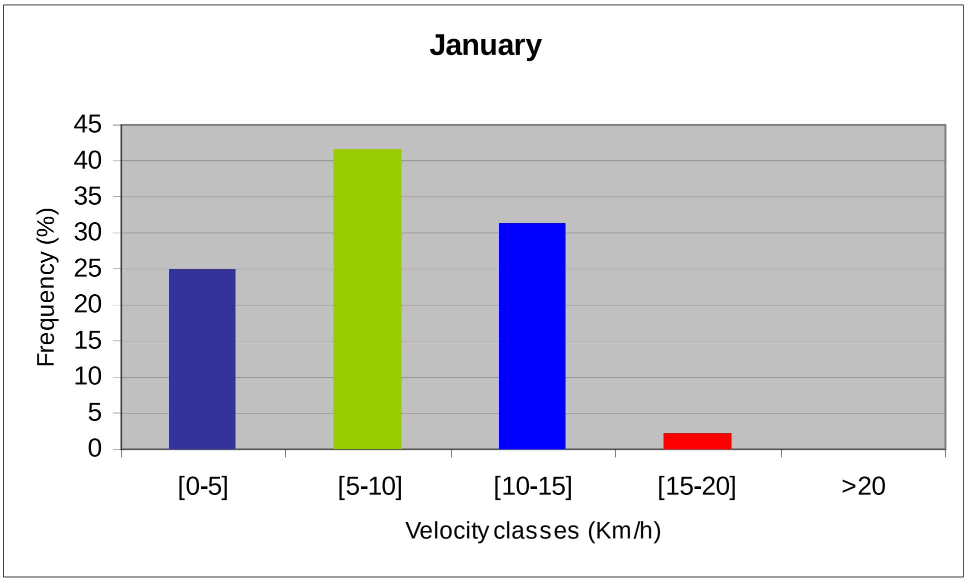


Figure 24 Frequency of the velocity as a function of velocity classes, January

In the month of April the winds are predominantly from the south (59%) and southwest (37%) (Figure 25); the most frequent winds have an average speed which varies between 10 and 15km/h (Figure 26).

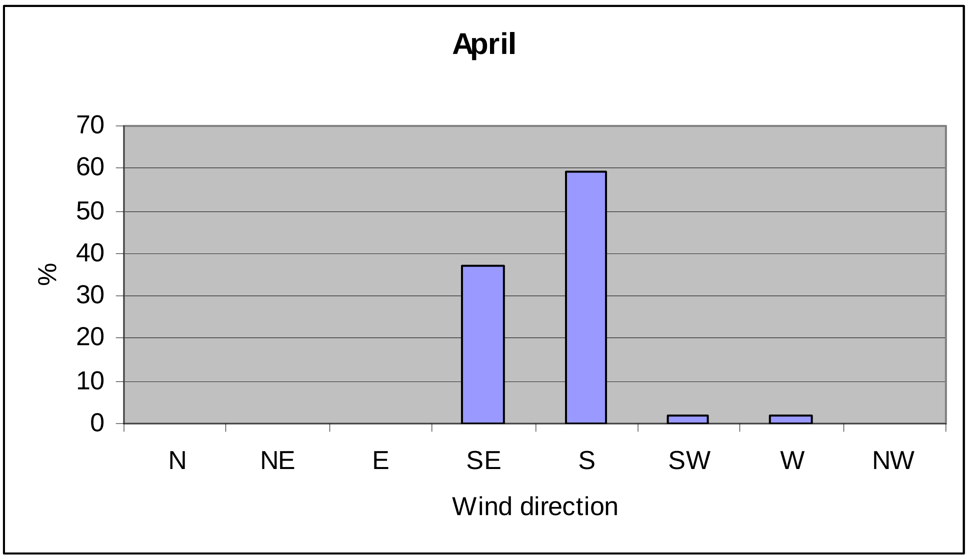


Figure 25 Wind direction – April (1962-2006)

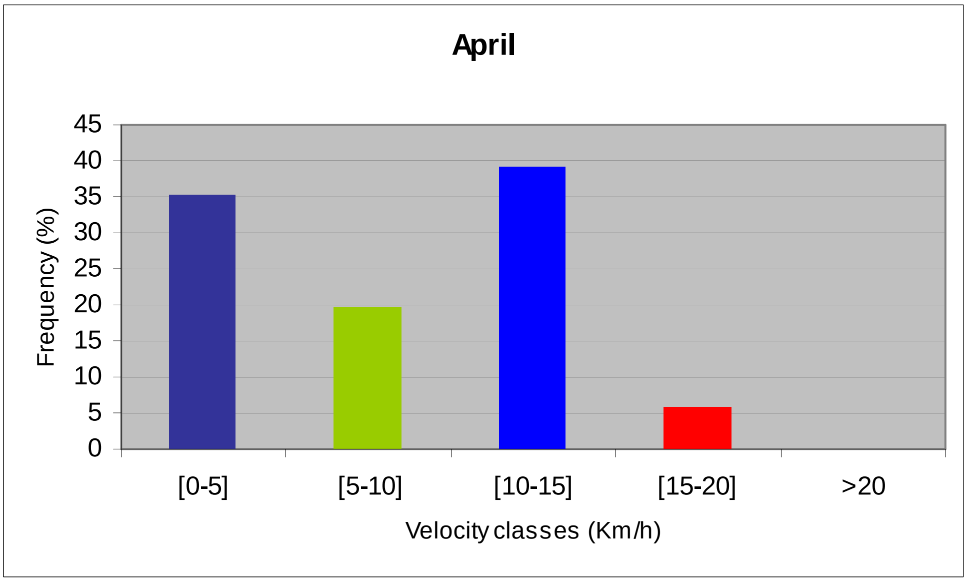


Figure 26 Frequency of velocity as a function the velocity classes, April

The strongest winds are during July with them reaching speeds greater than 20km/h (Figure 27). However, the most frequent have speeds between 15 and 20km/h (Figure 28).

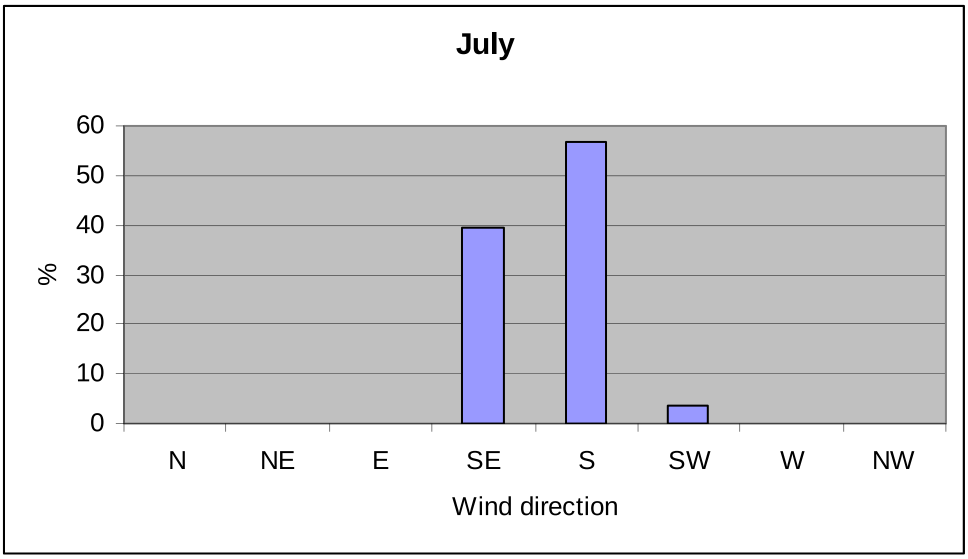


Figure 27 Wind direction – July (1962-2006)

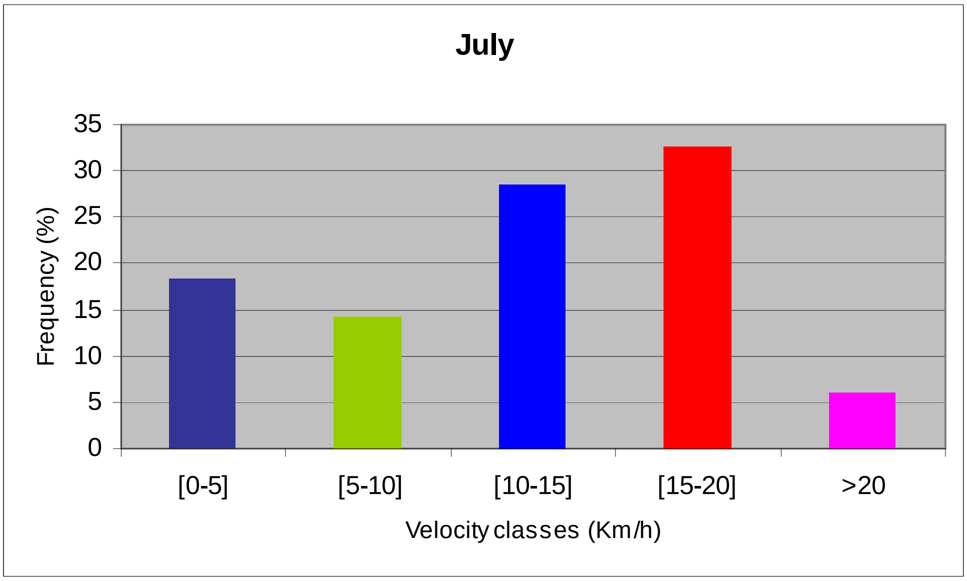


Figure 28 Frequency of velocity as a function of the velocity classes, July

In the month of September, the winds are predominantly from the southeast (34%) (Figure 29); the most common winds register velocities between 10 to 15km/h (Figure 30).

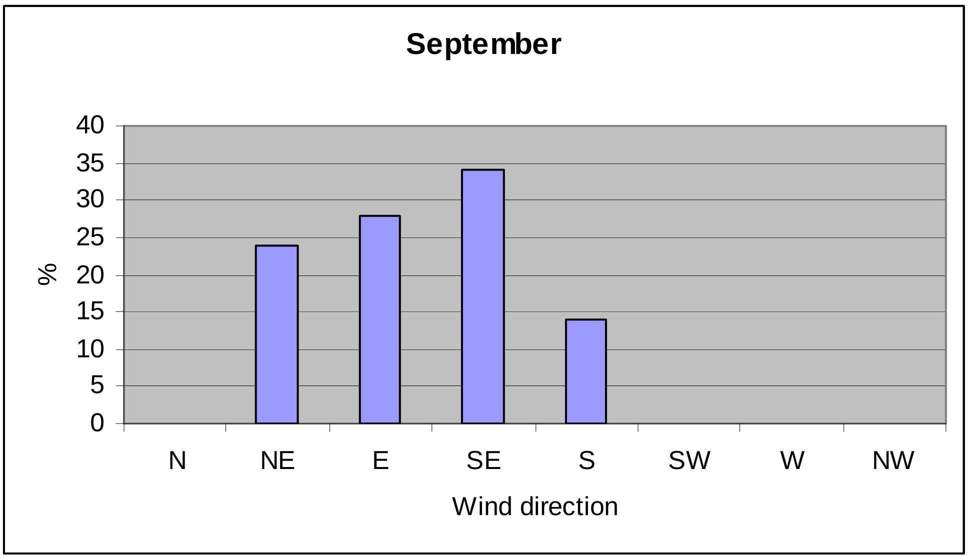


Figure 29 Wind direction – September (1962-2006)

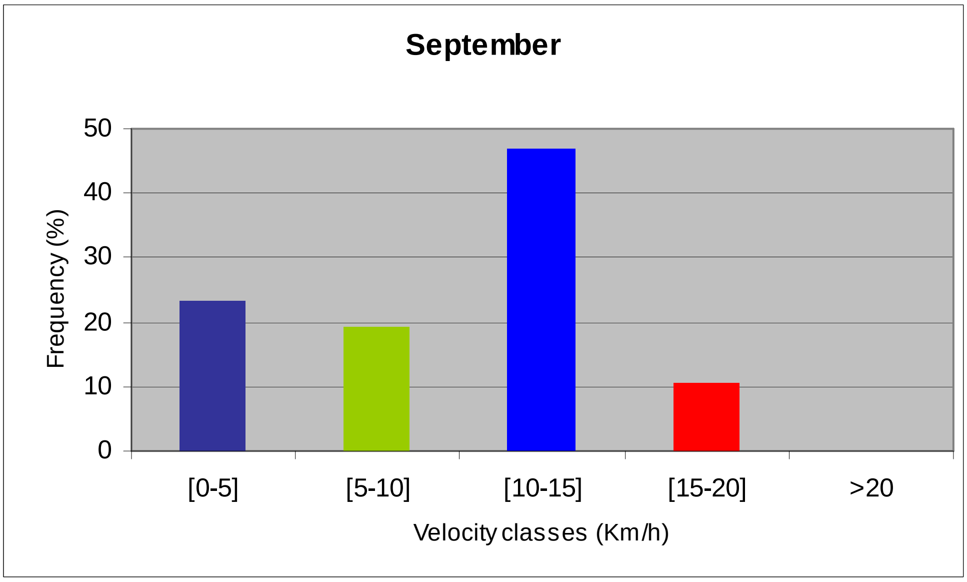


Figure 30. Frequency of velocity as a function of the velocity classes, September

5.2.2 Cyclones

Northern Mozambique is prone to cyclones and tropical storms. They are generated in the mid Indian Ocean, move South-West with speeds of about 10km hr^{-1}, impact Mozambique Coast at either Cabo Delgado or Nampula Province, turn South and reduce speeds until downgraded in the middle of the Mozambique Channel (Figure 31 below).

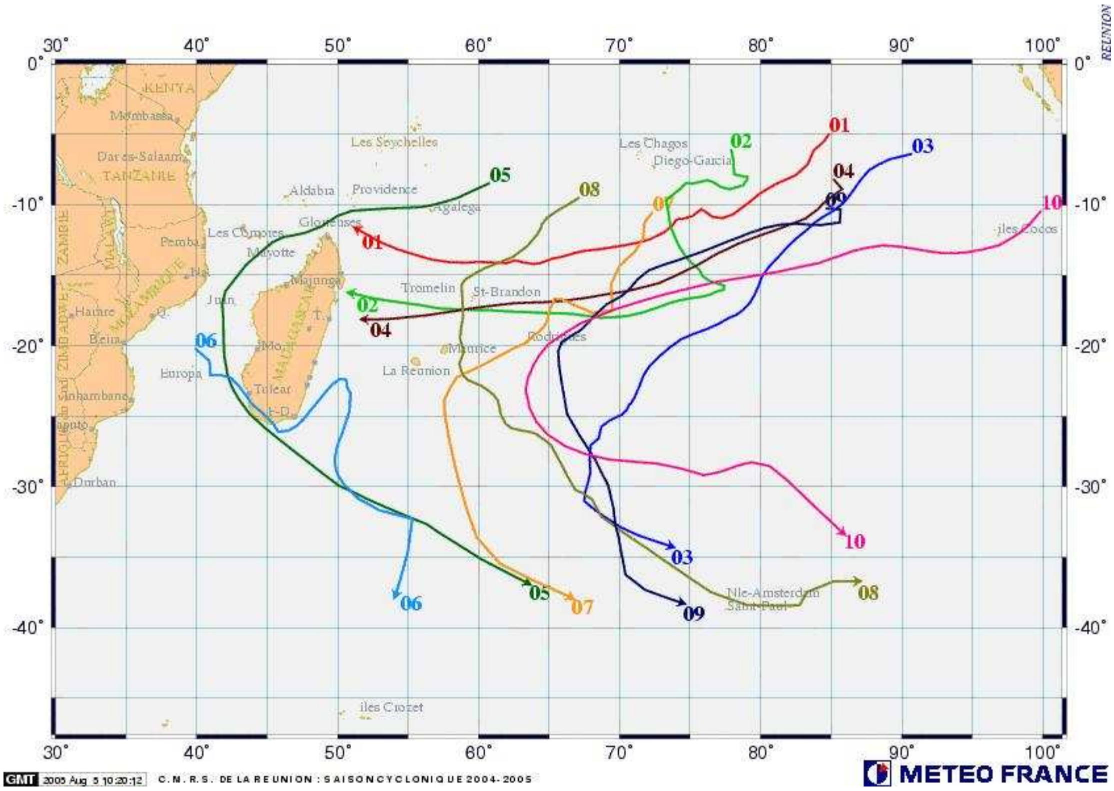


Figure 31 Trajectory of some cyclones in the Indian Ocean during the period 2004/2005 from France Meteo Services Web Page

On average, 15 to 20 cyclones are generated annually and the cyclones move from east to west. However, only a few of these cyclones actually reach the Mozambican coast, because most are intercepted by Madagascar or lose energy before reaching the coast.

The Mozambican coastline has been over the past years affected by more than 28 cyclones. The area of the country most prone to these cyclones is the central part of the country with heavy rains and winds causing notable damages.

Statistically, the north of Cabo Delgado is not prone to cyclones. However, in 1952 Cyclone Lindi affected the south of Tanzania, very close to the Mozambican border, causing damages in the city of Mtwara in Tanzania and in the District of Palma in the north of Mozambique. More recently, in November 2002, a cyclone occurred in the southwest basin of the Indian Ocean (Cyclone Atang). However when it reached the Mozambican coast it was weak, and it was in the form of a tropical depression. Nevertheless it caused heavy rains and strong winds with velocities of 70km/h in the Districts of Ibo, Palma, Mocímboa da Praia, Mueda and Macomia.

Figure 32 shows the cyclone trajectories in the Mozambique Channel including Cyclone Atang.

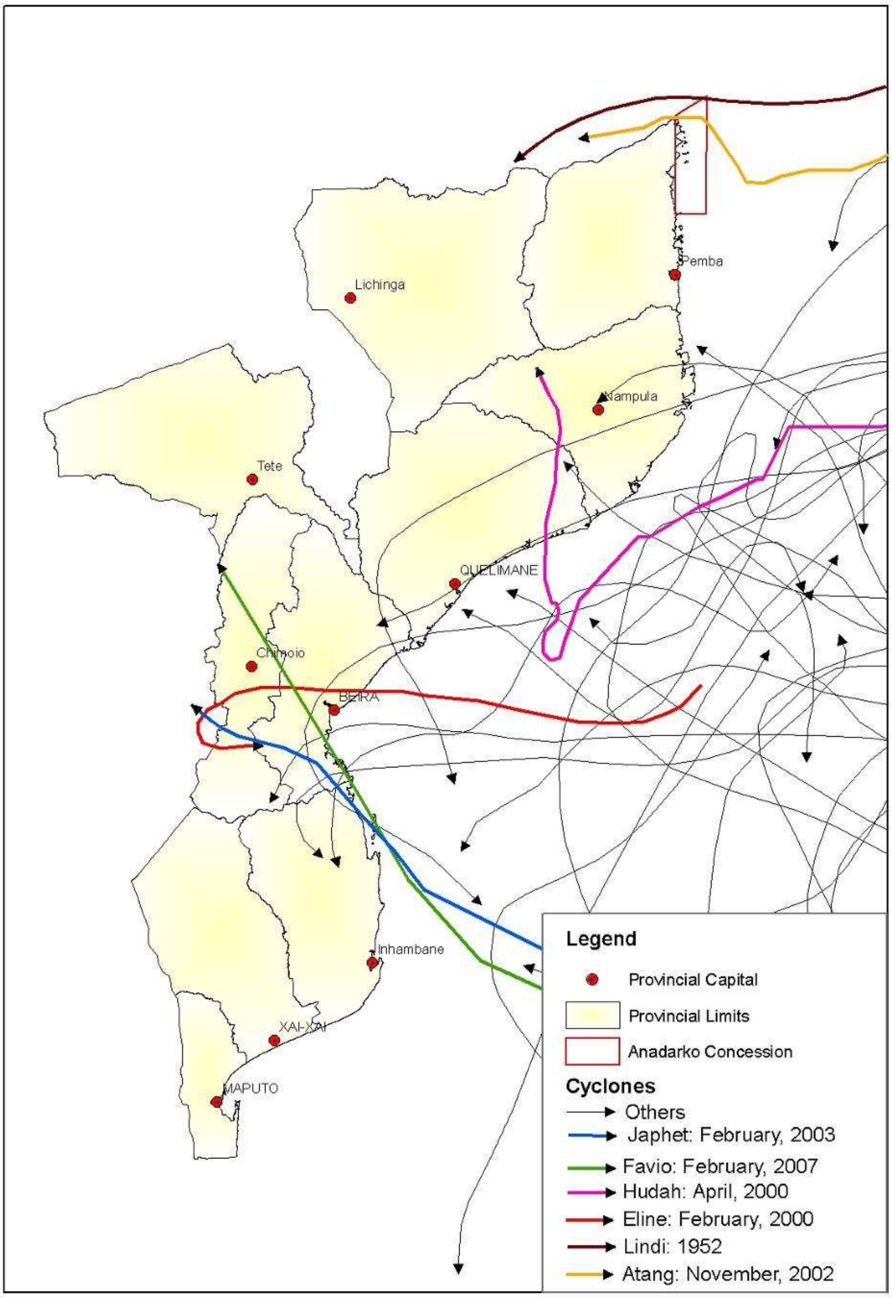


Figure 32 Cyclone trajectories on the Mozambican channel

Recently, Mozambique developed a Cyclone Alert system. This system came into force on the 1st of November 2002. It was developed by the National Institute of Meteorology (INAM) and the National Institute for the Management of Calamities (INGC) in collaboration with FEWS NET MIND, and 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: Atang was less than a Category 1 storm when it hit the coast. A Category 5 cyclone is rare and has not been recorded for Mozambique).

5.2.3 Waves and Tides

The waves in the region are relatively small, ranging from calm to about 3m significant wave height (Figure 33) except during cyclones.

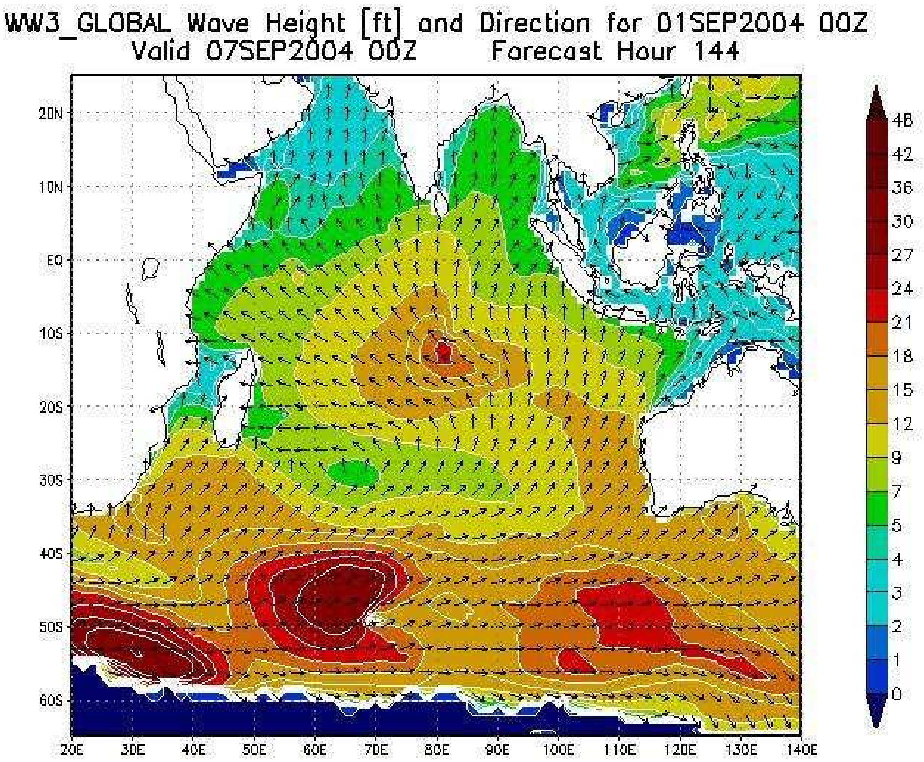


Figure 33 Sea state and swell Forecasting - WaveWatch III model data base from France Meteo Services Web Page

Waves enter Mozambique Channel through the South and North, turning anti-clockwise due to Coriolis.

The tides along the entire Mozambican coast are semi-diurnal, between 2m and 6.5m. One of the largest amplitudes on the entire African coast is found in Beira (6.3m) and is related to the broad and shallow continental shelf (140km in width) at this point (Figure 34).

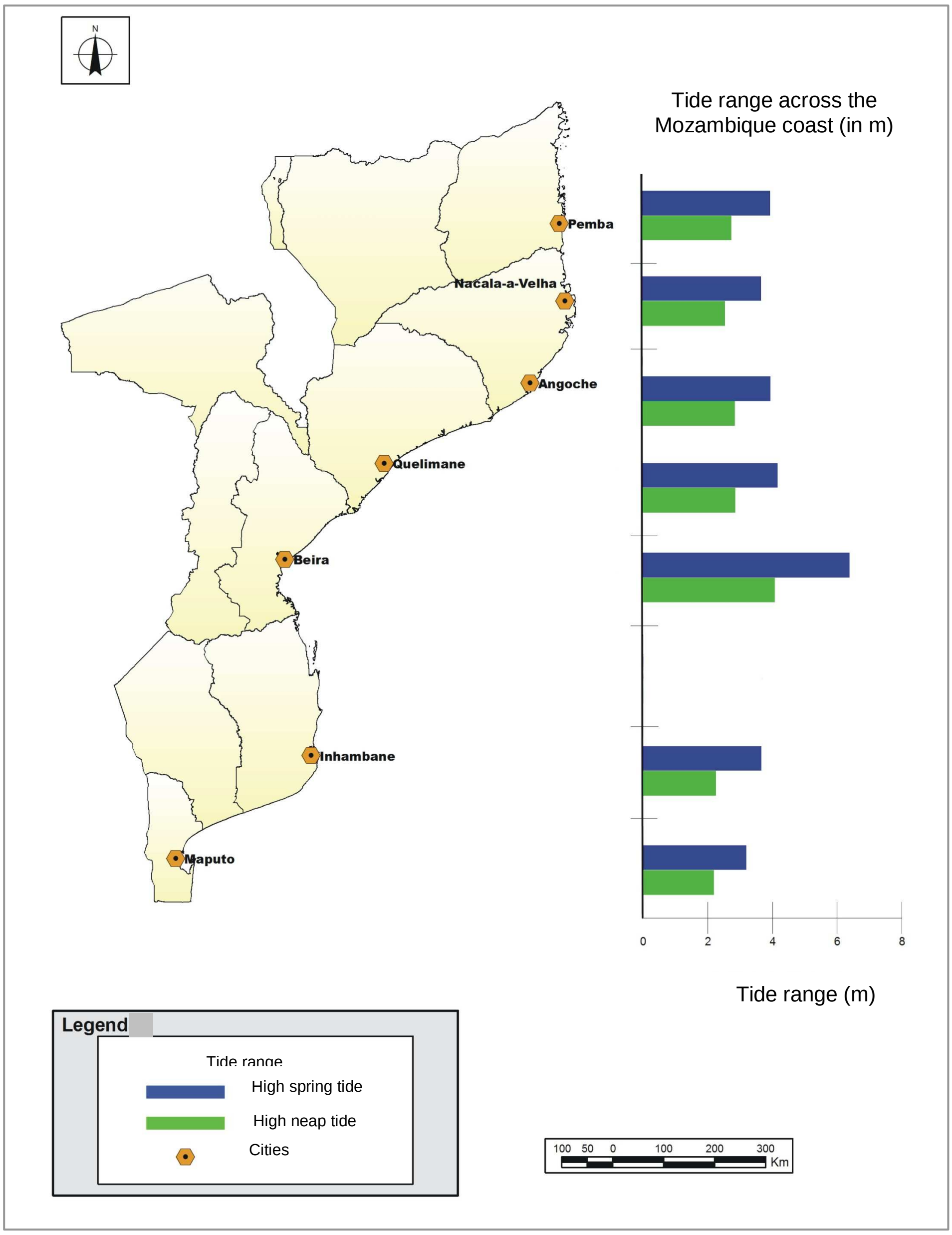


Figure 34 Tidal ranges along the Mozambican coast

The amplitude of the tides in Pemba is 4.0m (mean high spring tide) and 2.8m (mean high neap tide). Tides are diurnal with a form factor of 0.07 (Figure 35). The tidal range varies markedly throughout the month and can be as low 0.6m during low neap tides.

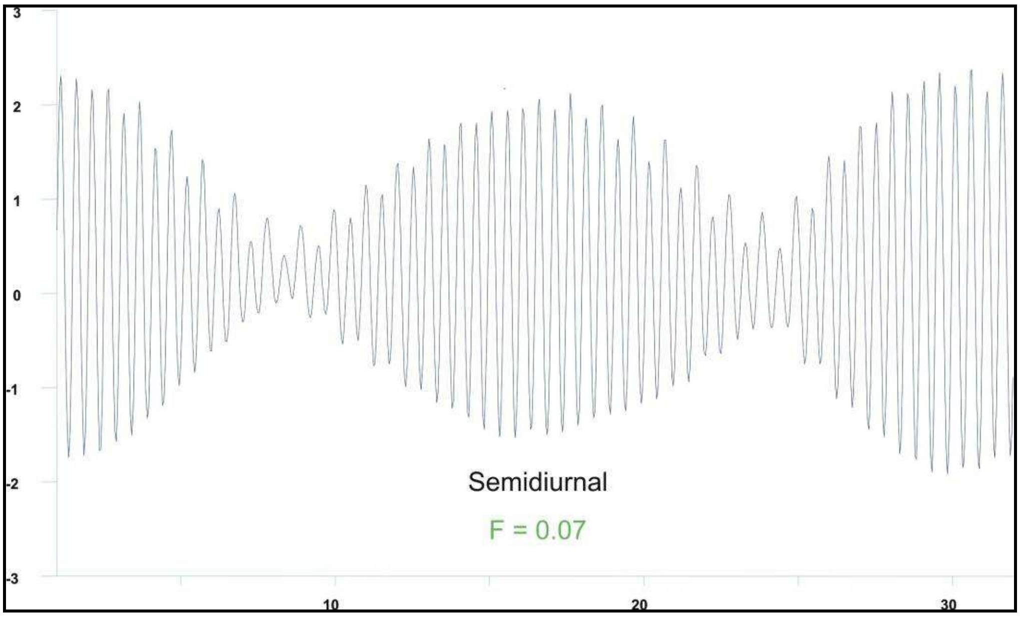


Figure 35 Monthly variation in tidal range at Pemba (Mahongo, 2006)

5.2.4 Circulation

The ocean circulation is characterized by a warm Mozambique current flowing south and by a seasonal upwelling due to the monsoon winds (Steen and Hoguane, 1992).

Regarding the circulation patterns in the Mozambique Channel, the classical interpretation is that the Indian Ocean has a huge gyre of water circulating anticlockwise, driven by the winds. This equatorial water mass known as the South Equatorial Current (SEC) flows westward across the Indian Ocean and splits when it reaches east Madagascar, into a southward flowing branch, the East Madagascar Current (EMC), and a northern branch that flows north to Cape Amber, the northern point of Madagascar. The latter branch veers westwards at Cape Amber towards the coast of Africa, where it bifurcates into northward and southward branches. The northward flow becomes the East African Coastal Current, while the southward flow becomes the Mozambique Current.

The Mozambican current has classically been viewed as a Western Boundary Current (WBC) of the Indian Ocean providing waters for the more powerful flowing Agulhas Current that flows in a southwest direction along the South African coastline.

Although the overall flow of Mozambique Current is southwards there are, however, several smaller semi-basin and regional circulation patterns as shown in Figure 36. Closer inshore, cooler pockets of water flow parallel to the coast, but in a direction opposite to the Mozambique Current.

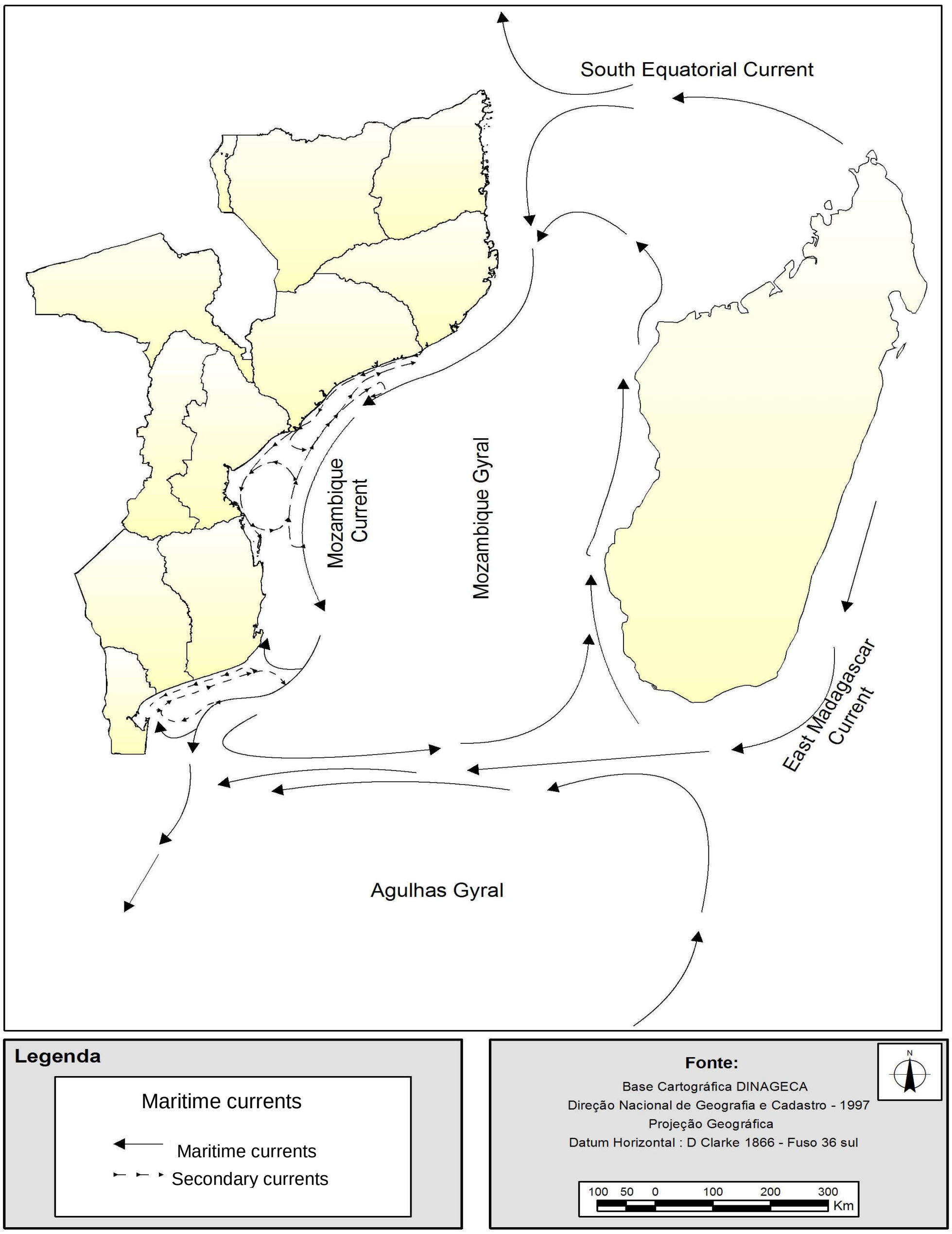


Figure 36 Circulation patterns in the Mozambique Channel from Impacto & CSA, 2007

Figure 37 below shows the anti-clockwise circulation induced by the South going Mozambican current in the northern Mozambique driven by an anti-cyclonic gyre induced by topography.

It provides the numerical results of the mean surface layer (20m depth) circulation (speed and current vectors every second grid node) in the Mozambique Channel for the winter season (left) and the summer season (right).

The currents along the slope, in the project area are towards the south and in general stronger, where values rich above 7 m s^{-1} along the coast at 20 m depth (Figure 37), as given by NORWECOM model (Asplin et al, 2006).

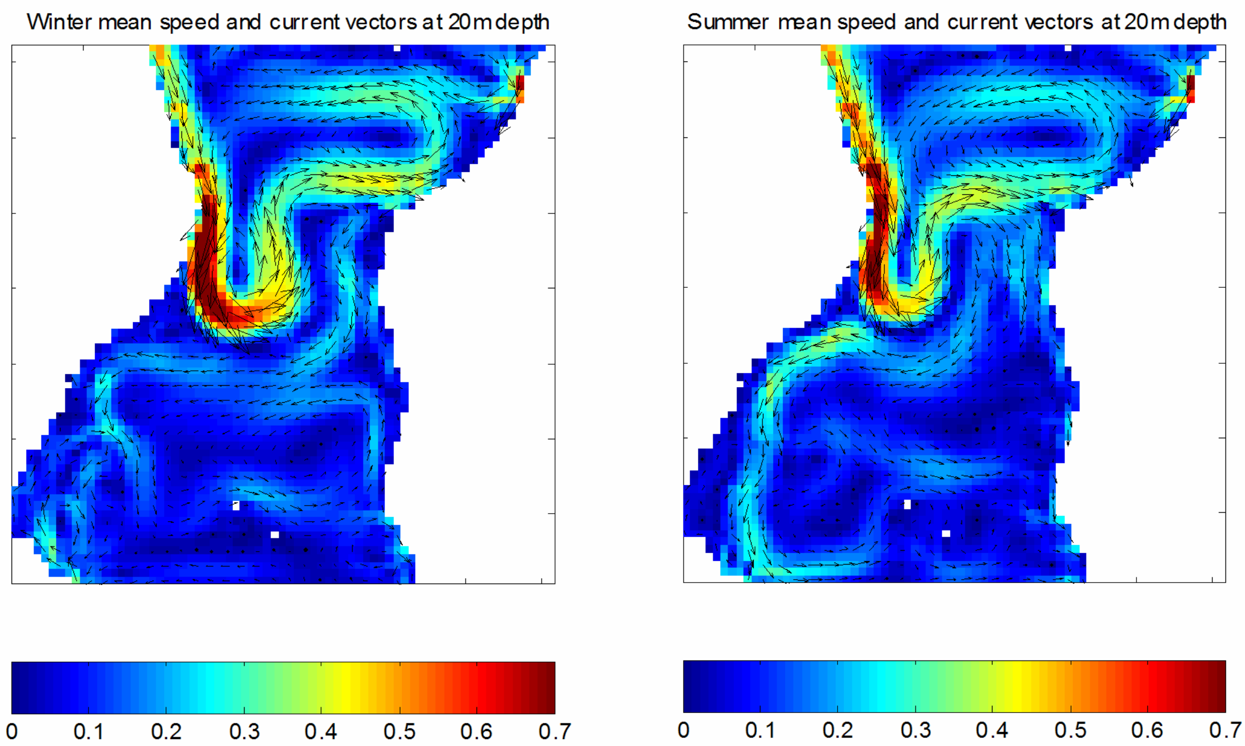


Figure 37 Numerical results of the mean surface layer (20m depth) circulation (speed and current vectors every second grid node) in the Mozambique Channel for the winter season (left) and the summer season (right) from NORWECOM model (Asplin et al, 2006)

Di Marco *et al* (2002) re-evaluated hydrographic data from lines 12 and 14 of the World Ocean Circulation Experiment (WOCE) Hydrographic Program (WHP) in the channel's northern and southern extremes (the latter at c. 24º30'S). The research team also reanalyzed data study a 1965 Australian cruise across the Mozambique Channel at 12ºS and 15ºS.

The researchers found a southward transport above 2500m depth of 29.1 and 5.9 SV for lines 12 and 14 (1 Sv = $1x10^6 m^3 S^{-1}$).

However, the southward flow through the Mozambique Channel does not appear a continuous flow as based on the WBC model. Saetre and da Silva (1982, 1989) postulated that the current in the channel occurs in the form of various large-dimension clockwise and counter-clockwise eddies (Figure 38).

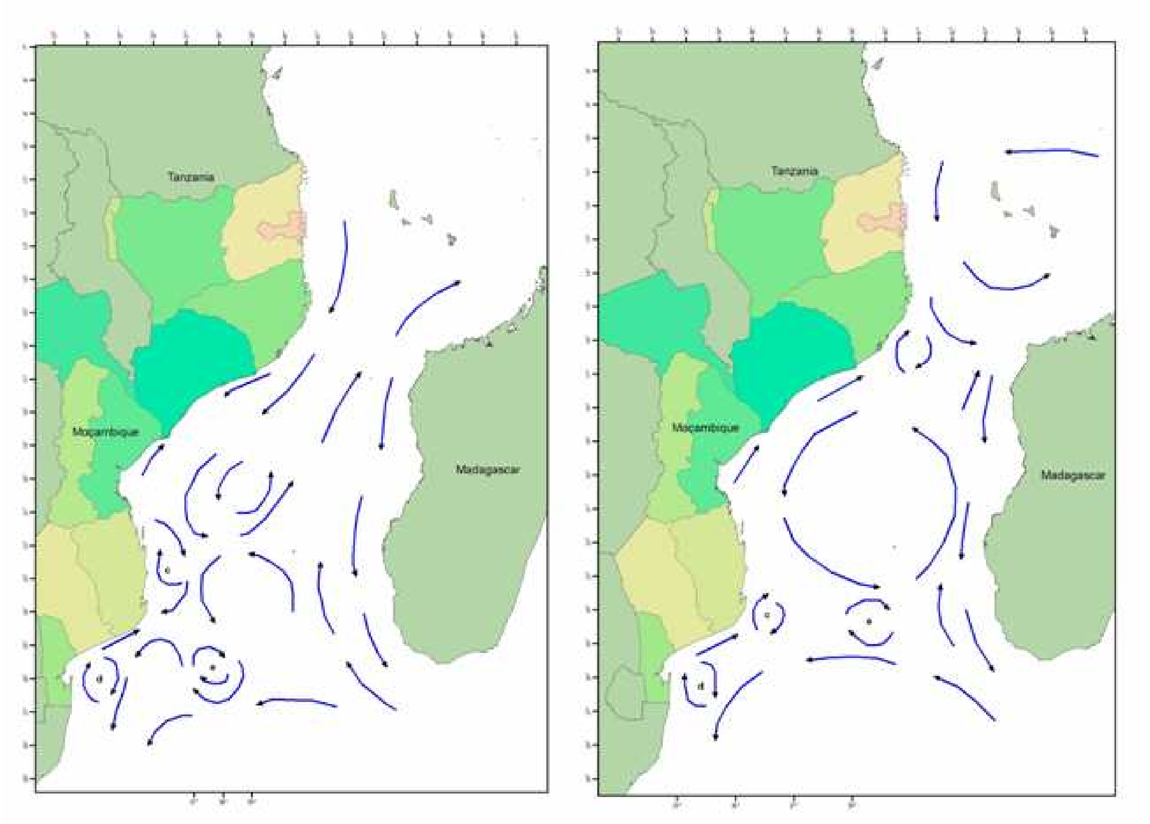


Figure 38 Circulation of the tides according to Saetre and da Silva [da Silda] (1984)

More recently, de Ruijter et al (2002) confirmed de Saetre and Silva's hypothesis through the use of satellite tracking of buoys. The results clearly show the movement of the buoys in a southerly direction, but via a series of counter-clockwise eddies of around 300km in diameter, along the whole water column (Figure 39).

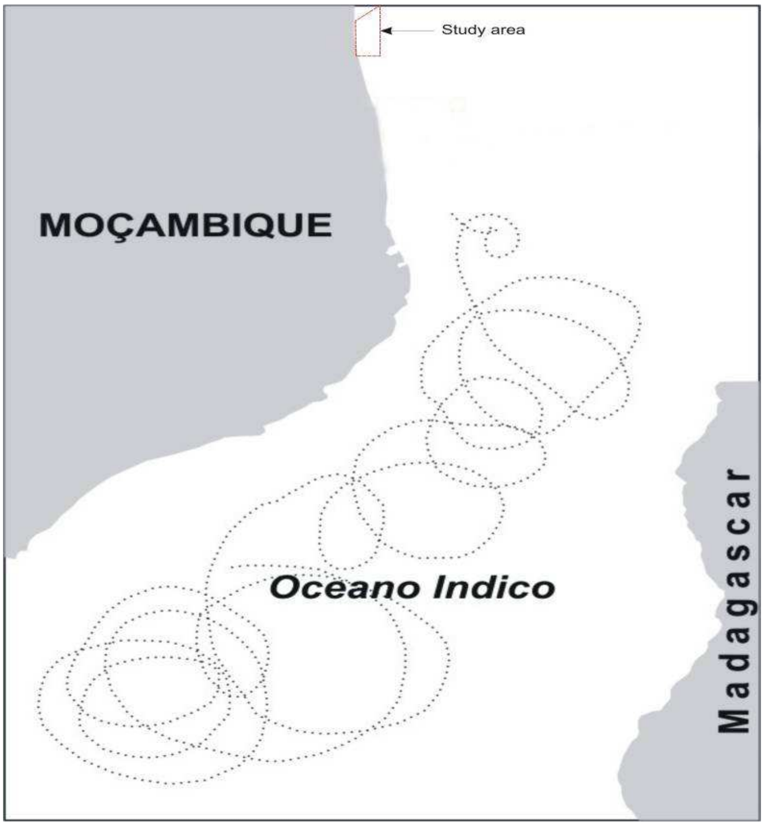


Figure 39 Patterns of buoys tracked by satellite in the Mozambique Channel from Ruijter et al, 2002

Rinderinkhof et al (2003) placed current measuring devices along a narrow part of the channel (around 17º S), clearly indicating a current of $1ms^{-1}$ in a southerly direction along the western side of the channel. Di Marco et al (2002) also described a transport in a southerly direction, with water flows above 2,500m of depth between 29.1 and 5.9 Sv (1 Sv = $1x10^6m^3S$).

These data, therefore, indicate an overall southward flowing current of varying velocities via a series of anti-cyclonic eddies rather than a consistent southerly flow as envisaged by the WCB model.

5.2.5 Bathymetry

The bottom topography in the area is characterized by narrow shelf and steep slope. The depth of the continental shelf increases to about 200m in about 1 Nautical Mile from the coast (Figure 40).

The Continental Shelf along Cabo Delgado Province has 481km² of tidal flats and 2059km² of sandy shallow water (0 to 20m deep) and a further continental slope between 20m and 200m (Figures 40 & 41).

The continental shelf in the northern area of Mozambique is very narrow and deeply incised with east-west orientated submarine canyons. These canyons run westwards from deepwater, between the islands towards the coast. Apart from the canyon incisions, the 1,000 and 2,000m isobaths generally lie parallel to the coast of the mainland.

Figure 40 Bathymetry in the study area

The coast is characterized by a fringe of islands surrounded by corals coupled with volcanic rocks (Hoguane, 2007). The bottom is actually rough and rocky in some parts of the study area. However, there is little information available for the project area regarding the bottom structure and composition.

Beyond the fringing coral reefs on the eastern side of the islands, the water depth increases sharply in many places; gradients of 1:1 (45º) may be found in water depths exceeding 2000m (Figure 41 below).

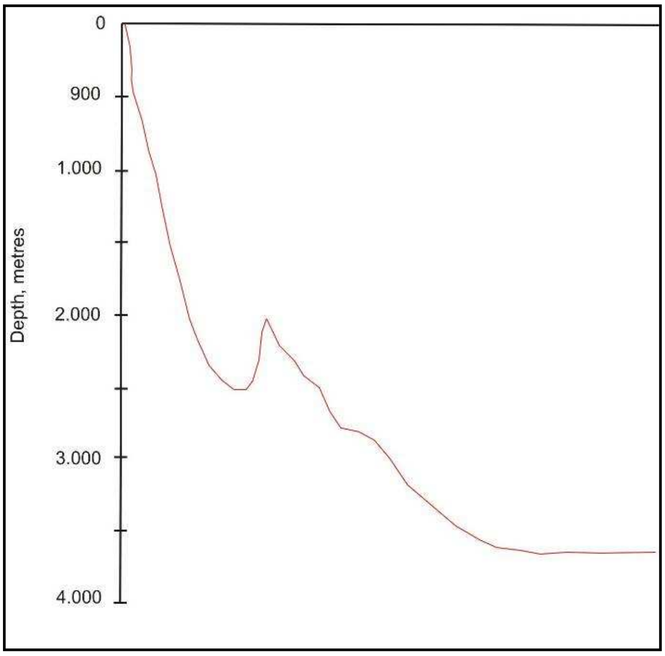


Figure 41 Profile of continental shelf and slope in Mocimboa da Praia from Impacto & CSA, 2007

5.2.6 Temperature, Salinity, and Oxygen

There is no systematic and detailed information on the physical and chemical parameters of the waters in the north of the Mozambique Channel. Some scientific data were obtained during the cruise of the “Dr Fridtjof Nansen” between 1977 and 1978 and are described in 1982 by Saetre and da Silva. During this cruise, measurements were carried out at various hydrographic stations, including 4 stations located within the AMA1 concession area (southern section).

More recently, in 2002, Di Marco et al (2002) presented data on some of the chemical and physical water parameters of the Mozambique Channel.

Temperature

During the summer months surface water temperatures vary between 28℃ and 28.5℃ and during the winter months between 25℃ an d 25.5℃. There is a marked decline in temperature with depth: at depths of 100 m the average temperature is

24℃ whilst at 300 m depth the temperature is 14℃ and at 500m depth the temperature is 10℃ (Saetre and da Silva, 1982). Re fer to Figure 42 below.

This happens because most of the heat energy of sunlight is absorbed in the first few centimeters at the ocean's surface, which heats up during the day, and cools at night (as heat energy is lost to space by radiation). Waves mix the water near the surface layer and distribute heat to deeper water, such that the temperature may be relatively uniform for up to 100 m. Below the 100m the temperature of the deep ocean drops gradually with depth.

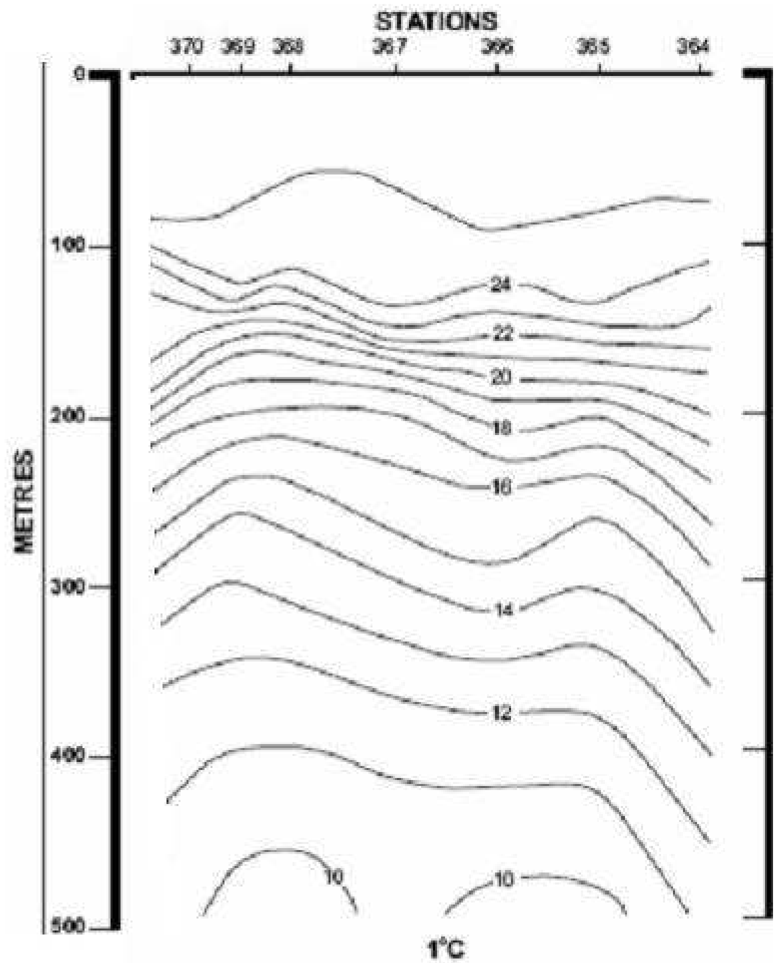


Figure 42 Temperature gradient across the Mozambique Channel with depth from Saetre and da Silva (1982)

Salinity

The northern region of the Mozambican coast is characterized by high salinities, although the spatial variation within this area is considered moderate when compared to the southern areas of the coast, where freshwater influence is greater due to the large Zambezi runoff (Impacto 2006).

In the offshore regions, surface salinity has been found to be stable throughout the year around 35.0 PSU[49]. On the Continental Shelf, slight variation has been observed, with salinities increasing marginally in the summer, probably due to the dilution caused by a greater precipitation. Salinity also increases with depth, and maximum levels of salinity (35.2 PSU) have been recorded at depths around 200m (Impacto 2006). Refer to Figure 43 below.

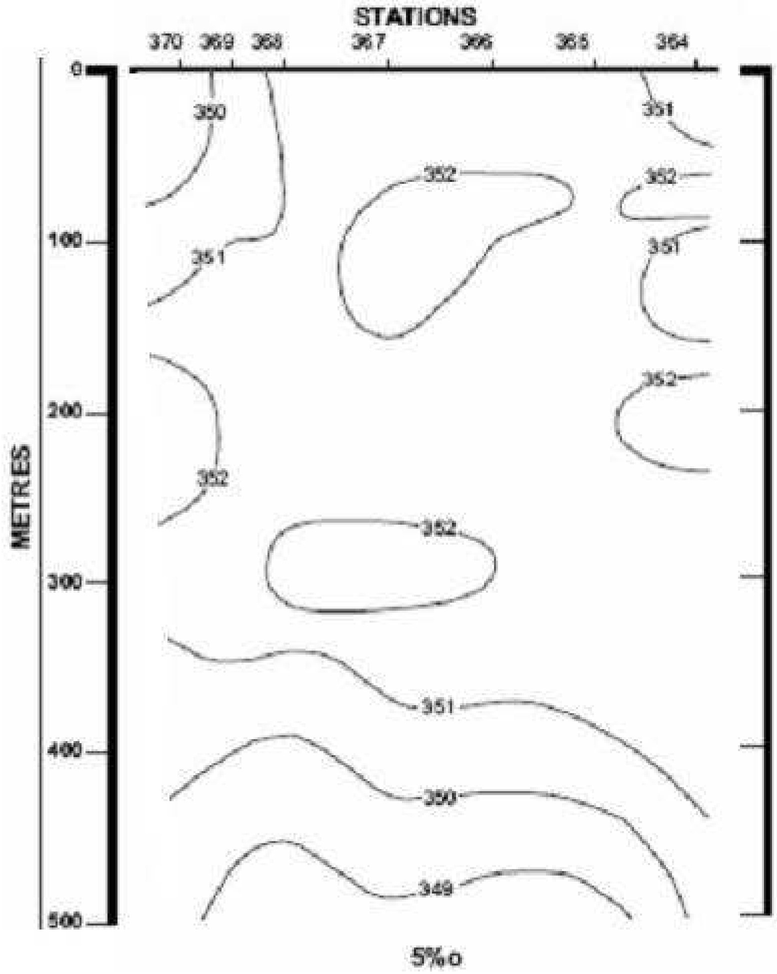


Figure 43 Salinity gradient across the Mozambique Channel with depth from Saetre and da Silva (1982)

More recently Di Marco *et al* (2002) found that surface temperatures exceeded 29ºC with relatively low salinities (in the order of 35.1-35.3 PSU) characterizing the upper 300 m the northern part of the channel. Di Marco et al. attribute the low salinities to the influence of the South Equatorial Current (SEC) of the Tropical Surface Water (TSW) which has relatively low salinity due to *inter alia* higher precipitation compared to evaporation.

At the southern extreme of the Mozambique Channel surface salinities were much higher (>35.4 PSU). Data from the Australian cruise (Saetre and da Silva, 1982), however, found surprisingly low salinities (<35.0 PSU). Although several rivers feed into the Mozambique Channel Di Marco *et al* suggest that they would not affect such

[49] Practical Salinity Units –international standard measure of salinity

a thick layer and the authors attribute low salinities to water from the SEC rounding Cape Amber and pushing south through the channel at the surface.

Dissolved oxygen

There is indication that surface waters of the study area are well oxygenated. A high-oxygen core of water is observed at 500m depth flowing west with the SEC north of Madagascar with oxygen values of >200µmol kg^{-1}. This high oxygen layer appears to flow west across the northern end of the Channel characterized by values of >180 µmol kg^{-1}.

At 12ºS, the maximum forms a band across the Mozambique Channel of oxygen values between 200 and 180 µmol kg^{-1}. This band of oxygen is still present across the width of the Channel at 15ºS.

The distribution of dissolved oxygen further supports the view of a flow into the Mozambique Channel from the north of the SEC.

Maximum dissolved oxygen values of 220 µmol kg^{-1} were also found even further south at 500m depth along the World Ocean Circulation Experiment (WOCE) line 14 (the southern extreme of the Mozambique Channel). These high levels of oxygen concentrations probably indicate the contribution of waters transported south in the EMC and/or re-circulated from further south in the Madagascar Basin.

Minimum oxygen values in the water column were found at intermediate depths of between 900 and 1,500m (varying between 60 µmol kg^{-1} along WOCE line12 and 120µmol kg^{-1} along line 14). At increasing depths (between 1,500 and 200 m) oxygen levels again increase to between 140 µmol kg^{-1} for WOCE line 12 and 160 µmol kg^{-1} for WOCE 14.

The increase in minimum oxygen values at intermediate depths from <60 µmol kg^{-1} at 900m depth at the north entrance of the Channel (WOCE line 12) to 120 µmol kg^{-1} at 1,100 m depth at the southern extreme of channel (WOCE line 14) may indicate southward spreading through the Channel with erosion of the oxygen-minimum layer from above by waters containing higher oxygen concentrations (Di Marco et al., 2002).

Figure 44 below shows that dissolved oxygen presents high values in the surface water, as one would expect (average of 5.0 ml/L) then a slight reduction occurs in the intermediate zone (between 300 and 400 metres), increasing once again in the deeper waters.

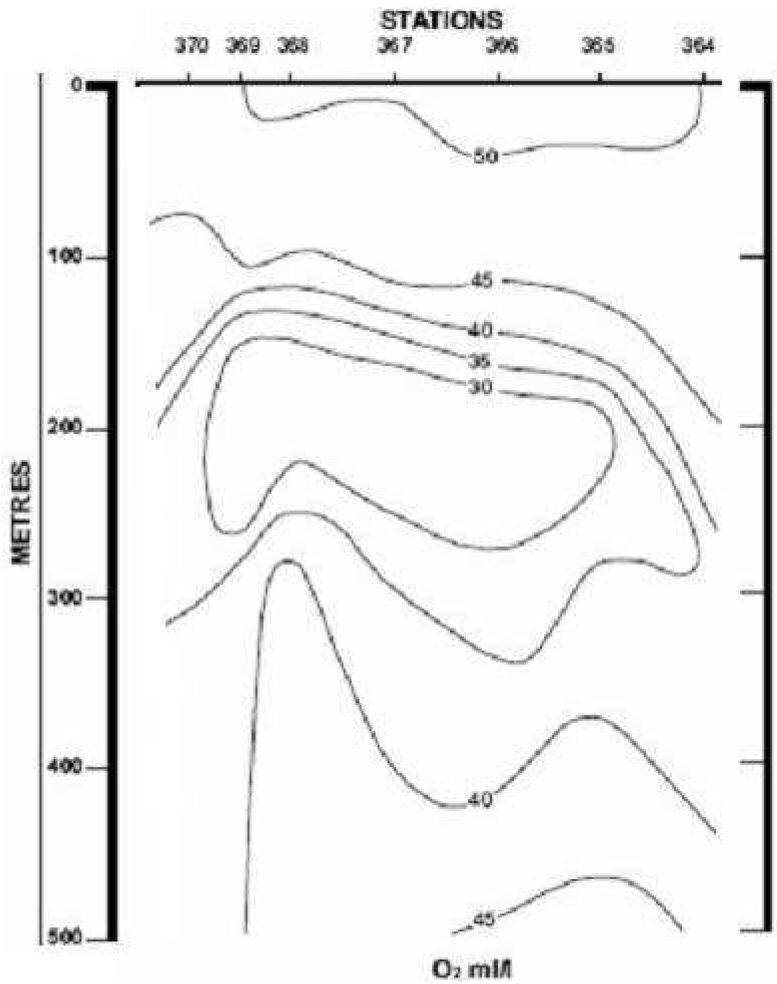


Figure 44 Oxygen gradient across the Mozambique Channel with depth from Saetre and da Silva (1982)

5.3 THE BIOLOGICAL ENVIRONMENT

5.3.1 Overview

Baseline studies in the offshore environment have been conducted by Impacto or by Impacto and Associates in the following areas:

Offshore Area 1 (AMA1 – Anadarko)
Offshore Area 4 (Eni and Galp)
Offshore Areas 2 and 5 (StatoilHydro)

Figure 45 shows all of the concession areas in the Rovuma Block.

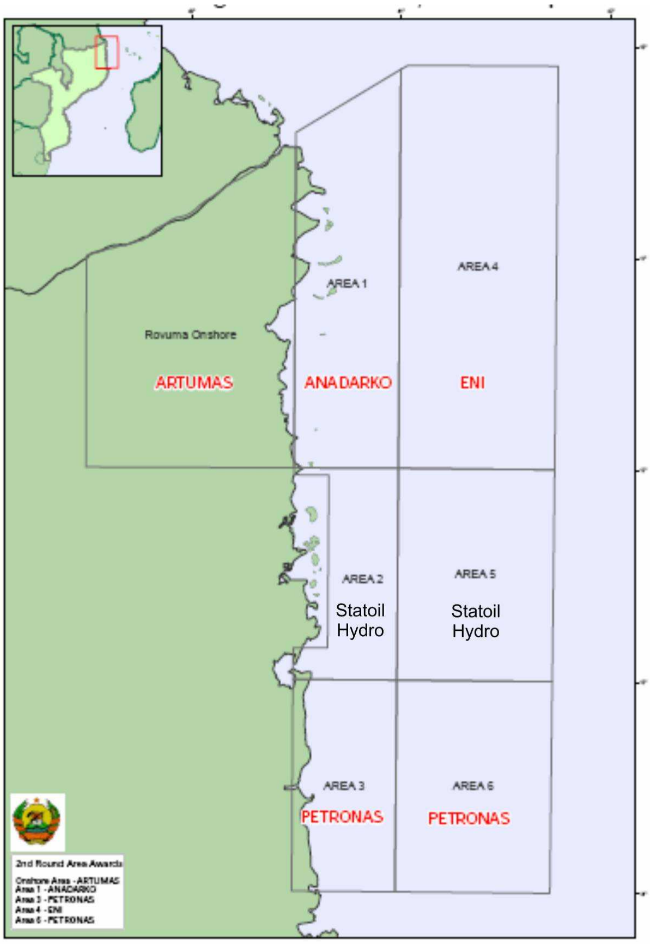


Figure 45 Concession areas in the Rovuma Block

Based on the above studies, there was sufficient data available to simply carry out a desktop review study. Therefore, the description of the biological environment was mainly prepared based on an extensive review and update of existing information, especially the EIA Report for the Seismic Survey prepared for the same area (Area 1) and the EIS for the offshore seismic survey proposed by Eni East Africa S.p.A in partnership with Empresa Nacional de Hidrocarbonetos, EP (ENH) and Galp Energia for Area 4 of the Rovuma Basin.

Although no official conservation areas occur in the AMA 1 concession area, the project area lies in the East African Marine Ecoregion, as defined by the World Wildlife Fund (WWF).

Although it is not within the AMA1 concession or the boundary of the currently proposed project, the Quirimba National Park (PNQ) lies directly to the south (7.5km) of the study area. The PNQ includes the southern most 11 islands of the Quirimbas Archipelago, as well as a large portion of the mainland. The marine protected portion of the QNP covers 152,237 km^2 and is one of the largest marine protected areas in Africa.

The Quirimbas Archipelago stretches a distance of approximately 400km from the Tanzanian border at the mouth of the Rovuma River southward to Pemba, the capital of Cabo Delgado Province. The Archipelago comprises 32 islands, banks, and reefs. Inshore of these islands is a rich complex of patch reefs, seagrass, and sand/mud flat habitats.

Extensive fringing reefs are seen along the eastern shorelines of the islands and banks of the Quirimbas Archipelago. The Cabo Delgado Biodiversity and Tourism Project (CDBTP) 2003 report (Garnier, 2003) identified 125 coral species in 42 genera from 14 families in the Vamizi Island area. Rodrigues et al. (2000) indicates that over 50 genera of corals have been reported from the reefs along the Quirimbas Archipelago.

These coral reefs are important to artisanal fishers and represent a major contributor to the livelihood of the many small coastal communities present throughout the area. In addition, the current flow patterns along this coastline make the reefs and nearshore waters of the Quirimbas Archipelago an important seed larva dispersal area for all of eastern Africa and the Indian Ocean.

The islands, coral reefs, seagrass beds, and mangrove fringing coastlines of the Quirimbas Archipelago are all considered sensitive areas due to their biological diversity and cultural and historical value. The most sensitive areas adjacent to the proposed survey area are the island of Macaloe (387 ha) in Macomia District and the islands of Vamizi (1,181 ha) and Rongui (969 ha) in Palma District. These three islands are part of the Cabo Delgado Biodiversity and Tourism Project (CDBTP) that has been developed to ensure the sustainable conservation of diverse and pristine wilderness areas. While these islands are outside the boundaries of this proposed project, the potential for impacts in these conservation areas was thoroughly investigated during the EIA process. The distances of these islands to the western edge of the drilling area are: Macaloe (7.5km), Vamizi (3.8km) and Rongui (3km).

Extensive mangrove coastal forests along the mainland shoreline also contribute to the Archipelago's productivity. At total of 11 species of seagrass and 10 species of mangroves is known to occur in these nearshore and coastal habitats.

5.3.2. Invertebrate Community

Mollusks (shellfishes) occur in littoral waters of the project area. Mollusk species collected as food items include the giant clam *Tridacna* sp., marine snails (*Murex* spp.), and the tulip shell *Fasciolaria trapezium.*

Echinoderms such as sea cucumbers *Holothuria* spp. and *Synapta* spp. also occur in the project area. These species are typically found in shallow subtidal zones within seagrass beds.

Squids are caught in the seine net fishery of the seagrass beds. However, it is expected that cuttlefish would dominate the cephalopod fauna of the water column. Deepwater squid species would be expected in the open ocean (IMPACTO and Mark Wood Consultants, 2006).

5.3.3 Fishes

Statistical data of the fish resources base for the commercial fishery in the northern Mozambican coast is relatively deficient when compared to other fishing areas such as Sofala Bank and Maputo Bay. This is been a result of almost nonexistent nationally based commercial fishery within this area. Nearly all knowledge of the fish resources available in the Rovuma Basin and surroundings have been a result of state sponsored surveys conducted along the last 30 years (e.g. Dr. Fridtjof Nansen surveys 1977, 1978 and 2007), and this has been a costly activity as daily rates for such surveys are around $20,000-$25,000. Despite the government's efforts in commissioning a survey of the fisheries resources along the whole coast, the northern coast still remains poorly unknown. The bottom topography of most of the northern coast is rocky with rough texture, thus inappropriate for demersal trawling and as a result demersal resources are poorly known.

Based on several fish resources assessment surveys carried out in the study area, four major fish fauna groups have been identified according to their habitats, namely demersal resources, small pelagic resources, large pelagic resources and mesopelagic resources. Due to a lack of information regarding existing resources along the northern Mozambican coast, an ecosystem survey aimed at updating current knowledge of the abundance and distribution of fish resources in the EEZ was conducted from 27 of September to 22 of December of 2007.

A total of 8 successful demersal trawl hauls were made on the northern inner shelf during the 2007 survey. No bottom trawling was carried out deeper than 80m due to the steepness and difficult sea floor conditions in the region. Locations of the trawling stations are presented in the Figure 46 below.

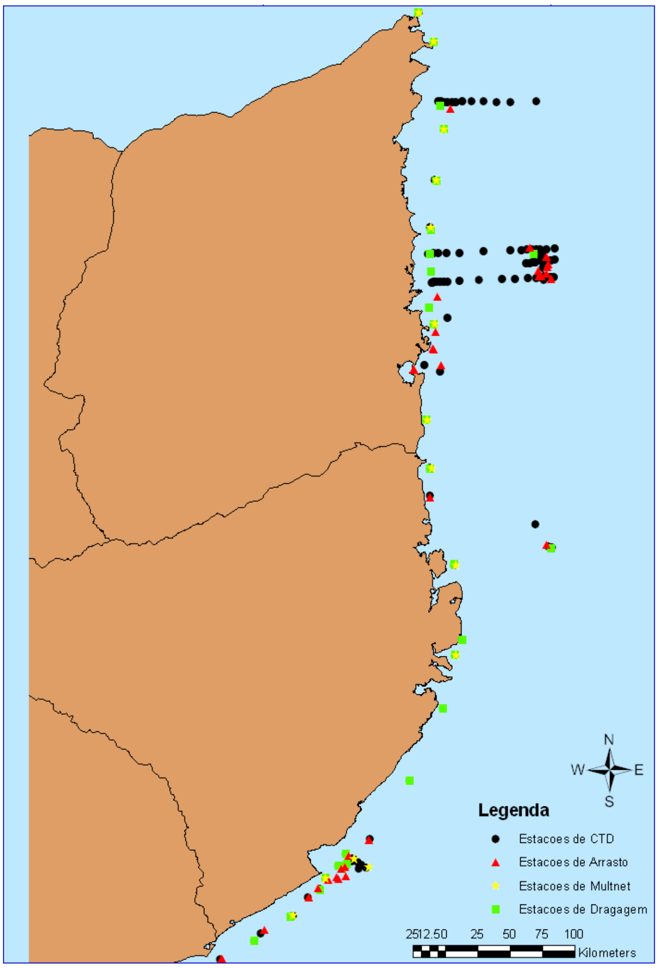


Figure 46 Location of the sampling stations in the northern coast of Mozambique during the Dr Fridtjof Nansen survey in 2007

Catch rates by main groups of commercial fish resources for the northern shelf are listed in Table 10 (from the Dr Fridtjof Nansen survey in 2007). Figure 47 shows corresponding mean catch rates. The mean catch rates of pelagic species were 4.7 kg/h or 1.8 % of the total catch while demersal species contributed 26 kg/h and 9.7 % of the total catch. Shrimps, cephalopods, sharks and rays contributed little to the total catch with 0.1 kg/h, 1.0 kg/h and 1.5 kg/h, respectively. The group of other or miscellaneous species (composed of species not considered of commercial value including jellyfish, some fish species and invertebrates) had a mean catch rate of about 232 kg/h or 88 % of the total. Jellyfish and invertebrates make up the major proportion of the group "Other"[50] that is added here as part of the total catch recorded for each station/ catch haul.

[50] The "Other" category is not included in the graphs (figures). The disproportionately high value would render comparison of the significant groupings difficult.

Table 10 Catch rates (kg/h) of main groups of commercial fish resources caught on the shelf (20-200m) from Dr Fridtjof Nansen Survey Report (2007)

Station	Gear depth	Demersal	Pelagic	Shrimps	Cephalopod	Sharks+rays	Other	Total
111	32.5	4.4	1	0	0.1	0	2.2	7.8
112	25	0	5.5	0	0.2	4.7	5	15.4
113	24.5	0	0	0	2.2	2.4	2.7	7.4
114	23.5	0.9	3.9	0.1	1.6	0.8	187.5	194.9
115	45.5	57.2	3.4	0.2	2.2	0	419.8	482.8
116	43	10.7	0.9	0.1	1	4.2	562.7	579.6
117	28.5	26	17.3	0	0.7	0	396.7	440.7
118	80	106	5.2	0	0.3	0	279.1	390.5
Mean	37.8	25.7	4.7	0.1	1.0	1.5	232.0	264.9
% catch		9.7	1.8	0.0	0.4	0.6	87.6	100.0

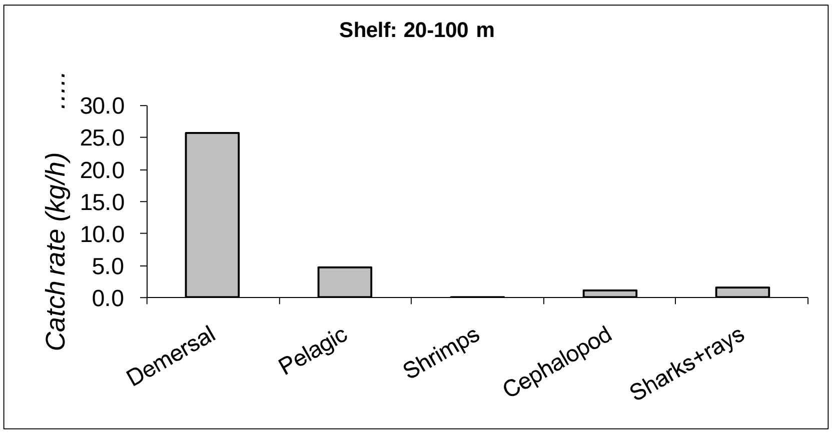


Figure 47 Mean catch rates (kg/h) by main groups in swept-area bottom-trawl hauls on the shelf (20-100 m) from Dr Fridtjof Nansen Survey Report (2007)

5.3.3.1 Demersal resources

Demersal resources are composed of species associated with the benthic habitats. Often these species attain large body size and have low growth rates. They generally are of high quality and with great commercial value. Due to their low growth rates and high biomass they have low turnover rates therefore they are slow in recovering to disturbance in their abundance.

Assessments of demersal resource abundance and distribution require the use of demersal trawls. This method is often not feasible if the sea floor is rough and rocky as it is the case with the study area. Longlines and hand lines are often applied as an alternative methods, however the use of longlines have shown to be difficult in the northern coast due to frequent strong current episodes in the area. During the 2007 Dr. Fridtjof Nansen survey it was possible to have some successful trawl hauls and this allowed acquisition of some data for updating 1977 to1978 data on the demersal resources.

Catch rates of the commercially most important demersal fish groups in the northern region are presented in Table 11. Corresponding mean catch rates are shown in Figure 48. Snappers and groupers contributed with 4.2% and 2.8% respectively of the total catch. The average catch rate of snappers was 11.2 kg/h, and 7.5 kg/h for the groupers. Actual fish species belonging to these two families are listed in Table 12.

As this section only assesses the catch rates of the commercially most important demersal fish groups, broken down into respective families, the “Other group includes the Pelagic, Shrimp, Cephalopodes, Sharks and rays and the inicial “Other” species (as per Table 10 above).

Table 11 Catch rates (kg/h) of main demersal species grouped by families in swept-area bottom-trawl hauls on the shelf (20-100m) from Dr Fridtjof Nansen Survey Report (2007)

Station	Gear depth	Snappers	Groupers	Other	Total
111	32.5	0	0	7.8	7.8
112	25	0	0	15.4	15.4
113	24.5	0	0	7.4	7.4
114	23.5	0.9	0	194	194.9
115	45.5	13	39.2	430.6	482.8
116	43	1.3	0.4	577.8	579.6
117	28.5	20.2	0	420.5	440.7
118	80	53.9	20	316.7	390.5
Mean	37.8	11.2	7.5	246.3	264.9
% catch		4.2	2.8	93.0	100.0

Note: No catch of seabream, grunts, croakers, hake and ophidiidae (eels)

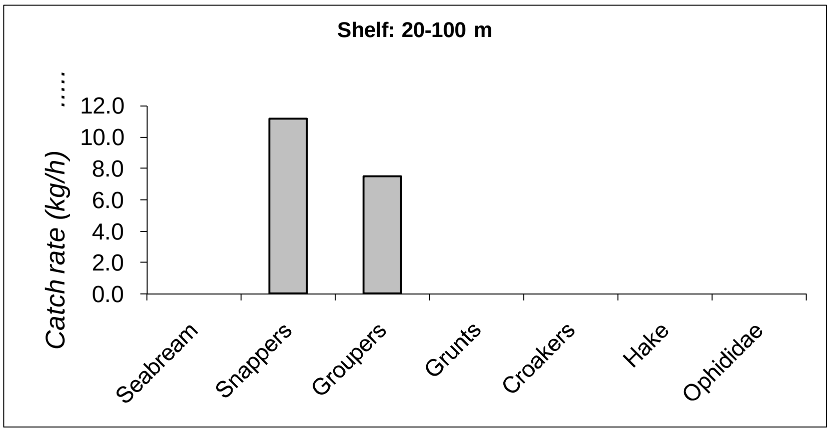


Figure 48 Mean catch rates (kg/h) of main demersal species grouped by families in swept-area bottom-trawl hauls on the shelf (20-100 m) from Dr Fridtjof Nansen Survey Report (2007).

Table 12 Main demersal family's with common species found in the northern coast from Dr Fridtjof Nansen Survey Report (2007)

Main Group	Main Family	Typical Species
Demersal	Serranidae (groupers)	*Epinephelus tauvina* *Epinephelus areolatus* *Epinephelus epistictus* *Epinephelus albomarginatus* *Epinephelus andersoni* *Epinephelus poecilonotus* *Epinephelus chabaudi* *Epinephelus coioides* *Epinephelus flavocaeruleus*
	*Lutjanidae (snappers)	*Aprion virescens* *Lutjanus sp.* *Lutjanus sebae* *Lutjanus argentimaculatus* *Lutjanus sanguineus* *Lutjanus lunulatus* *Lutjanus sp. (cf malabaricus)* *Paracaesio xanthurus*

5.3.3.2 Pelagic resources

Pelagic species dwell in the water column. They often occur in large schools and therefore require the use of aggregating devices known simply as FADs for their commercial capture. Three groups of pelagic fishes are recognized in the study area, the small pelagic, the large pelagic and the mesopelagic fishes. Small pelagic are species of small dimensions, occurring as large schools and exhibiting intense diel vertical migrations patterns. This fauna can be found in shallow waters up to 200m deep, forming large schools of fish near the bottom during daytime and dispersing at night. This behaviour influences the catches. Night time catches have tendency to be 2-5% higher than daytime. Large pelagic species, which include tuna and tuna like species, are often fast swimmers and migrate long distances. Large pelagic species occur over a wide range of depths from 2 miles from the coast (small-scale fisheries), to the shelf and beyond the shelf (commercial vessels). Refer to Section 5.6.7 below.

Mesopelagic fishes dwell in the water column at depths between 200 and 1000 meters. Many mesopelagic species migrate to shallower depths during night when they may migrate to as shallow as 100m (Saetre and Silva, 1979).

With the exception of large pelagic fishes where their assessment requires the use of seine nets and long line, pelagic resources in general are assessed with use of a combination of acoustic methods and pelagic trawls and some time even bottom trawls. Seine nets and long lines have not been frequently used in the pelagic resources assessment surveys conducted in the Mozambique Channel. This has resulted in limited knowledge on large pelagic abundance in the study area, and along the entire coast of Mozambique over the years. Information available with regards to this group is been derived from earlier Dr. Fridtjof Nansen cruises in 1977-1978 and commercial catch statistics of the tuna fishery operating in the northern coast of Mozambique. Small pelagic and mesopelagic fishes are moderately to well known in the study area. Much of the information available on these two pelagic groups have been acquired from the Dr Fridtjof Nansen cruises on 1977, 1978 and updated recently with the 2007 cruise.

Small pelagic

Bottom trawls

Table 13 shows the catch rates of the main small pelagic families caught in the bottom trawl in 2007 at 8 sampling stations off the northern Cabo Delgado coast. Corresponding mean catch rates are represented in Figure 49. The dominant species group at these stations were carangids, mainly (*Decapterus russelli)* with an average of 4.6 kg/h. Clupeids and barracudas were only caught in one trawl station (Station 114), and each group had an average catch of only 0.1 kg/h. As with the earlier assessments (1977 and 1978) scombrids and hairtails showed zero catch rates in the northern region.

This section only assesses the catch rates of the commercially most important pelagic fish groups broken down into respective families. The “other group” includes the Demersal, Shrimp, Cephalopods, Sharks and rays and the initial “Other” species (as per Table 10 above).

Table 13 Catch rates (kg/h) by main pelagic families in bottom-trawl hauls on the shelf (20-100 m) from Dr Fridtjof Nansen Survey Report (2007)

Station	Gear depth	Clupeids	Carangids	Scombrids	Hairtails	Barracuda	Other	Total
111	32.5	0	1	0	0	0	6.8	7.8
112	25	0	5.5	0	0	0	9.8	15.4
113	24.5	0	0	0	0	0	7.4	7.4
114	23.5	0.8	3.4	0	0	0.5	190.1	194.9
115	45.5	0	3.4	0	0	0	479.4	482.8
116	43	0	0.9	0	0	0	578.7	579.6
117	28.5	0	17.3	0	0	0	423.4	440.7
118	80	0	5.2	0	0	0	385.3	390.5
Mean	37.8	0.1	4.6	0.0	0.0	0.1	260.1	264.9
% catch		0.0	1.7	0.0	0.0	0.0	98.2	100.0

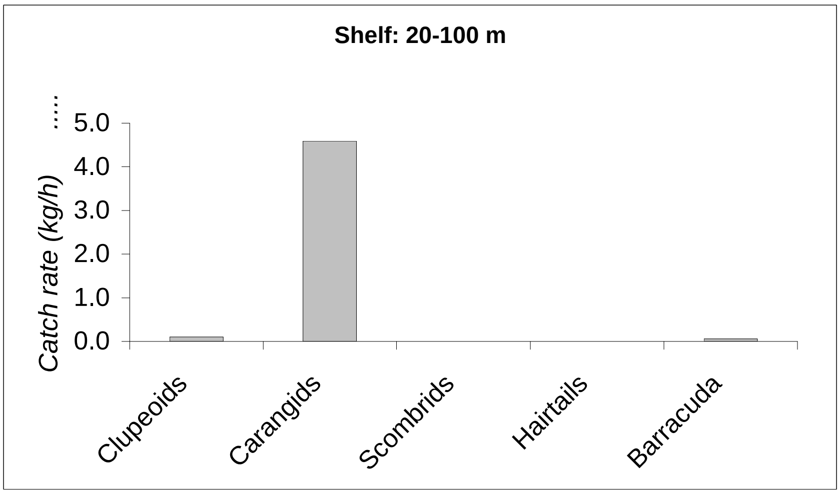


Figure 49 Mean catch rates (kg/h) by main pelagic families in swept-area bottom-trawl hauls on the shelf (20-100 m) from Dr Fridtjof Nansen Survey Report (2007).

Acoustic survey

Acoustic determination of small pelagic abundance and distribution undertaken during the Dr Fridtjof Nansen Survey (2007) has revealed clupeids (PEL1) and a group mainly composed of carangids, barracudas, hairtails and scombrids (PEL2) to occur in low to median levels in the entire Mozambican coast Based on this method it has been estimated that the whole shelf may have around 19,900 tons of clupeids and 34,300 tons of PEL2 or carangids, barracudas, hairtails and scombrids. The PEL2 group has been observed to occur in a small area south of Pemba as it is shown in the small pelagic fishes distribution map in Figure 50.

Table 14 Main groups of common species of small pelagic fishes detected using the acoustic determination method from Dr Fridtjof Nansen Survey Report (2007)

Main Group	Main Family	Species
Pelagic	Clupeidae	*Amblygaster sirm* *Dussumieria acuta* *Herklotsichthys quadrimaculat*. *Hilsa kelee* *Pellona ditchela* *Sardinella gibbosa* *Sardinella albella* *Sardinops ocellatus*
	Carangidae	*Alectis indicus* *Alepes sp.* *Alepes djedaba* *Alepes kleinii* *Atule mate* *Caranx heberi* *Carangoides malabaricus* *Carangoides fulvoguttatus* *Carangoides chrysophrys* *Carangoides armatus* *Carangoides caeruleopinnatus*

		Carangoides equula *Carangoides cf. malabaricus* *Decapterus tabl* *Decapterus macarellus* *Decapterus macrosoma* *Decapterus kurroides* *Decapterus russelli* *Megalaspis cordyla* *Parastromateus niger* *Charybdis affinis* *Portunus sanguinolento* *Selar crumenophthalmus* *Scomberoides tol* *Scomberoides commersonianus* *Seriola lalandi* *Trachurus trachurus*

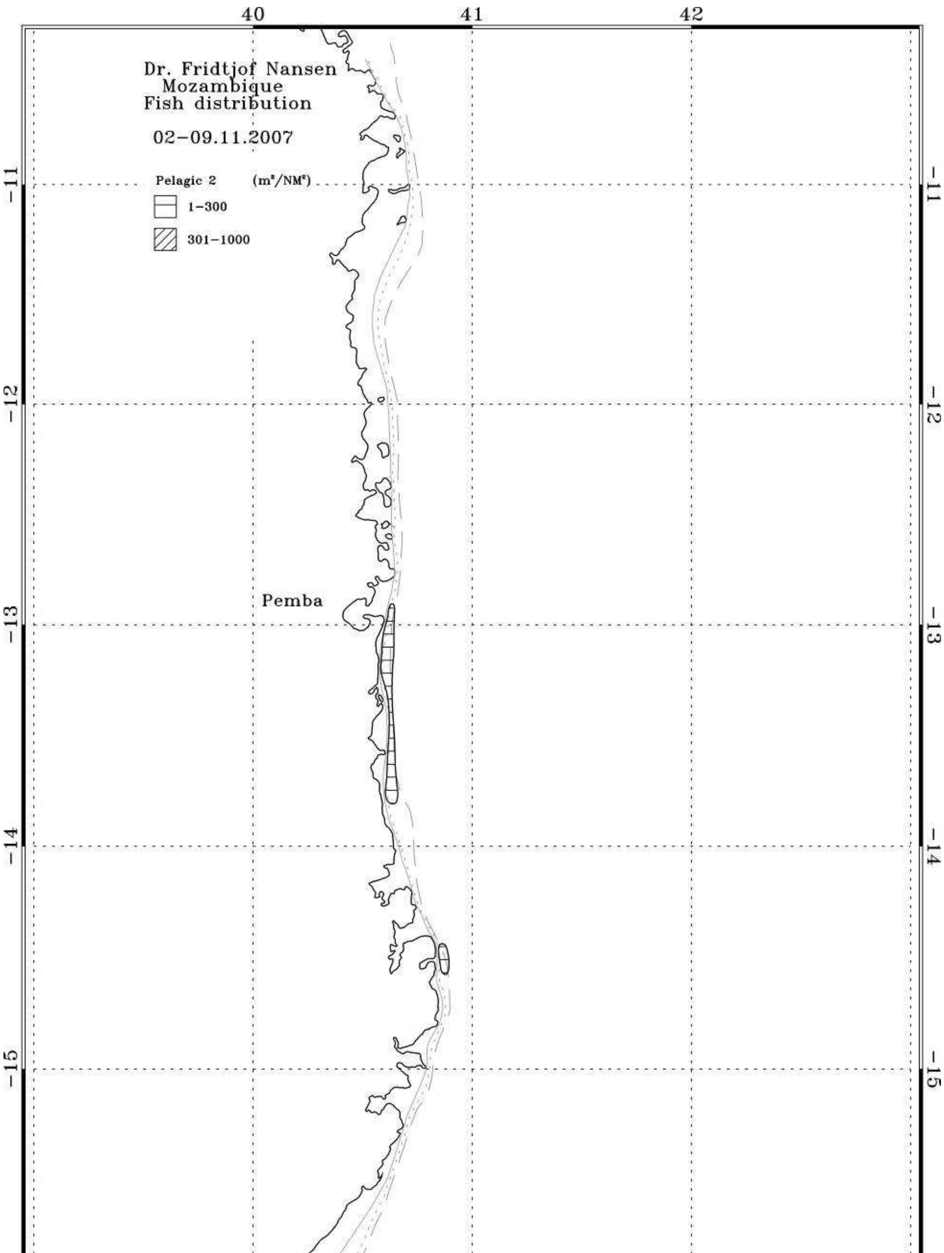


Figure 50 Small pelagic fish distribution in the northern shelf of Mozambique from Dr Fridtjof Nansen Survey Report (2007)

Large pelagic

Information on large pelagic fish abundance in the Mozambican coast is scarce in the official literature. However, according to the reports from the Indian Ocean Tuna Commission (IOTC), a regional management body responsible for managing transboundary fishery, this resource is abundant in the northern coast. According to Saetre and Silva (1979), most of the schools of fish observed by Dr Fridtjof Nansen (1977 and 1978) and Kattegat (1977) were restricted to open ocean regions and composed of tuna species (Figure 51). During the 1977 Kattegat cruise several schools of Albacora (*Thunnus albacares*) were also observed north of Pemba.

Earlier estimates of tuna biomass in the northern coast by Silva et al. (1990) indicated this resource to be around 7000 tons. Unfortunately this estimate has not been updated recently.

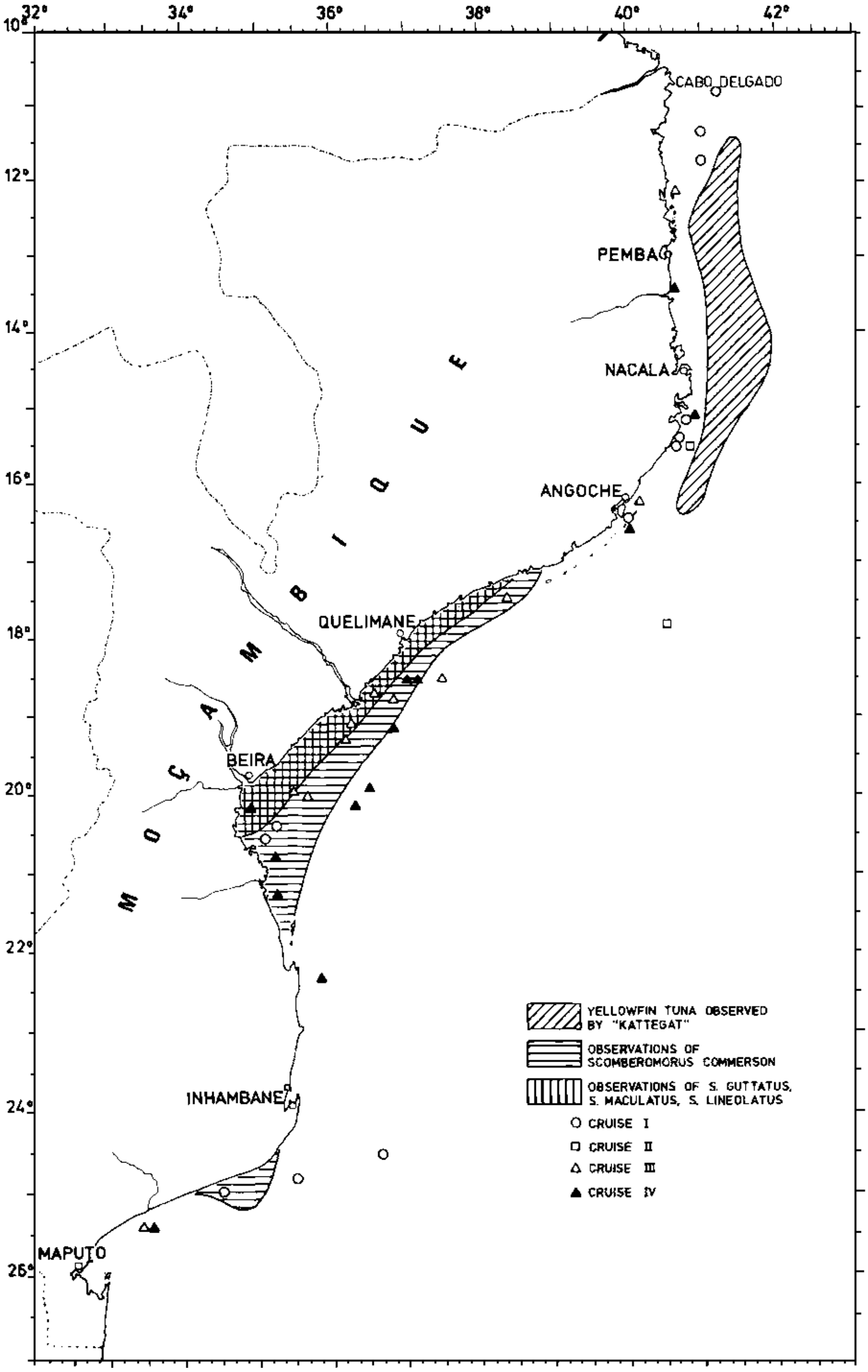


Figure 51 Distribution of large pelagic species in the Mozambique coast from Saetre and Silve (1979)

Mesopelagic resources

Recent attempts to update current knowledge on mesopelagic fish abundance and distribution were not successful. 2007 acoustic records over the entire coast have found generally low to medium acoustic densities of mesopelagic fishes in the entire shelf. From the shelf break and further offshore mesopelagic fishes did not show significant density. However earlier assessments by Saetre e Silva (1979), mesopelagic fishes were found to be well represented in the northern coast. *Benthosema fibulatum, Symbolophorus evermanni, Diaphus garmani, D. nielseni, D. perspicillatus* and *Lampanychtus sp* were found to be the dominant species of the mesopelagic fish assemblage (Table 15).

Table 15 Mesopelagic fishes identified near the coast of Cabo Delgado during the cruise 3 and 4 of the 1977 and 1978 of the R/V "Dr. Fridtjof Nansen" (Saetre and Silva, 1979)

Mesopelagic Species
Bethosoma fibulatum
Myctophun hygomi.
M.obtusirostrum
Symbolophorus evernanni
Diaphus garmani
D.nielseni
D.suborbitale
Lampanychtus sp

Dr Fridtof Nansen has found mesopelagic fishes to be particularly abundant between 30 to 200 miles from the coast, when compared to 0-30 miles from the coast (Table 16).

Table 16 Abundance estimate of mesopelagic fishes (thousands tons) in 0-30 nautical miles and 30-200 nautical miles beyond the 200 m isobath (Saetre and Silva, 1979)

Survey	South to 18°S		North to 18°S		Total
	0-30 miles	30-200 miles	0-30 miles	30-200 miles	
1	1.2	1.0	0.02	0.3	2.5
2	0.4	2.9	0.8	1.7	5.8
3	0.9	5.9	0.2	1.5	8.5
4	1.1	1.2	0.5	2.7	5.5
Mean	**0.9**	**4.5**	**0.4**	**1.6**	**5.6**

5.3.4 Sea Turtles

Five species of sea turtles inhabit Mozambican coastal waters, namely the green turtle *(Chelonia mydas),* the leatherback turtle *(Dermochelys coriacea)*, the loggerhead turtle *(Caretta caretta)*, the Olive Ridley turtle *(Lepidochelys olivacea)* and the hawksbill turtle *(Eretmochelys imbricata)* (Hugues 1971). All of these species are listed as endangered or critically endangered on the 2007 International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species (IUCN, 2007), with the leatherback turtle and the hawksbill turtle considered critically threatened.

The IUCN Red List is widely recognized as the most comprehensive, apolitical, global approach for evaluating the conservation status of plant and animal species. The categories that IUCN (2007) uses to classify species conservation status are defined as follows:

- Critically Endangered (CE) **–** A species is Critically Endangered when the best available evidence indicates that it faces an extremely high risk of extinction in the wild.
- Endangered (EN) **–** A species is Endangered when the best available evidence indicates that it faces a very high risk of extinction in the wild.
- Vulnerable (VU) **–** A species is Vulnerable when the best available evidence indicates that it faces a high risk of extinction in the wild.
- Near Threatened (NT) **–** A species is Near Threatened when it has been evaluated against the criteria but does not currently qualify for Critically Endangered, Endangered, or Vulnerable, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
- Least Concern (LC) **–** A species is classified as Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable, or Near Threatened status. Widespread and abundant taxa are included in this category.
- Data Deficient (DD) **–** A species falls into the Data Deficient category when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status. A species in this category may be well studied and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is, therefore, not a category of threat.

Recent studies undertaken by the Maulane Group Ltd. in conjunction with the London Zoological Society on the coast of Cabo Delgado Province, on the islands of Vamizi and Rongui as well as in the Macaloe Island, indicate that only two species of turtles nest in the area, namely the green turtle and the hawksbill turtle (Hill and Garnier, 2003). The turtles nest mainly on the sandy beaches of the islands, with the nesting periods being different from those observed in the southern and central regions of Mozambique. In these areas, the turtles nest throughout the year, but in Vamizi Island it peaks in January and August. In Macaloe Island the turtles have their nesting peak between November and May, with the reasons for this variation being unknown.

The distribution of the sea turtles in the waters of the continental shelf of the Quirimbas Archipelago was recently documented by CSA International (2007) as being scattered over the whole Archipelago. The turtles were four times more abundant in the waters of Quirimbas National Park than on the northern part of this Archipelago, outside the Park. The largest aggregations of turtles outside of the park were observed in the deep waters situated around the Macaloe and Medjumbe Islands. During the seismic exploration conducted by Anadarko from January to May 2008, marine mammal observers onboard the seismic vessel, made 4 individual turtle sightings in the concession area. Although specific identification was not possible, it was thought that all records were of either Loggerhead Turtle (*Caretta caretta*) or Green Turtle (*Chelonia mydas*). Turtles were mostly seen in the northern area of the concession area (Marine Team Offshore, 2008). Refer to Figure 57 below which summarizes the sighting locations of turtles and marine mammals.

A green turtle was tagged (received a satellite positioning device and named Claudia) by a team from the Zoological Society of London (ZSL) in April 2007 on Vamizi Island (3,8km from the western boundary of the offshore drilling area), where it had nested. Presently, Claudia is located on the Kenyan coast. Its course was undertaken along the coast and often in waters shallower than 1,000m deep (see Figure 52, from the site:
http://www.zsl.org/field-conservation/marine-and-freshwater/turtle-tracking.615.AR.html). The greater part of the journey was undertaken in the first twenty days.

The tagging of this turtle occurred as part of the Cabo Delgado Biodiversity and Tourism Project (Maluane), initiated in 1998, as a partnership between ZSL and a group of private individuals, in order to ensure the conservation of the coastal areas in the northern Quirimbas.

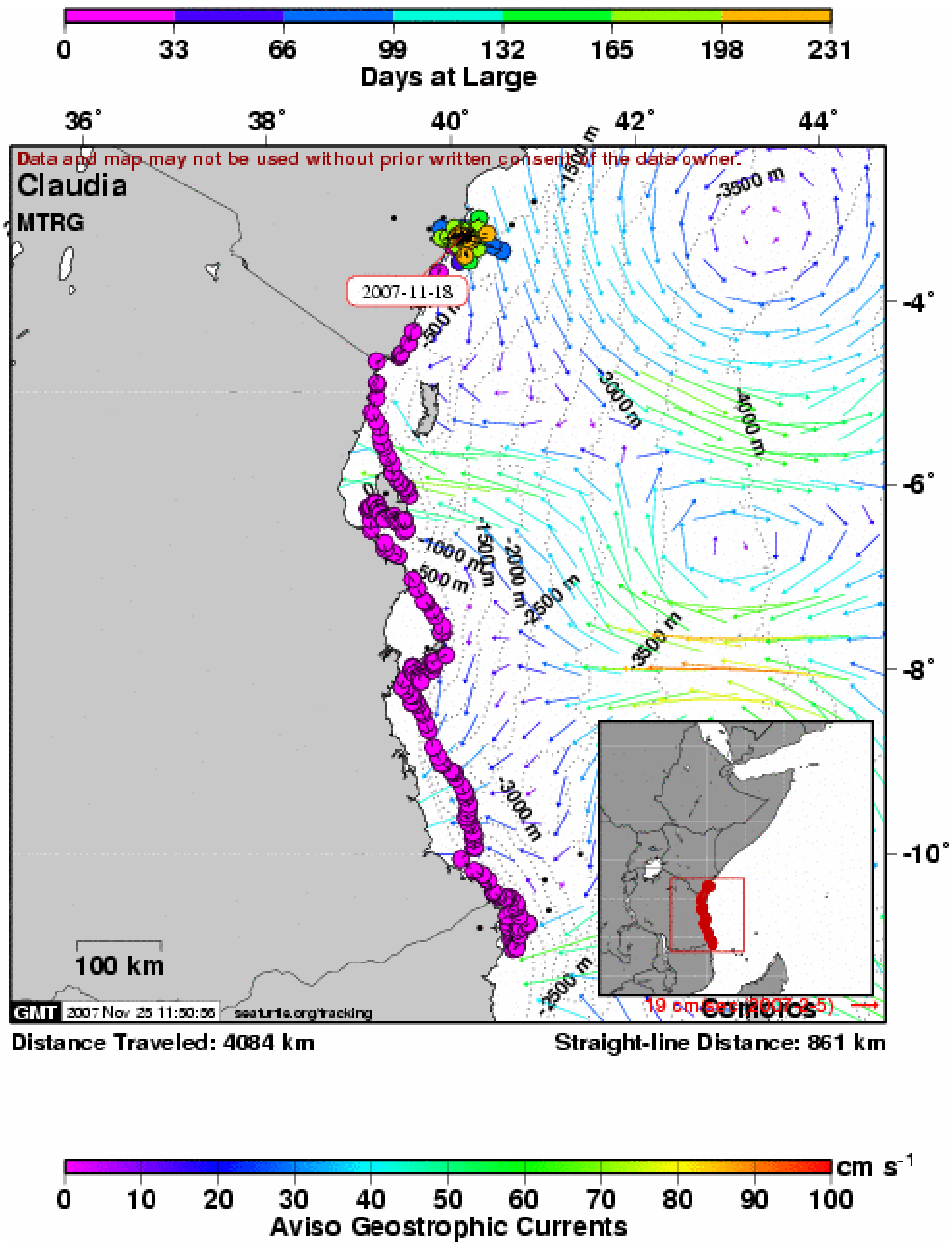


Figure 52 Journey of the green turtle Claudia from www.zsl.org

As part of the same project, in May 2008, two new green turtles were tagged after laying nests on Vamizi Island. One of the turtles (named Kiki) laid 3 nests before migrating back to her feeding grounds. She has been sticking close to home venturing no further than around 30 km away from the northern end of Vamizi Island. According to the journey, Kiki has travelled within the AMA1 drilling area (Figure 53 below). It is believed that she could be staying close in order to lay another nest or two(http://www.zsl.org/field-conservation/marine-and-freshwater/turtle-tracking,910,AR.html).

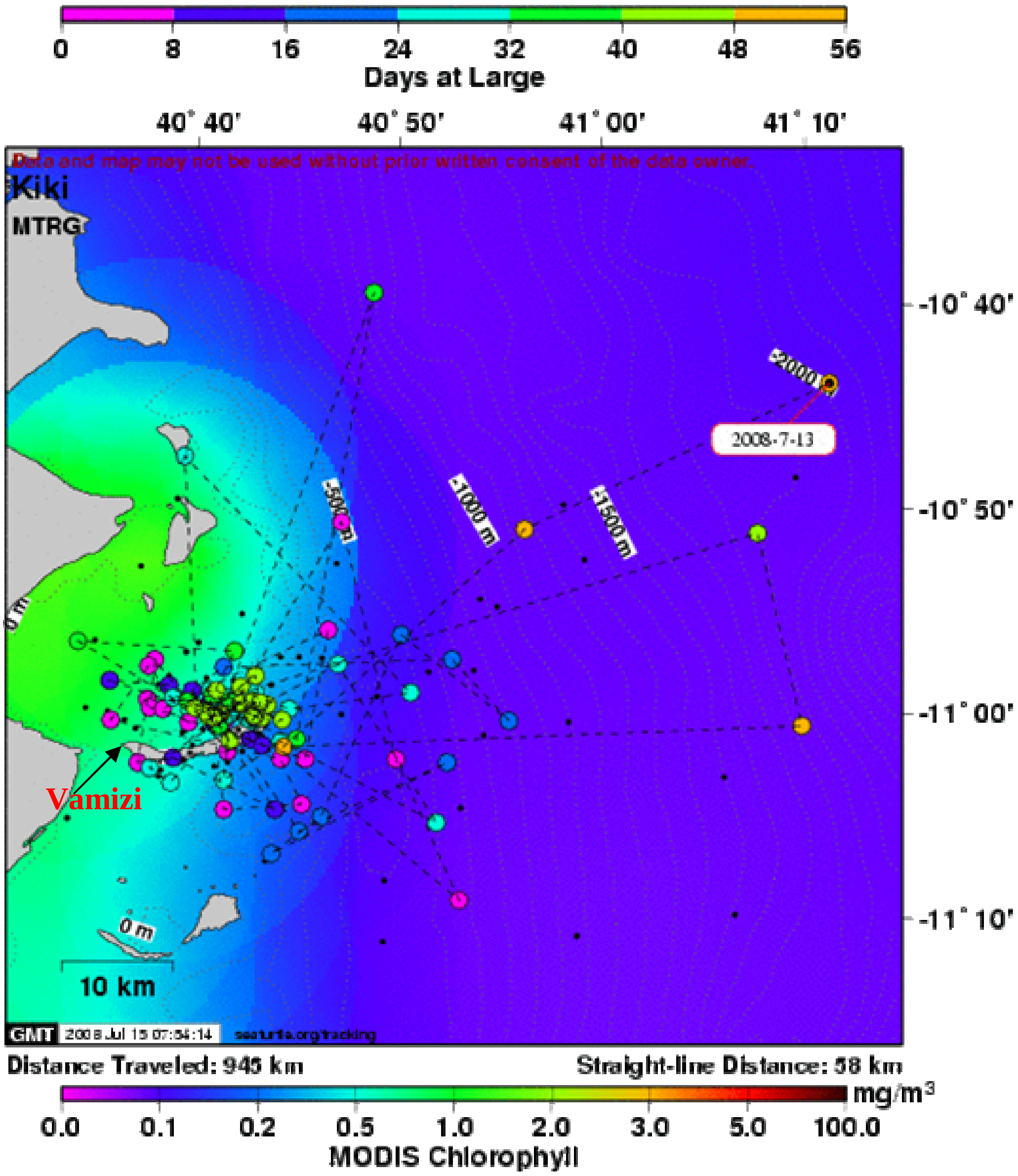


Figure 53 Journey of the green turtle Kiki, in the vicinity of Vamizi Island, from www.zsl.org

5.3.5 Seabirds

Nine taxonomic families of seabirds (broadly defined as species that spend a large portion of their lives on or over seawater) are found in both offshore and coastal waters of northern Mozambique (Table 17). Some species of this group primarily inhabit offshore (continental slope) habitats (e.g., albatrosses, petrels and their allies, boobies and gannets, and tropicbirds). Most Mozambique Channel seabird species, however, inhabit waters of the continental shelf and shelf edge and adjacent coastal and inshore habitats (Newman, 2002; Sinclair and Ryan, 2003).

Two species (wandering albatross and cape gannet) are currently listed by the IUCN as Vulnerable, and two species (Jouanin's petrel and African skimmer) are listed as Near Threatened (IUCN, 2007). The first three species are offshore species whereas the African skimmer is a coastal/inland specie.

Census surveys performed within the Quirimba Archipelago, south of the survey area, showed large numbers of terns (Sternidae), particularly common tern (*Sterna hirundo*), lesser crested tern (*S. bengalensis*), and swift tern (*S. bergii*) (Dodman et al., 1997). Common and lesser crested terns were the most common seabird species sighted along the western boundary of the survey area within waters of the continental shelf edge during the 2007 CSA benthic habitat characterization survey (CSA, 2007b).

Table 17 Seabirds of Northern Mozambique and their current (2007) IUCN listing status (From: Harrison, 1983; Newman, 2002; Sinclair and Ryan, 2003)

Common Name	Species Name	Local Distribution	Seasonality	Local Presence	IUCN Listing Status
Albatrosses (Family Diomedeidae)					
Wandering albatross	*Diomedea exulans*	Offshore	n/a	Uncommon visitor	VU
Indian yellow-nosed albatross	*Thalassarche carteri*	Offshore	Winter	Common visitor	n/a
Shy albatross	*Thalassarche cauta*	Offshore	Winter	Common visitor	n/a
			Summer	Uncommon visitor	
Petrels, Shearwaters, and Storm Petrels (Family Procellariidae)					
Great-winged petrel	*Pterodroma macroptera*	Offshore	n/a	Common visitor	LC
Pintado petrel	*Daption capense*	Offshore	Winter	Common visitor	LC
Jouanin's petrel	*Bulweria fallax*	Offshore	n/a	Uncommon visitor	NT
Wedge-tailed shearwater	*Puffinus pacificus*	Offshore	n/a	Infrequent visitor	LC
Flesh-footed shearwater	*Puffinus carneipes*	Offshore	n/a	Uncommon visitor	LC
Cory's shearwater	*Calonectris diomedea*	Offshore	n/a	Common visitor	LC
Audubon's shearwater	*Puffinus lherinieri*	Offshore	n/a	Uncommon visitor	LC
Wilson's storm petrel	*Oceanites oceanicus*	Offshore	n/a	Common visitor	LC
Black-bellied storm petrel	*Fregetta tropica*	Offshore	Winter	Uncommon visitor	LC
Boobies and Gannets (Family Sulidae)					
Cape gannet	*Morus capensis*	Offshore	n/a	Common resident	VU

Common Name	Species Name	Local Distribution	Seasonality	Local Presence	IUCN Listing Status
Masked booby	*Sula dactylatra*	Offshore	n/a	Common visitor	LC
Red-footed booby	*Sula sula*	Offshore	n/a	Uncommon visitor	LC
Tropicbirds (Family Phaethontidae)					
White-tailed tropicbird	*Phaethon lepturus*	Offshore	n/a	Common visitor	LC
Red-tailed tropicbird	*Phaethon rubricauda*	Offshore	n/a	Uncommon visitor	LC
Frigatebirds (Family Fregattidae)					
Lesser frigatebird	*Fregata ariel*	Offshore/ Coastal	n/a	Rare visitor	LC
Greater frigatebird	*Fregata minor*	Coastal/ Offshore	n/a	Common resident	LC
Gulls, Terns, and Skuas (Jaegers) (Family Laridae)					
Grey-headed gull	*Larus cirrocephalus*	Coastal/ Inland	n/a	Common resident	LC
Lesser black-backed gull	*Larus fuscus*	Coastal/ Inland	n/a	Uncommon visitor	LC
Little tern	*Sterna albifrons*	Coastal/ Inland	n/a	Common visitor	LC
Caspian tern	*Sterna caspia*	Coastal/ Inland	n/a	Common resident	LC
Gull-billed tern	*Sterna nilotica*	Coastal/ Inland	n/a	Rare vagrant	LC
Sandwich tern	*Sterna sandvicensis*	Coastal/ Offshore	Summer	Common visitor	LC
Lesser crested tern	*Sterna bengalensis*	Coastal/ Offshore	Summer	Common visitor	LC
Swift (greater crested) tern	*Sterna bergii*	Coastal	n/a	Common resident	LC
Common tern	*Sterna hirundo*	Coastal/ Offshore	Summer	Common visitor	LC
Sooty tern	*Sterna fuscata*	Offshore	n/a	Uncommon visitor	LC
Whiskered tern	*Chlidonias hybridus*	Coastal/ Inland	n/a	Uncommon resident	LC
White-winged tern	*Chlidonias leucopterus*	Coastal/ Inland	Summer	Common visitor	LC
Lesser noddy	*Anous tenuirostris*	Offshore	n/a	Uncommon visitor	LC
Pomerine jaeger	*Stercorarius pomarinus*	Offshore	n/a	Common visitor	LC
Parasitic jaeger	*Stercorarius parasiticus*	Offshore	n/a	Common visitor	LC
Long-tailed Jaeger	*Stercorarius longicaudus*	Offshore	n/a	Common visitor	LC
Skimmers (Family Rynchopidae)					
African skimmer	*Rhynchops flavirostris*	Coastal/ Inland	n/a	Common resident	NT
Pelicans (Family Pelecanidae)					
Pink-backed pelican	*Pelecanus rufescens*	Coastal/ Inland	n/a	Uncommon resident	LC
Eastern (great) white pelican	*Pelecanus onocrotalus*	Coastal/ Inland	n/a	Common resident	LC
Cormorants (Family Phalacrocoracidae)					
Reed cormorant	*Phalacrocorax africanus*	Coastal/ Inland	n/a	Common resident	LC
White-breasted (great) cormorant	*Phalacrocorax carbo*	Coastal/ Inland	n/a	Common resident	LC

LC = Least Concern; NT = Near Threatened; VU = Vulnerable.

The categories IUCN (2007) uses to classify species conservation status are defined in Section 5.3.4 above.

All common endemic and migratory species are expected to be present in the concession area.

According to the Notícias newspaper (14 July 2008), 200 species of resident and migratory birds have been recently identified in the PNQ during a 10-day bird identification and conservation training course for community guides. Some rare species, likely to occur in the AMA1 Concession Area, have been identified. These include the Bohm´s fly-catcher (*Muscicapa boehmi*), Livingstone´s fly-catcher (*Erythrocercus livingstonei*), Brown-breasted barbet (*Lybius melanopterus)*, Zanzibar red bishop (*Euplectes nigroventris*), Mascarene Martin (*Phedina borbonica*), Bohm´s spine-tail (*Neafrapus boehmi*) and Martial eagle *(Polemaetus bellicosus*).

5.3.6 Dugongs

The dugong is a herbivorous sirenian which feeds on sea grasses and is classified as vulnerable on the east coast of Africa, due to its extremely low density (WWF Eame 2004). Its distribution in Mozambique was initially described by Hughes (1971), who indicated its occurrence on the coast between Maputo Bay and the Save River and in the area between Angoche and Pemba Bay. This author suggested that dugongs should likewise occur on the north coast of Mozambique, in the Quirimbas Archipelago. Hugues (1971) indicated that in general the dugongs were relatively common on the coast, even though they were rare to the south of Inhambane. At that time, frequent catches of these animals were already reported in the non-industrial fisheries spread throughout the country (Hughes 1971).

The ecological value of this species is high, due to its important role in the dynamics of sea grasses. It is one of the priority marine species for conservation, due to its monophyletic character and its extreme vulnerability to disturbance factors. The Mozambican coast possesses one of the possible viable populations of dugongs on the east coast of Africa (WWF Eame, 2004).

Although the species has historically been reported as occurring in the area between the islands of the Bazaruto Archipelago and the mainland, in the area between the Island of Macaloe and the Island of Sencar (WWF Eame, 2004), an aerial reconnaissance undertaken in the month of March 2004 over the whole Quirimbas Archipelago in the waters of the continental shelf, did not observe any dugongs. Moreover, during a recent survey for marine mammals and turtles conducted within continental shelf waters of the AMA1 Concession Area (at depths less than 200m), no dugongs were sighted (CSA, 2007a). This implies that the species is very rare in the area. On the other hand, it is unlikely that the dugongs occur beyond the waters of the continental shelf, although these animals are capable of crossing extremely deep areas.

5.3.7 Whales and Dolphins

5.3.7.1 Overview

The knowledge of species of marine mammals in the Mozambique Channel dates back to the 18th century, during the period of the exploitation of cetaceans, and is based mainly on records from whaling ships (Wray and Martin 1983). After this period, no detailed study was undertaken. In 1979, a brief survey was made of species on the Mozambican coast by scientists on board the R/F Fridjot Nansen (Saetre, Paula and Silva 1979) which explored the entire Mozambican coast. Some whale and dolphin species were reported.

More recently, in 1991 and in 2003, two cruises were held along the Mozambican coast, but both were limited to the southern and central regions (the first as far as Quelimane, and the second as far as Mozambique Island) (Findlay *et al*, 1993 and Findlay *et al.* 2004). However, based on various information gathered sporadically on the waters of the Mozambique Channel (in both Mozambique and Madagascar), Peddemors *et al.* (1997) compiled the list of cetaceans (whales and dolphins) that occur in the Mozambique Channel (de Boer *et al.* 2003).

Furthermore, in 2007, an aerial reconnaissance of marine mammals and sea turtles undertaken on the continental shelf (from the coast up to 200 metres in depth) in the AMA1 Concession Area, resulted in the observation of 3 species of marine mammals – *Sousa chinensis* in waters near the coast, *Tursiops aduncus* in the eastern part of the islands and an enormous school of the genus *Stenella*, near Tecamaji island. Additionally, the acoustic and visual monitoring undertaken as part of the seismic explorations held in Block 1 by the company AMA1, from January to May 2008, confirmed the occurrence of dolphins (long-snouted spinner, bottlenose, risso and melon-headed dolphins as well as several unidentified species), a pilot whale (*Globicephala melas*), a sperm whale (*Physester macracephalus*) and a humpback whale (*Megaptera novaeangliae*) (Marine Team Offshore, 2008).

5.3.7.2 Species of marine mammals existing in the Project area

According to Peddemors *et al.* (1997), at least eighteen species of marine mammals have been recorded in the Mozambique Channel, twelve of which probably occur in the project area (Table 18). Peddemors *et al.* (1997) compiled this list based on observation of cruises undertaken along the Mozambican coast in 1991, as well as on other observations obtained during cruises carried out in the Mozambique Channel and on the southeast and southwest coasts of Madagascar in 1994.

Three species of whales (i.e., sei whale, blue whale, and fin whale) are currently listed by the IUCN as Endangered, and two species (i.e., humpback whale and sperm whale) are listed as Vulnerable (IUCN, 2007).

5.3.7.2.1 Fin whales (true whales)

Two species of fin whales occur off the coast of Mozambique, namely the humpback and minke whales. The humpback whale (*Megaptera novaeangliae)* occurs in the waters of the Mozambique Channel during the southern winter, where it travels for purposes of mating and procreation. Findlay et al (1994, 2004), who conducted two cruises on one part of the Mozambican coast in 1991 and 2003, confirmed that more females with newborn calves predominate in the northern part of Mozambique than in the southern part. The whale numbers were estimated at 1,954 animals in 1991 and close to 6,000 whales in 2003. In the marine region between the Islands of Vamizi and Rongui, in the Quirimbas Archipelago, humpback whales occur between June and November, mostly females with new-born calves, which stresses the importance of this region as a humpback whale breeding ground (Isabel Silva, biologist at Maluane Ltd., 2006). These mother-calf pairs are sensitive to the approach of motor boats used for sports fishing and attempt to avoid the vessels, changing their movements[51].

During the seismic exploration undertaken from January to May 2008, marine mammal observers reported a single sighting of a humpback whale in the project area (Figure 54 below) (Marine Team Offshore, 2008). This observation was made during a period outside that of the migration of these whales, and requires further investigation.

Despite their distribution close to the coast, humpback whales may cross very deep areas, heading towards the Comoro Islands and Mayotte or to Madagascar. The whales, which move along the coast of Mozambique may often cross the Mozambique Channel at various locations, in order to reach the islands in the middle of the Mozambique Channel or even the Island of Madagascar, where their mating sites are located (Best *et al.* 1998). Often, sounds of solitary individuals making these crossings have been recorded (Best *et al.* 1998).

In the Indian Ocean, the minke whale (*Balaenoptera acutorostrata)*, occurs in two forms which differ in size. These whale species have been observed in the waters of the continental shelf of the Mozambique Channel but are not very well-known. The form that inhabits the North Pacific area is known as *Balaenoptera acutorostrata scammoni*, while a dwarf minke whale, which occurs in the Southern Hemisphere is known as *Balaenoptera acutorostrata* subspecies. The area of the Northern Quirimba Archipelago is at the boundary of these species distribution area and it is possible that the two forms may overlap their distribution. Normally, minke whales rest in areas where the depth is between 20 and 50m.

Despite not being very well-known, it is considered the most common whale and engages in solitary behaviour. During the southern summer, it occurs in the Antarctic circumpolar region and in winter it migrates to the region situated between the latitudes of 7ºS and 35ºS. Although it feeds on krill, it also consumes pelagic fishes. Its social structure is complex, with divisions by age, sex and reproductive stage. Its occurrence in the Mozambique Channel is seasonal, mainly between June and November.

5.3.7.2.2 Sperm whales

There are three species of sperm whales in the Indian Ocean, namely the sperm whale *(Physester macrocephalus),* the pygmy sperm whale *(Kogia breviceps)* and the dwarf sperm whale *(Kogia simu).* Generally, these species inhabit the deep areas of the continental shelf and of the continental slope. They possess the spermaceti organ in the head, which is filled with liquid wax oil. This organ provides them with buoyancy and the ability to dive deeper (up to several hundred metres).

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[51] The implication of this avoidance behaviour on survival and energetic demands of calves is unknown, but the presence of an active drilling vessel and the movement of supply and support vessels in the calving area would likely trigger avoidance behaviour that could increase the extent and frequency of mother-calf pairs movements.

The *Physester macrocephalus* sperm whale was the target for hunting in the Indian Ocean in the 18th and 19th centuries, which considerably reduced its population. The males exhibit wide migratory movements out to very high (circumpolar) latitudes while the females, with a cohesive social structure, tend to remain in certain areas close to undersea slopes and abysses. They can stay immersed for up to forty minutes, and normally stay on the surface for periods of ten minutes in the interval between dives. Visual and acoustic observations made in between January and May 2008, during seismic exploration in Area 1 of the Rovuma Basin, confirmed the presence of the sperm whale in waters of depths between 500 and 1,000m, near Vamizi Island, close to a deep sea abyss (Figure 54 below).

The pygmy sperm whale and the dwarf sperm whale differ slightly in the form of the fin and in the size and number of teeth. Their adult size is 2.7 and 3.2m, respectively. Normally they are solitary or occur in groups reaching six to ten animals. They tend to stay for long periods on the surface of the sea, but have the ability to dive to great depths. Their migratory movement is unknown, as is their abundance. They inhabit the deep waters of the continental shelf and slope.

5.3.7.2.3 Killer whales

Two species of killer whales occur in the Mozambique Channel: the killer whale *(Orcinus orca)* and the pygmy killer whale *(Feresa attenuata)*. Their distribution and numbers in the Mozambique Channel and in the project area are not very well-known. The killer whale *(Orcinus orca)* tends to inhabit the circumpolar regions, but during the winter they tend to wander, that is, they do not display a distinct migratory movement and feed off a variety of prey, including other whales, dolphins, sea turtles and fish.

The pygmy killer whale *(Feresa attenuata)* can reach 2.6m, with a pan-tropical distribution, inhabits ocean waters and forms groups of about fifty animals. Its distribution in the Mozambique Channel is unknown, but the species is considered rare and does not carry out any migratory movement, i.e. they occur in the Mozambique Channel during the entire year.

5.3.7.2.4 Short-finned pilot whale

The short-finned pilot whale *(Globicephala macrorhynchus),* which can reach up to 7m in size, inhabits tropical waters and occurs in groups of fifteen to fifty animals. In the southern hemisphere, mating occurs in May and births during July – August, occurring in the Mozambique Channel during the entire year. Its diet is dominated by squid. Its status is considered good and the species is abundant, although the numbers are unknown. It does not have a migratory nature, although it wanders. The Marine Team Offshore (2008) reported one sighting of the short-finned pilot whale in waters about 1,000m deep in front of the Bay of Mocimboa da Praia, in January 2008 (Figure 54 below).

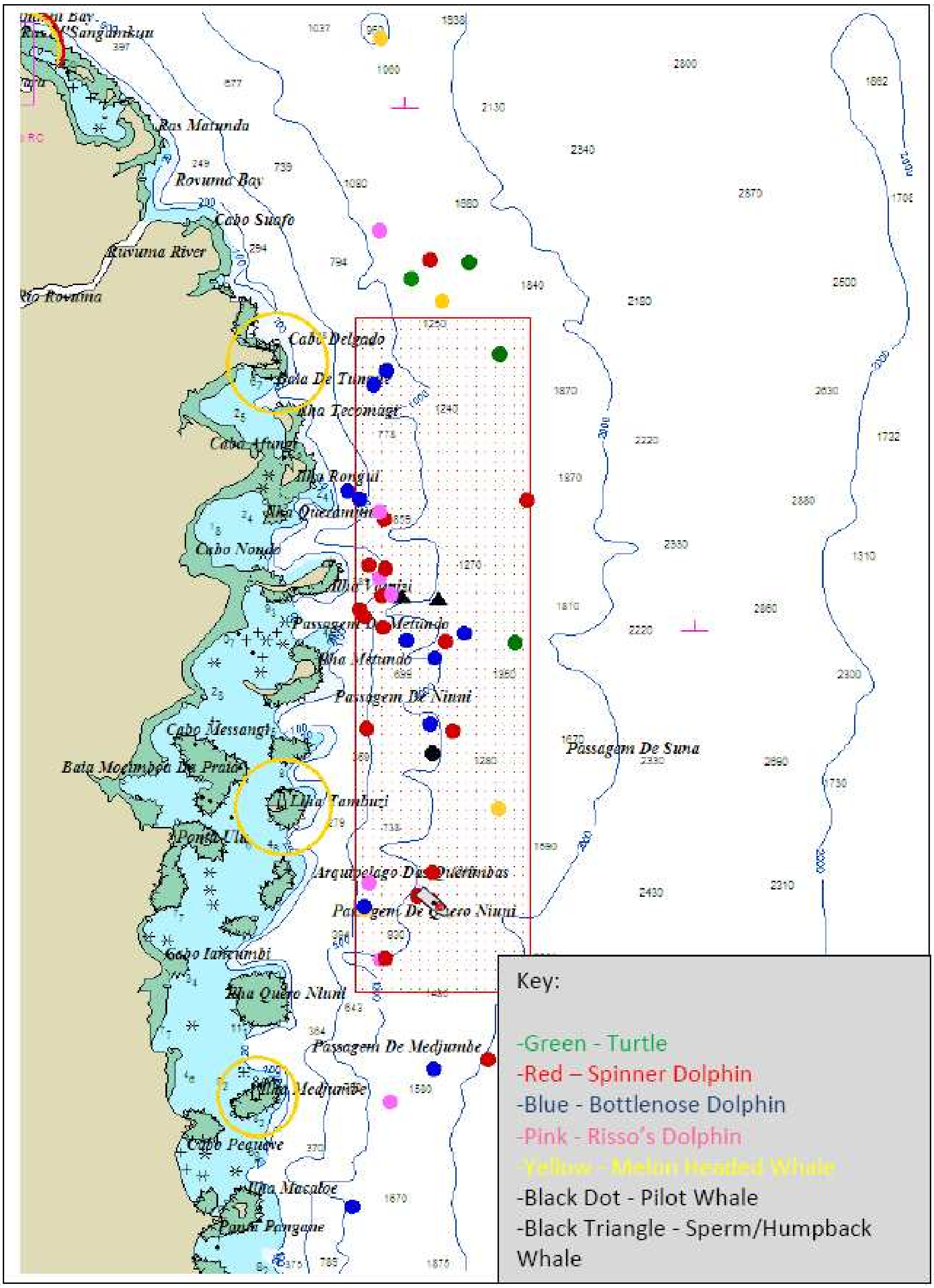


Figure 54 Species positively identified by the MMO during seismic survey, from Marine Team Offshore, 2008.

5.3.7.2.5 Melon-headed whale

The melon-headed whale *(Peponocephala electra)* has a broad distribution in tropical seas and oceans, but not going beyond latitudes 20°S and 20°N, inhabiting sites where the shelf is narrow and next to the continental slope. It is an extremely gregarious species, with groups that can reach hundreds of animals. It feeds on prey (fishes, squid and crustaceans), which inhabit great depths (1,500m). Its status is not considered critical, although its numbers are not known. It does not have a migratory nature, but its all year occurrence in temperate waters may be associated with its preference for warmer currents. There is no any estimate of the species abundance in the Mozambique Channel.

5.3.7.2.6 False killer whale

The false killer whale *(Pseudorca crassidens)* has a broad distribution, and is gregarious (groups normally of ten to twenty individuals) in the coastal regions, up to depths of 1,000m. It feeds on various animals, including other cetaceans, but normally it occurs on the continental slope and prefers cephalopods (squid). Its numbers on the Mozambican coast are unknown. No migratory character is known.

5.3.7.2.7 Cuvier's beaked whale

The Cuvier's beaked whale (*Ziphius cavirostris*) can reach a length of 7m, inhabits the cold deep ocean waters of the tropical and temperate regions, in locations with a sharp depth gradient (in abysses). Normally they are solitary or occur in groups of up to seven animals. They feed on squid, fish and some deep-water ocean crustaceans. Their number is unknown, but it is known that the species is very vulnerable to certain types of sound emissions caused by intense industrial or recreational activities (Reeves et al. 2002), and the military (Fernandez et al. (2005); The Antartic and Southern Ocean Coalition (2004). There is no any estimate of the species abundance in the Mozambique Channel.

5.3.7.2.8 Blainville's beaked whale

The Blainville's beaked whale (*Mesoplodon densirostris*), which may reach a maximum length of 4.5m, is widely distributed in tropical and warm temperate waters. There is no evidence of them being migratory, and they occur in locations the depths of which range from 500 to 1,500m, and in abysses. They occur in groups of 3 to 5 animals; they may dive for up to 22 minutes and are sensitive to acoustic trauma caused by mid-range sonar that causes severe, diffuse congestion and hemorrhage around the acoustic fat jaw, ears, brain and kidneys (Fernandez et al. 2005, Reeves et al. 2002). There is no estimate of abundance in the Mozambique Channel.

5.3.7.2.9 Risso's dolphin

The Risso's dolphin (*Grampus griseus*) which is less than 4m in length normally has a spotted body. It occurs in the tropical and temperate regions and inhabits very narrow niches on a seasonal basis, with temperatures that vary between 10℃ and 28℃, on the steep continental slopes where the dep th reaches 300m. It has no defined migration patterns and feeds on various kinds of cephalopods, mainly at night. They are considered to be abundant in the world but their abundance in the Mozambique Channel is unknown.

5.3.7.2.10 Rough-toothed dolphin

The Rough-toothed dolphin (*Steno bredanensis*) occurs in ocean waters of the tropical regions and rarely close to the mainland. However, it may occur close to the islands, the coast of which is situated near the continental slope. It forms groups of ten to twenty individuals, undertakes deep dives and can stay submerged for fifteen minutes. It feeds on fish and cephalopods. It is considered a common and a widely distributed species. Peddemors et al (1997) reported this species in the Mozambique Channel throughout the year.

5.3.7.2.11 Long-snouted spinner dolphin (Stenella longirostris)

The Long-snouted spinner dolphin (*Stenella longirostris*) inhabits the coastal tropical and subtropical waters, and is most abundant between the tropics, where the water is deeper than 50m. Its migratory character is not known and it forms enormous groups in the ocean regions. They reproduce at any time of the year, although they have a reproductive peak, which varies between the different regions. Normally this species rests during the day, off the islands situated near the marine boundary of the continental shelf, and feeds at night on meso-pelagic prey, which rises to the surface. It is an amply abundant species, which causes no concern for conservation. A group of more than 200 dolphins of this species was seen in the Quirimbas Archipelago on the open sea on the edge of the continental shelf across from the Town of Palma (CSA International, 2007). They are not migratory.

5.3.7.2.12 Spotted dolphin

The Spotted dolphin (*Stenella attenuata*) occurs in the tropical and warm temperate oceans, between the latitudes of 40º N and 40º S, inhabiting local coastal waters and in some parts of the world it changes location on a seasonal basis, within a diameter of 200 to 300 nautical miles. It is a gregarious species, forming schools of hundreds to thousands of individuals, containing various social units of twenty individuals of a given age range or reproductive state. It reproduces at any time of the year, with various seasonal peaks. It feeds on small pelagic fish, cephalopods and crustaceans. The global population is estimated at around three million individuals, and it runs no risk of extinction.

5.3.7.2.13 Striped dolphin

The Striped dolphin (*Stenella coeruleoalba*) is cosmopolitan, occurring in tropical and warm temperate ocean waters. Peddemors et al (1997) observed only one group of individuals of this species off the Mozambican coast in 1991. They travel in schools which can exceed 100 individuals, with their diet being varied, including pelagic fish and cephalopods. It is a species that is very abundant, occurring in the Mozambique Channel throughout the year.

5.3.7.2.14 Bottlenose dolphin

The Bottlenose dolphin (*Tursiops* sp.) is dimorphous: a coastal form, the size of which is normally less than 2.5m, inhabiting the coastal waters out to sites where the depth is no more than 30m *(T. aduncus)* (Figure 55) and another oceanic form *(T. truncatus),* whose adult size is larger than 2.5m, which occurs in waters more than 50m deep, on the continental shelf.

Figure 55 The bottlenose dolphin (*Tursiops aduncus*) Photo taken by Angie Gulland

Dolphins of the *T. aduncus* species occur in groups, with an observed average in Maputo Bay of 27 animals (Guissamulo 2006). During the survey undertaken in the waters of the continental shelf of the Quirimbas Archipelago, few groups of these dolphins were noted and the average size of the group was 8.5 animals (CSA International, 2007). A larger number occurred in open waters close to the islands with reefs. Generally speaking, they were relatively rare in relation to other sites in the South of Mozambique.

Little is known about the oceanic form *(T. truncatus),* beyond the fact of it has a more robust body. On the east coast of South Africa, this species exhibits migratory movement following the migration of sardines from the coast of Cape Town out to the coast of Natal Province, during the months of June – July, which is to say, in the winter (Peddemors and Cockcroft, 1993). In 2006 there were beachings of the oceanic form of dolphins in Zanzibar (around 600 dolphins) (Narriman Jidawi, personal communication 2006) and in 2007 on the Island of Bazaruto 46 dolphins ran ashore (Cockcroft and Guissamulo, 2007), with the causes of these beachings being unknown. However, the group appeared to be dominated by juvenile males, but contained some adult females. A lot of these dolphins were found with empty stomachs or filled with the remains of the digestion of fish and cephalopods.

5.3.7.2.15 Indo-Pacific humpback dolphin

The Indo-Pacific humpback dolphin (*Sousa plumbea* or *S. chinensis*) is classified as vulnerable due to its occurrence in places with intense human activity and habitat degradation. It does not have a migratory nature and inhabits the coastal waters associated with mangroves and rocky or coral reefs, in waters that are rarely more than 20m deep.

Its distribution is known within the project area, where it was normally found in the waters between the islands of the Quirimbas Archipelago and the coast of the mainland, with the groups varying from one to ten individuals and the average being four animals (CSA International, 2007). Given its occurrence in shallow waters, it is less susceptible to the action of seismic surveying. It does not normally display seasonal movements (Guissamulo and Cockcroft 2004; Karczmarski 2000). In tropical waters this species apparently tends to occur in smaller areas than in the temperate regions (coast of South Africa) where there are seasonal variations of temperature and of prey availability. The groups observed in Maputo Bay were extremely large when compared with those reported in other areas of its distribution (Guissamulo and Cockcroft, 2004). Peddemors *et al.* 1997 observed this species near the main rivers. It should be noted that these observations were taken from waters of greater depths than those inhabited by this species, due to limitations of the vessel in which the cruise was undertaken. Also, its expansion into distant areas was due to the extension of its habitat next to the large riverine systems.

Figure 56 Humpback Dolphin (Photo: Almeida Guissamulo)

5.3.7.2.16 Long-Beaked Common Dolphins

Although Peddemors et al (1997) did not observe this species (*Delphinus capensis*) in the Mozambique Channel, it occurs in Mozambican waters. A school of these dolphins was observed in May 2003 in the area separating the Islands of Vamizi and Rongui (Guissamulo. personal observation) travelling at high speed alongside a passenger and cargo transport vessel, with some members of the school remaining beside this vessel for a period of three minutes. The site where it was observed consisted of deep waters (between 200 and 600m), in one of the abysses situated between these islands. The collection of two crania, one found in the Bay of Sofala and another in Maputo Bay also prove the occurrence of this species in Mozambique.

This species is considered oceanic and in South Africa it carries out migratory movements associated with the migration of sardines (Peddemors *et al.* 1997). However, it is not known if the species is migratory in Mozambique. On the other hand, its status is unknown. It feeds mainly on schools of pelagic fish. Reproduction occurs in summer.

The map of the observations of marine mammals obtained during the seismic program in Area 1 of the Rovuma Basin (see Figure 57) indicates the position of all marine mammals and turtle detections made from the source vessel in relation to the survey grid. However, it does not identify the species observed. In any case, this map shows that dolphin species are widely distributed in the project area. The map also shows sightings and detections of three species of whales and of marine turtles between January and May 2008 (Marine Team Offshore, 2008). Markers refer to the vessel position when the sightings were made and are not indicative of range. Red circles indicate the areas of higher detection frequencies.

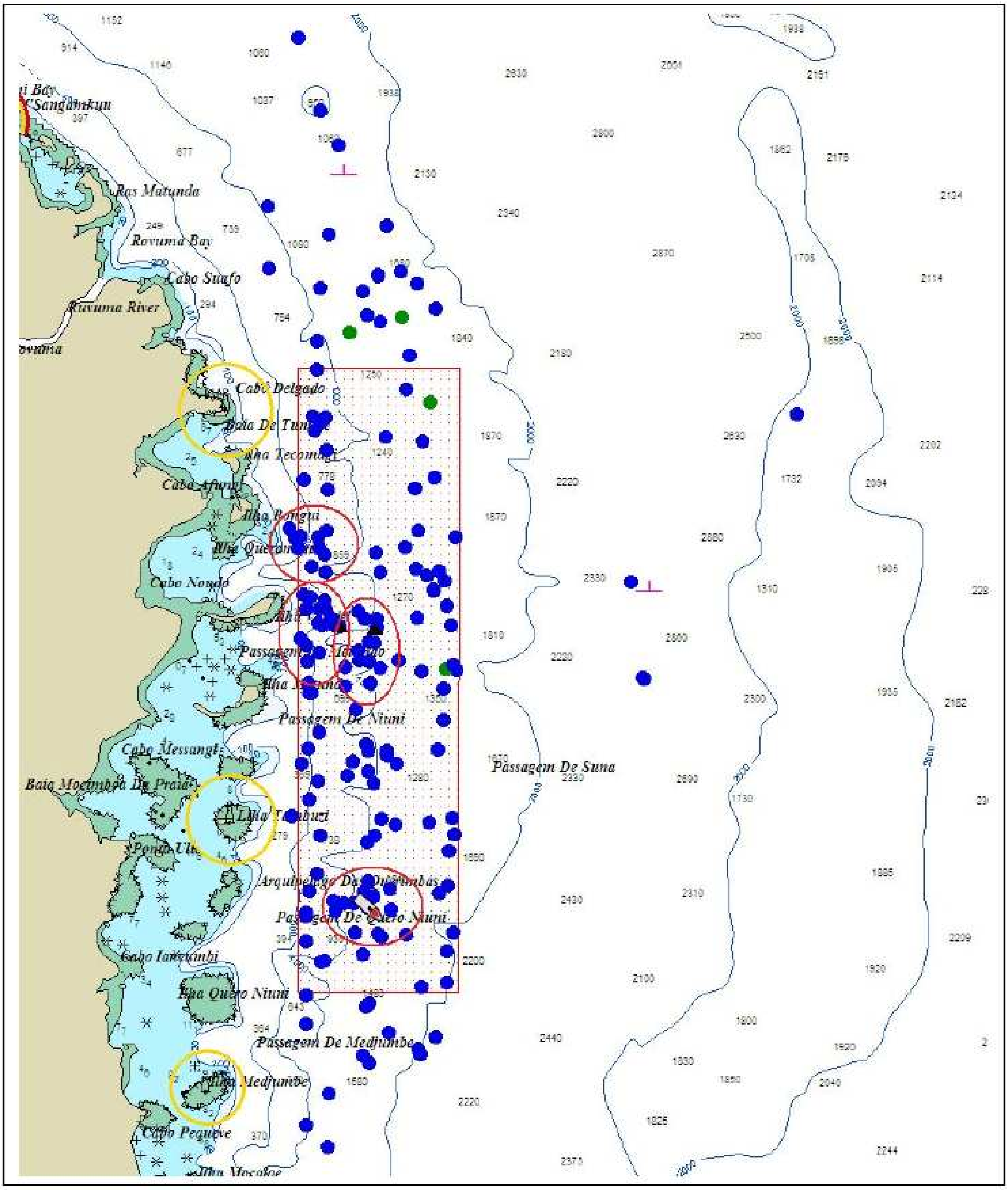


Figure 57 Map of all Marine Mammals and Turtle Sightings and Detections, from the Marine Team Offshore (2008)

Tables 18 and 19 below present a summary of the main mammals found in the Mozambique Channel and their periods of residence.

Table 18 Marine mammals in the Mozambique Channel

Common name	Species
Fin whales	
Humpback whale	*Megaptera novaeangliae***
Minke whale	*Balaenoptera acutorostrata**
Odontocete (toothed) whales and dolphins	
Dolphin	*Delphinus delphis**
Pygmy killer whale	*Feresa attenuata*
Short finned pilot whale	*Globicephala macrorhynchus***
Risso's dolphin	*Grampus griseus***
Pygmy sperm whale	*Kogia breviceps**
Blainville's beaked whale	*Mesoplodon densirostris**
Killer whale	*Orcinus orca*
Melon-headed whale	*Peponocephala electra**
Sperm whale	*Physeter macrocephalus***
False killer whale	*Pseudorca crassidens**
Indian humpback dolphin	*Sousa plúmbea***
Spotted dolphin	*Stenella attenuata**
Striped dolphin	*Stenella coeruleoalba**
Long-snouted spinner dolphin	*Stenella longirostris***
Rough-toothed dolphin	*Steno bredanensis**
Bottlenose dolphin	*Tursiops truncatus***
Long-beaked common dolphin	*Dephinus capensis*
Cuvier's beaked whale	*Ziphius cavirostris**
Sirenians	
Dugong	*Dugong dugon*

* Probably occurs in the project area (Source: Peddemors et al. 1997);
** Occurrence confirmed in the project and surrounding areas (Other sources: Marine Team Offshore, 2008)

Table 19 Periods of residence of marine mammal species in the Mozambique Channel

Common Name	Speces	Residence	Period
Humpback whale	*Megaptera novaeangliae**	Seasonal	June-November
Minke whale	*Balaenoptera acutorostrata*	Seasonal	June- November
Dolphin	*Delphinus delphis/capensis**	Unknown	All year
Pygmy killer whale	*Feresa attenuata*	All year	All year
Short-finned pilot whale	*Globicephala macrorhynchus**	All year	All year
Risso's dolphin	*Grampus griseus**	All year	All year
Pygmy sperm whale	*Kogia breviceps*	All year	All year
Blainville's beaked whale	*Mesoplodon densirostris*	All year	All year
Killer whale	*Orcinus orca*	Seasonal	
Melon-headed whale	*Peponocephala electra**	All year	
Sperm whale	*Physeter macrocephalus*	All year/ males migratory	All year
False killer whale	*Pseudorca crassidens**	All year	All year
Indian humpback dolphin	*Sousa plúmbea**	All year	All year
Spotted dolphin	*Stenella attenuata**	All year	All year
Striped dolphin	*Stenella coeruleoalba**	All year	All year
Long-snouted spinner dolphin	*Stenella longirostris**	All year	All year
Rough-toothed dolphin	*Steno bredanensis**	All year	All year
Bottlenose dolphin	*Tursiops truncatus**	All year	All year
Cuvier's beaked whale	*Ziphius cavirostris*	All year	All year
Dugong	*Dugong dugon*	Unknown	All year

5.4 HABITATS

Although the habitats described in this section do not occur in deep water areas (they are shallow water habitats), these are described here due to their high intrinsic value (locally and regionally), importance to the marine fauna and the local communities and due to their proximity to the drilling area, which makes them vulnerable to impacts from non-routine events, such as oil spills.

5.4.1 Mangrove Forest

Mangrove forests are well developed along the northern sector of the coast. The northern coastal sector runs almost N-S between the Tanzanian border and Pemba with large areas of mangrove occurring along the coast, in the bay of Mocímboa da Praia and to the south of Mocímboa da Praia. These are highly indented and protected by numerous offshore islands and well developed coral reef formations. There are also several small bays along this stretch of coastline.

Several rivers enter in this sector, but because the coastal plain is narrow, the rivers are not tidal for any great distance, and tidal forests are, in consequence, confined to the vicinities of their mouths except for the Rovuma River estuary. The mangroves of Rovuma Estuary are the largest and best developed along the northern sector of the coast and occur as a continuous stand across the border into Tanzania. Approximately 7,600 ha of mangroves occur in the Rovuma estuary on the Mozambican side of the border.

Generally, *Sonneratia alba* is the seaward pioneer adapted to the open coastal and coral platforms occupying sites that are deeply flooded every day. *Pemphis acidula* is a beach tree that thrives on old coral within reach of the waves and often intrudes into the *Sonneratia* fringe if it is interrupted by a coral outcrop.

In creek mangroves *Rhizophora mucronata* and *Sonneratia alba* line the canals behind which *Bruguiera gymnorrhiza* and *Xylocarpus granatum* may dominate. In drier sites, thickets of *Ceriops tagal* (often stunted) may form broad belts. These may give way to a dwarf *Avicennia marina* zone. Further inland the mangrove is replaced by large expanses of highly saline tidal flats. Succulent herbaceous species such as *Arthrocnemum australasicum, Arthrocnemum indicum, Arthrocnemum perenne, Salicornia perriere, Chenolea diffusa* and *Suaeda monoica* occur in these saline areas.

Patches of mangrove occur on Tecomaji, Rongui and Vamizi Islands with the largest stand on Rongui Island.

Mangrove tree species registered for the northern Cabo Delgado are listed in Table 20 and their distribution is shown in Figure 58.

Table 20 Tree species occurring in the mangroves of northern Cabo Delgado

Family	**Species**
Rhizophoraceae	*Rhizophora mucronata* *Ceriops tagal* *Bruguiera gymnorrhiza*
Verbenaceae	*Avicennia marina*
Combretaceae	*Lumnitzera racemosa*
Sonneratiaceae	*Sonneratia alba*
Meliaceae	*Xylocarpus granatum*
Lythraceae	*Pemphis acidula*

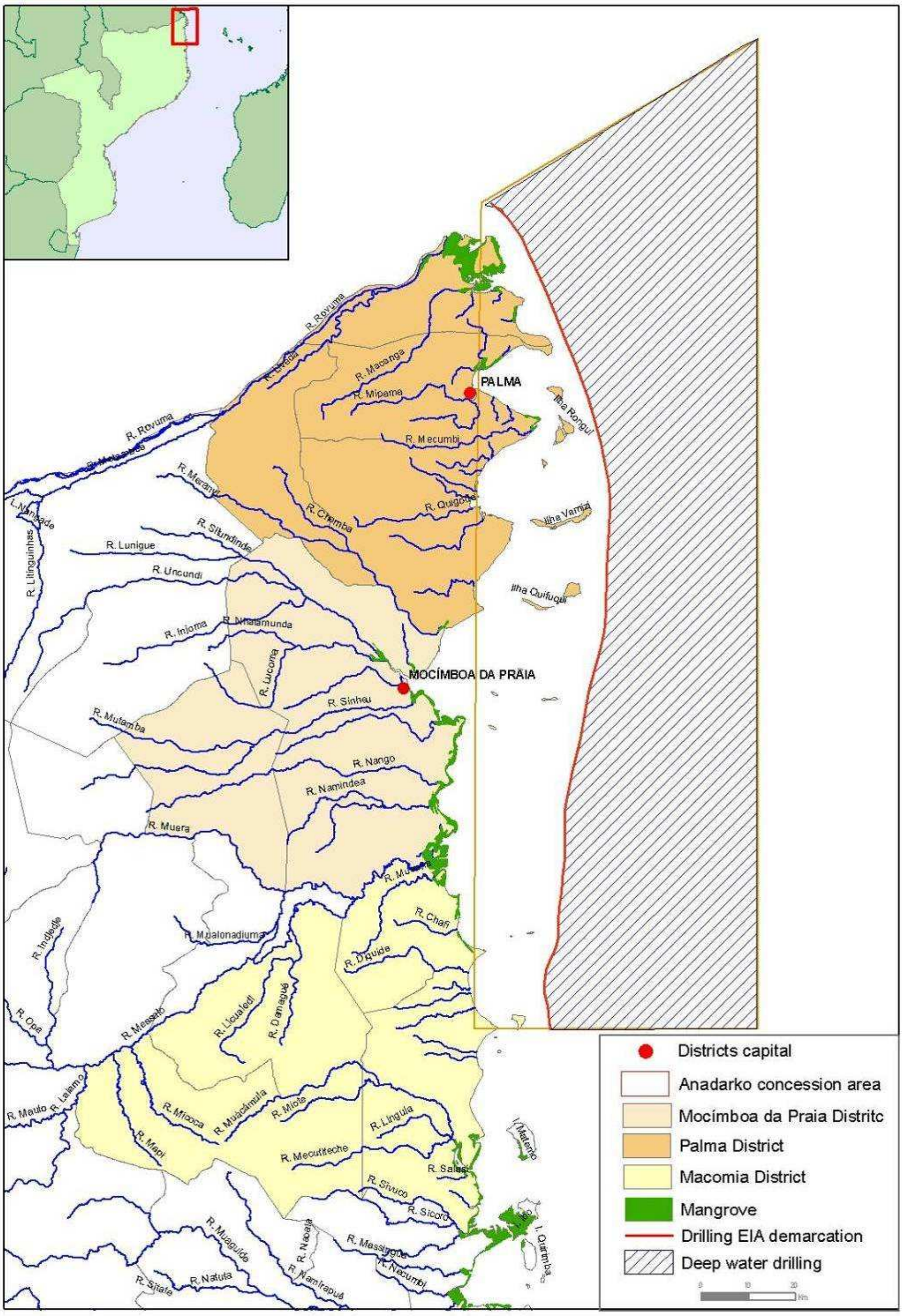


Figure 58 Mangrove distribution in the Rovuma Basin

The mangroves provide habitat for a variety of bird species, crustaceans, fish, and molluscs.

According to Impacto and Mark Wood Consultants (2006) fourteen bird species use the mangroves as a feeding and breeding habitat including: the black egret (*Egretta ardesaica*), the little egret (*E. garzetta)*, and the western reef heron (*E. gularis*); the goliath (*Ardea goliath)* and black-headed herons (*A. melanocephala*), the white (*Ciconia ciconia)* and black storks (*C. nigra*), the sacred ibis (*Threskiornis aethiopicus*), the mangrove (*Halcion senegaloides*) and brown hooded kingfishers (*H. albiventris*), the African fish eagle (*Haliaeetus vocifer*), the African hawk eagle (*Hiearaoetus faciatus*), and the lesser flamingo (*Phoenicopterus minor)* and greater flamingo (*P. ruber*).

Crustaceans comprise the fiddler crabs (*Uca* sp.) and the mud crab (*Scylla serrata*). Mollusc species include mud creepers, *Terebralia palustris*; pencil bait, *Solen capensis*; mud snails, *Cerithidea decollate* and giant knobbed ceriths, *Cerithium nodolosum* (Impacto and Mark Wood Consultants 2006).

Mangrove forests will not be found in the project area since this area is located in water depths greater than 200m. However, they are included in this report as they are an important habitat type that is in the area of potential impact from certain operations and unplanned events such as oil spills.

5.4.2 Seagrass Beds

Along the Cabo Delgado coastline and the Quirimbas Archipelago ten species of seagrass belonging to seven genera have been recorded (Whittington *et al.* 2000). Fish species assemblages associated with sea grass meadows are incredibly diverse. 249 species of fish belonging to 64 families were recorded for the southern Quirimbas (Whittington *et al.* 2000). Seagrass meadows occur in close association with the fringing coral reefs that form part of the Quirimbas archipelago. They constitute the dominant vegetation in the shallow water ecosystems. The sub-tidal *Enhalus acoroides* and *Thalassodendrun ciliatum* dominate the seagrass beds. There are also small areas of the fine cylindrical seagrass *Syringodium isoetifolium*.

The coastal area is subject to a tidal range of approximately 4.2m, which combined with gently sloping topography leads to the occurrence of extensive intertidal zones. These habitats are suitable for seagrass beds as well as macroalgae assemblages associated with rich fauna. Seagrass beds tend to occur in sheltered waters with suitable substrate (sand/mud) such as embayments (e.g. Mocimboa Bay, Tungue Bay and Quionga Bay). Telford (1998) recorded five species of seagrasses from five genera during this preliminary survey of the northern coastline (Table 21). This diversity represents 50% of the overall seagrass diversity already known to occur in the Quirimbas Archipelago. Of these only *Thalassodendron ciliatum* was recorded associated with coral reefs but occurring only in small patches.

Table 21 Seagrasses recorded for the Mocimboa da Praia and Palma coastline

Family	Species
Cymodoceaecea	*Thalassodendron ciliatum*
	Halodule wrigthtii
	Thalassia hemprichii
Hydrocharitaceae	*Halophila ovalis*
	Seringodium isoetifolium

The seagrass beds and macroalgae assemblages play a valuable role by providing food, shelter and serving as nursery grounds for a diversity of commercially exploited species such as fish, crustaceans, gastropods and sea cucumbers. The seagrasses are important feeding grounds for the dugong (*Dugong dugon*) and the green turtle (*Chelonia mydas*).

5.4.3 Coral Reefs

Corals are ecosystems located along the coastline and adjacent to islands, in waters less than fifty metres deep.

Extensive fringing reefs are seen along the eastern shorelines of the islands and banks of the Quirimbas Archipelago. The Cabo Delgado Biodiversity and Tourism Project (CDBTP) 2003 report (Garnier, 2003) identified 125 coral species in 42 genera from 14 families in the Vamizi Island area. Rodrigues et al. (2000) indicates that over 50 genera of corals have been reported from the reefs along the Quirimbas Archipelago. According to these reports, the Quirimbas Archipelago contains one of the most extensive, pristine and continuous fringing reefs in the country. Direct pressure from people is low despite existence of artisanal fisheries in the area.

The most common species of corals reported as follow: *Echinophora hirsutissima*, *Astreopora muriophthalma*, *Goniastrea rectiformis*, *Porites spp*, *Seriatophora hystrix*, *Favia stelligera* and *Acropora lattistela*. The rare Indo-Pacific coral reefs occurring in the area include *Acanthastrea ishigakiensis*, *Acropora ocellata*, *Acropora willisae*, *Goniopora tenuidens*, *Montipora peltiformis*, *Porites lichen* and *Turbinaria mesenterina*. The same study showed that the coral reefs of this area are healthy with small damage of 20% coverage and a mortality of 10% of the covering area.

Observation of the abundant state of the reefs along the Quirimbas Archipelago was confirmed during the Representative Marine Habitats Survey conducted in association with the EIA for the Seismic Project (AMA1 area). These reefs appeared to be very healthy; showing no evidence of specific coral diseases or bleaching at the time of that survey. The reefs and nearshore habitats visited showed very little natural or anthropogenic damage. One area off Tambuzi Island showed an area of reef damage that may have been attributable to net drag, but that was not confirmed. During the marine mammal aerial survey also prepared for the same EIA, gill nets and larger pull nets were observed in use in the Quirimbas Archipelago, but no nets were observed during the ground level habit survey.

These reefs are part of a chain, which extends from Somalia, through Kenya and Tanzania, down to the South of Mozambique. This ecosystem is recognised throughout the world for its high biodiversity. The coral reefs represent one of the main attractions for the tourism industry in Mozambique.

No coral reefs occur in the project area. The minimum distance between the drilling area and the coral reefs around the islands is approximately 2.3km (Vamizi Island reefs). Refer to Table 24 below.

Figure 59 shows the AMA1 concession and indicates the major coral reef areas in relation to the 200m bathymetric depth contour along the islands forming the Archipelago. These coral reefs are important to artisanal fishers and represent a major contributor to the livelihood of the many small coastal communities present throughout the area.

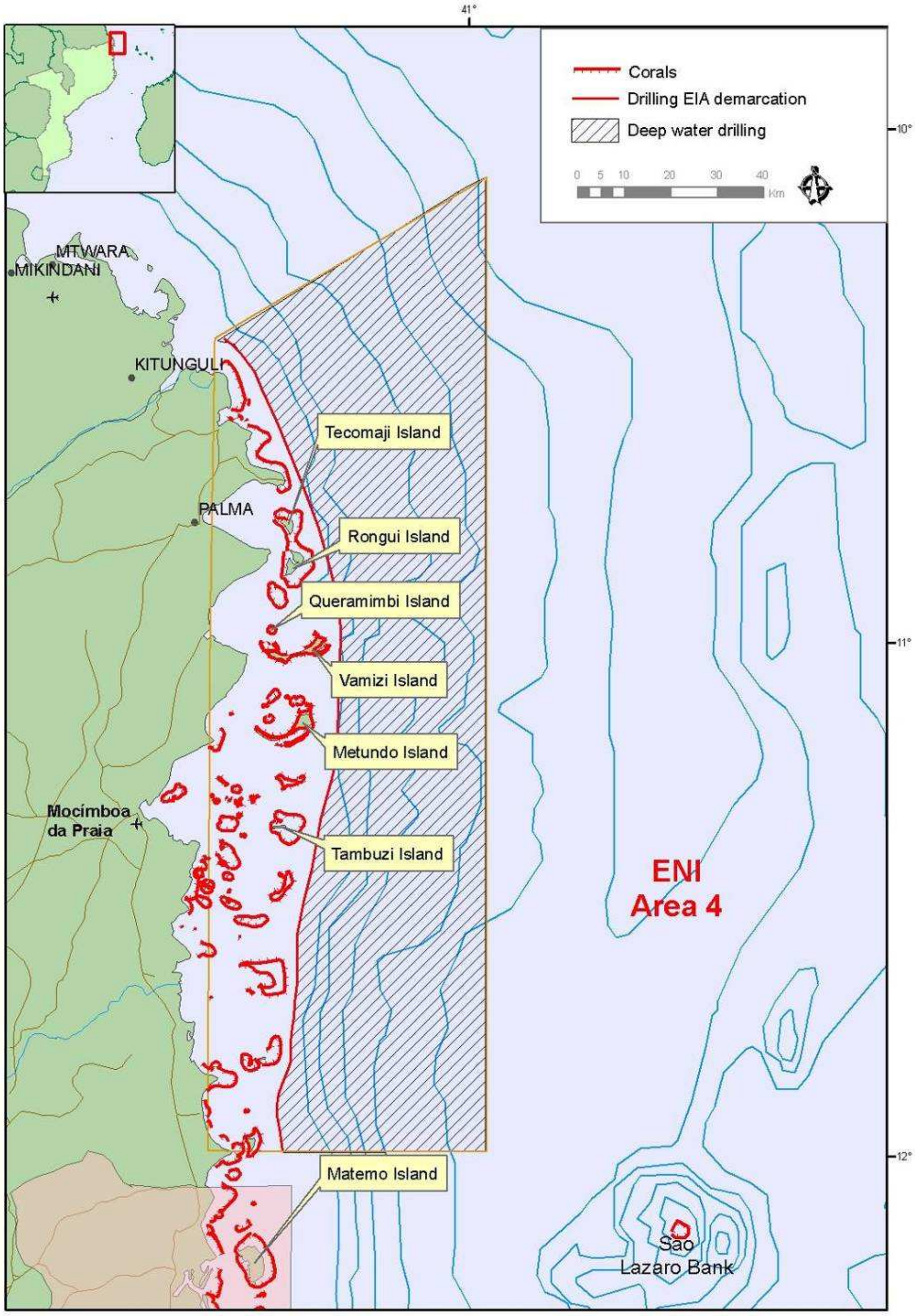


Figure 59 The major coral reef areas in relation to the 200m bathymetric depth contour of the drilling project

Well-developed back reef and spur-and-groove coral habitats are seen shoreward of the reef drop-off in water depths less than 30m (Figure 60).

Figure 60 Typical back reef community in the Vamizi Island area

Inshore of the reefs are vast areas of mixed seagrass and patch reef communities (Figure 61). These areas are important in terms of nursery areas for the juvenile life stages of reef fishes and invertebrates harvested by artisanal fishers along the reef line.

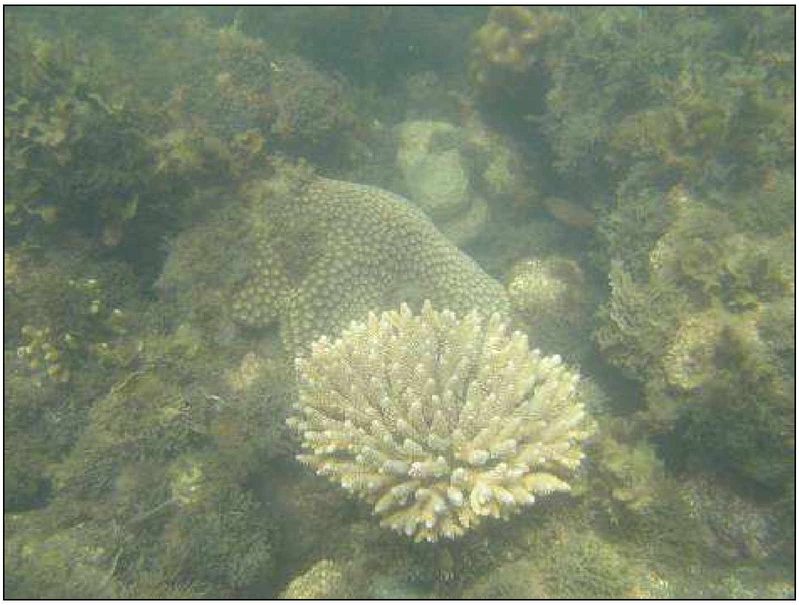


Figure 61 Coral and algal patch reef community in the vicinity of Tambuzi Island

5.5 CONSERVATION AREAS

No official conservation areas have been established in the AMA 1 Concession Area. However, a very small portion of the Proposed Rovuma National Reserve occur within the AMA1 Concession area, beyond the 200m bathymetric line, where the proposed wells will be drilled.

The Quirimbas National Park (QNP) is located 7.8km from the southern boundary of the concession area whilst the Mnazi Bay-Rovuma [52] Estuary Marine Park (MBREMP) in Tanzania is located 3km to the north of the concession area (Figure 62). The Mnazi Bay-Rovuma Estuary Marine Park (official in July 2000) includes the whole of Mnazi Bay, nearby islands and approximately 20km of the Rovuma River estuary which forms the border with Mozambique.

Currently, the only specifically identified sensitive areas adjacent to the proposed survey area are the island of Macaloe (387 ha) in Macomia District and the islands of Vamizi (1,181 ha) and Rongui (969 ha) in Palma District. These three islands are part of the Cabo Delgado Biodiversity and Tourism Project (CDBTP) that has been developed to ensure the sustainable conservation of diverse and pristine wilderness areas. The distances of these islands to the western boundary of the drilling area are: Macaloe (7.5km), Vamizi (3.8km) and Rongui (3km).

The Ministry for the Coordination of Environmental Affairs, under the auspices of the GEF-funded Marine and Coastal Biodiversity Management Project, recently commissioned a study to investigate the possibility of creating a Transfrontier Conservation Area (TFCA) across the Mozambican-Tanzania border to link up with the Mnazi Bay-Rovuma Estuary Marine Park.

The report of the study (Bandeira, 2007) recommends the creation of a new conservation area in Mozambique (proposed name: the Rovuma/Palma National Reserve). The study also recommends some modifications in the boundaries of the MBREMP to form a contiguous Transfrontier Conservation Area with the proposed conservation area in Mozambique. The limits of the present and proposed conservation areas are shown in the Figure 62 below.

The QNP includes the southern most 11 islands of the Quirimbas Archipelago, as well as a large portion of the mainland. The marine protected portion of the QNP covers 152,237km^2 and is one of the largest marine protected areas in Africa.

The General Management Plan for the park expresses the Mozambique government's commitment to biodiversity and conservation in the form of a concrete plan for conservation and management of the QNP as a natural resource. Hydrocarbon exploration and drilling are prohibited in all use zones. A 10km buffer zone from all park boundaries has been recently proposed to protect the QNP.

The Saint Lazarus Bank, located 40km south east of the AMA 1 concession area, is recognised for its biological importance, for corals and fishes. Despite the fact that this Bank is not formally part of the QNP, the latter's management measures also encompass this area.

Figure 63 below shows the location of the project area in relation to the conservation areas. As can be seen from the figure, only a very small portion of the Proposed Rovuma National Reserve occur within the AMA1 Concession area, beyond the 200m bathymetric line, where the proposed wells will be drilled.

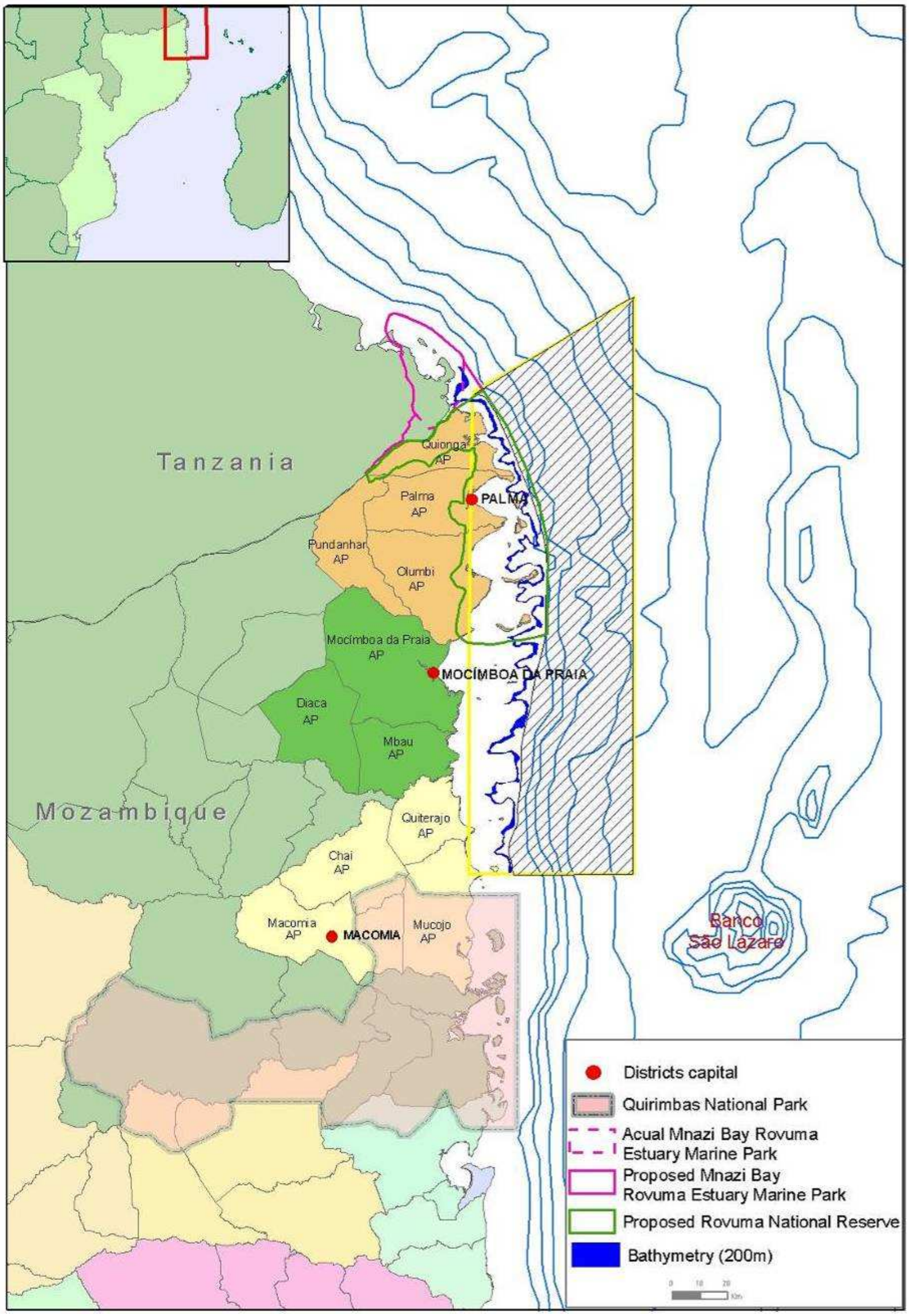


Figure 62 The Drilling area in relation to the conservation areas

5.6 THE SOCIOECONOMIC ENVIRONMENT

5.6.1 Geographic Layout

The AMA1 concession area falls within three districts, from north to south: Palma, Mocimboa da Praia, and Macomia (Figure 63). While project activities are only to take place offshore, these activities may potentially affect the on-shore socio-economic environment on the mainland as well as on the islands of the Quirimbas Archipelago (32 in total), 21 of which fall within the AMA1 Concession Area but none within the study area (drilling area).

All the districts are administrated according to Mozambican Government Law and they comprise three levels of administration: district administrative posts, localities and villages (Table 22 and Figure 63).

Table 22 Districts and administrative posts in the project area

District	Administrative Post
Palma	Quironga
	Palma
	Olumbi
Mocimboa da Praia	Mocimboa da Praia
	Mbau
	Diaca
Macomia	Quiterajo
	Mucojo
	Macomia

Source: IDPPE, 2002.

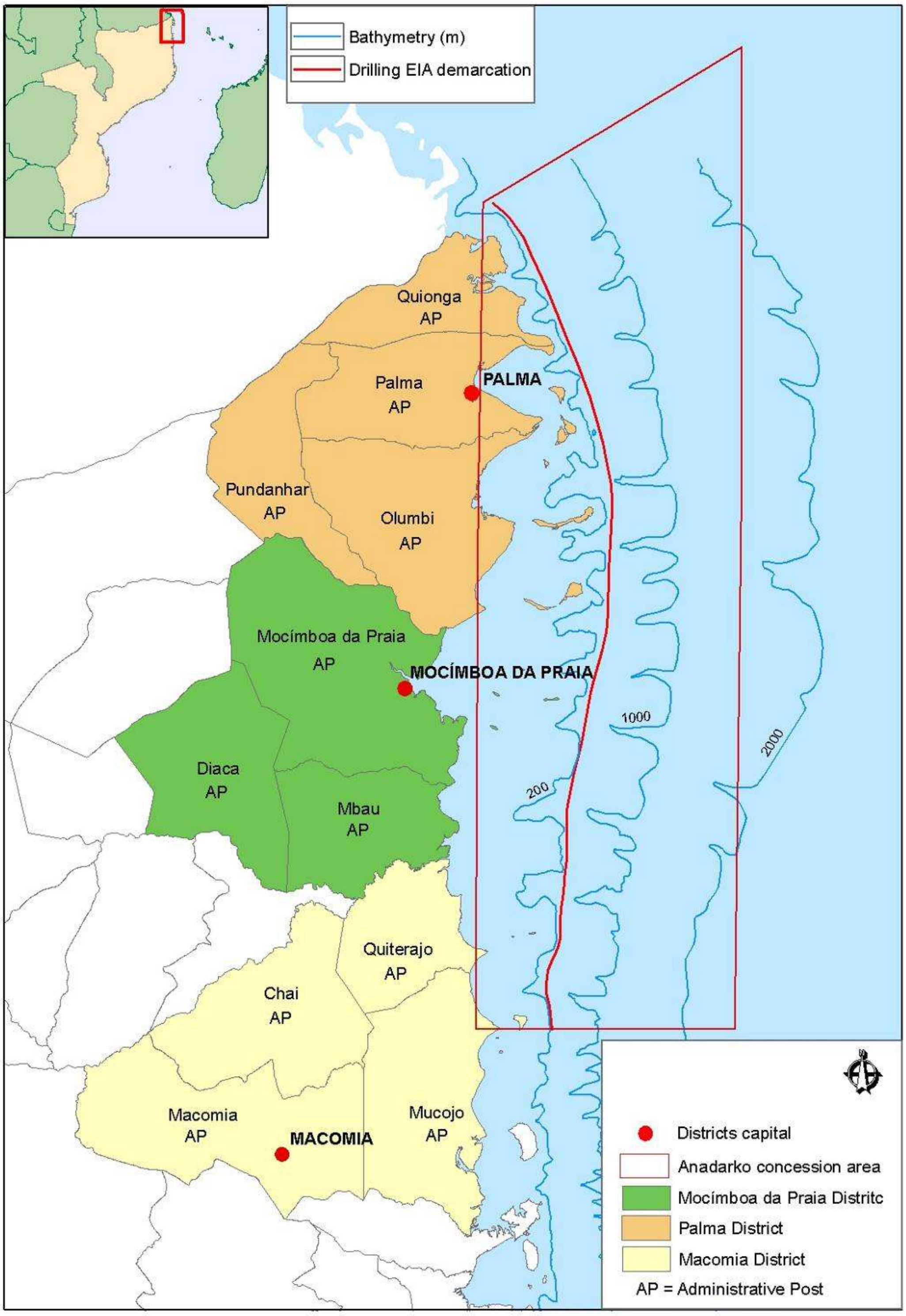


Figure 63 The AMA1 concession area in relation to administrative boundaries

Islands in the Concession Area

There are 21 islands in the Concession Area among which, 8 fall under the jurisdiction of the Palma District, 10 fall under the Mocimboa da Praia District, and 3 all administratively under the Macomia District (Table 23). Some of these are located very close to the drilling area but none are within this deeper (>200m depth) region.

Table 23 Islands in the study area per district

District	Island
Palma (Total = 8)	Quiriamimbi
	Vamizi
	Tecomaji
	Comezi
	Rongui
	Vumba
	Metundo
	Quifuqui
Mocimboa da Praia (Total = 10)	Tambuzi
	Muichanga
	Nhonge
	Suavo
	Niuni
	Mejumbe
	Quissanga
	Namadoro
	Muissune
	Quirianhune
Macomia (Total = 3)	Macaloe
	Quifula
	Rolas

Figure 64 and Table 24 outlines the distances from a number of points on the mainland and a number of islands to the western boundary of the survey area. Table 24 also outlines the distance from the outer reefs of selected islands to the western boundary.

Table 24 Distances from mainland, islands, and outer reef line at key points to the western boundary of the survey area

Island or Point	Distance to Western Boundary of Survey Area (km)	Distance from outer reef line to Western Boundary of Survey Area (km)
Cabo Delgado (cape north of Palma)	3.6	--
Palma	24.8	--
Tecomaji Island	5.7	4.0
Rogui Island	5.0	3.9
Olumbe	31	--
Vamizi Island	3.8	2.3
Metundo Island	5.7	5.0
Tambuzi Island	7.0	3.9
Mocimboa da Praia	38	--
Medjumbe Island	5.6	2.7
Pangane	10.9	--
Macaloe Island	5.6	3.8

Figure 64 Distances from a number of points on the mainland and a number of islands to the western boundary of the survey area

5.6.2 Institutional Organization

The political structure in the study area comprises both formal and traditional authorities, organized in accordance with GOM legislation. The highest level of authority in the Province is the Provincial Governor, who is based in Pemba Cidade (Pemba City). Each district is headed by a District Administrator, who reports to the Provincial Governor. Each District Administrator coordinates a number of Chefes dos Posto Administrativos, who are appointed by the GOM. Figure 65 provides a diagrammatic outline of this institutional structure. Localidades are further subdivisions within the authority areas of the Posto Administrativos which fall under Chefes de Localidade. Traditional leaderships, known as Lideres Comunitarios, function below the level of the Chefe de Posto. These Lideres Comunitarios are appointed according to community criteria, but their position has been formalized through Decree 15/2000, which gives them the authority to make decisions on a range of important community issues.

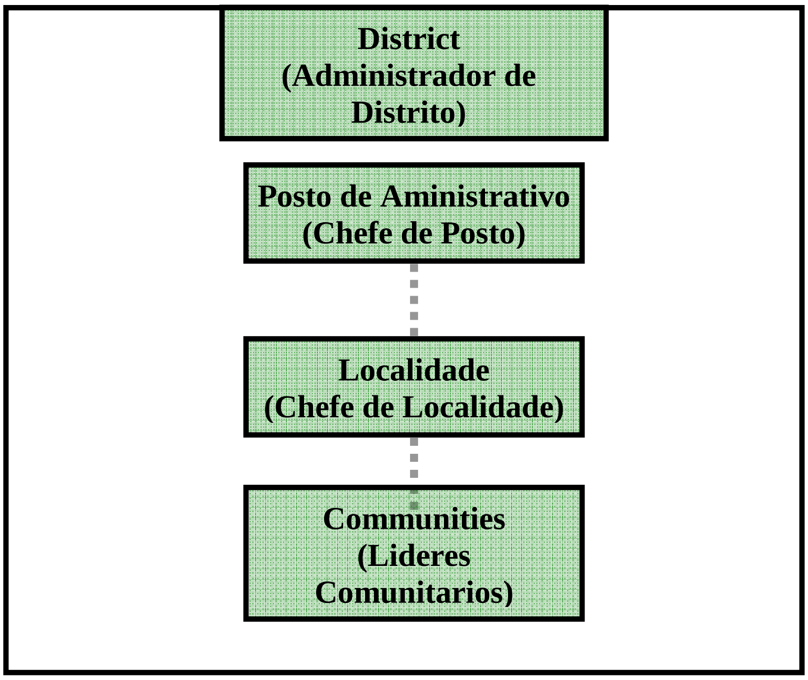


Figure 65 Institutional arrangements

Each district comprises the following departments

a) Economic Activities (Agriculture, Fisheries, Forests, Commerce and Industry),
b) Health and Social Action,
c) Education, Youth, Sport, Culture and Technology,
d) Planning and Infrastructure,
e) Fiscal Area Directorate *(Direcção da área fiscal)*
f) Social Security and Labor
g) Civil Registrar Conservatory

h) Small Scale Fisheries Development Extension Station (IDPPE)
i) Custom and Migration
j) Public Prosecutor and
k) Police

This structure has been recently established under the new state law (Law No. 8/2003 of 19th of May) and Regulations (Decree 11/2005 of 10th of June) of the Local State Bodies - Lei dos *Órgãos Locais do Estado*), which gives emphasis on the role of the districts in development strategies and implementation of plans. In this approach all activities related for example to fishing administration, extension and development will be implemented by the district government. Local fisheries governments have been enforced by allocating more human resources for extension (12 from IDPPE) and administration (3 from fisheries administration) in all districts from the study area (Table 25).

Table 25 IDPPE extension and Fisheries administration officers in the study area

District	Administrative Post	Locality	IDPPE Extension officers	Fisheries Administration representative
Palma	Olumbi	Olumbi	1	1
	Palma-sede	Palma-sede	2	
		Quirinde	1	
Mocimboa da Praia	Mocimboa-sede	Mocimboa-sede	2	1
		Ulo	1	
		Malinde	1	
Macomia	Mucojo	Mitacata	1	1
		Ingoane	1	
		Pangane	1	
		Darumba	1	
		Total	**12**	**3**

The Law and Regulations of the Local State Bodies define the district as the basic planning unit for the development of the country, and indeed with a provision for the transfer of funds from the central government to the district level. In this regard, it requires a restructuring of provincial and district governments as well as clearly defined competencies of the different levels of government responsibilities for the management of sector policies.

5.6.3 Demographic Characteristics

5.6.3.1 Cabo Delgado Province

According to the most recent census (2007), the total population of Cabo Delgado Province is estimated at 1.63 million (of which 52% are women). This represents a growth rate of approximately 21% when compared to the 1997 figures (Table 26).

Recent and specific population figures per Administrative Post (Posto Administrativo), Locality (Localidade) as well as per Islands are also to be finalized by the INE. However, the population census done in 1997 by the INE found that the average population by localities was approximately 7,000 and the coastal localities appeared to be the most inhabited (Table 26).

Table 26 General demographic profile of Cabo Delgado Province from INE (2007) (preliminary data)

District or City	Population		
	Total	Men	Women
Ancuabe	109,792	52,041	57,751
Balama	126,116	60,482	65,634
Chiure	230,044	108,718	121,326
Ibo	9,509	4,545	4,964
Macomia	81,208	39,071	42,137
Mecufi	43,573	20,448	23,125
Meluco	25,184	12,150	13,034
Mocimboa da Praia	94,197	45,426	48,771
Montepuez	185,635	89,316	96,319
Mueda	120,067	56,750	63,317
Muidumbe	73,457	34,732	38,725
Namuno	179,992	86,194	93,798
Nangade	63,739	30,341	33,398
Palma	48,423	24,247	24,176
Quissanga	35,192	16,643	18,549
Pemba-Metuge	65,365	31,833	33,532
Pemba City	141,316	70,298	71,018
Total	1,632,809	783,235	849,574

Detailed and updated demographic parameters are still not available since the general population census of 2007 is to be finalized. However, although changes in population dynamics has been expected during last 10 years, some population parameters were extracted from the 1997 census and used as reference in this study. According to these figures, the economically active population (15 to 64 years old) was approximately 78% of the total population (1.28 million). By that period more than 80% resided in rural areas, leaving almost 20% of the population in urban centers.

5.6.3.2 Districts in the study area

The study area falls into three districts (Macomia, Mocimboa da Praia, and Palma), comprising 10 *Posto Administrativos* and 23 *Localidades*. The total population of the three districts is approximately 223,828 people. This represents a growth rate of 29% from the 1997 demographic figures (Table 27).

Table 27 Population and area size per District from INE 2007 (preliminary data)

District	Area (km^2)	Population		
		1997	**2007**	**Growth Rate**
Palma	4,967	42,182	48,423	15%
Mocimboa da Praia	4,570	75,001	94,197	26%
Macomia	3,561	56,788	81,208	43%
Total	**---**	**173,971**	**223,828**	**29%**

The Tables 28 and 29 below show the population figures per localities and for some islands (Tambuzi, Vamizi and Muichanga) respectively, according to the census done in 1997 by the INE. It shows that Mocímboa da Praia is the most populated district and Palma the least populated of the three districts. However, in terms of Posto Administrativo, Palma is the most populated after Mocímboa da Praia-Sede.

Table 28 Population per District, Posto Administrativo and Localidade from INE (1997)

Population by District		Population by Posto Administrativo		Population by Localidade	
Palma	42,182	Palma	20,526	Palma	13,131
				Mute	7,395
		Olumbe	13,455	Olumbe	7,315
				Quisengue	6,140
		Pundanhar	2,489	Nhica Rovuma	2,489
		Quionga	5,712	Quirinde	5,712
Mocimboa da Praia	75,001	Mocimboa da Praia-sede	48,052	Mocimboa da Praia-Localidade	25,506
				Mocimboa da Praia-sede	11,524
				Quilimane	11,022
		Diaca	15,703	Diaca-sede	9,369
				Nango	6,334
		Mbau	11,246	Mbau-sede	7,571
				Marere	3,675
Macomia	56,788	Macomia	10,808	Nacate	3,973
				Nquida	6,835
		Chai	14,273	Chai-Sede	10,912
				Nkoe	3,361
		Mucojo	24,522	Mucojo	5,913
				Manica	4,785
				Naunde	5,557
				Pangane	8,267
		Quiterajo	7,185	Quiterajo-Sede	3,517
				Imala	3,668

Except Vamizi, Tambuzi and Muichanga, population data from other islands was included with that of the mainland area, and this makes it difficult to figure out the specific demographic profile of each island. The national Artisanal Fisheries Census done by IDPPE in 2004 found that almost all islands were inhabited by fishers living in temporary fishing camps of between 100 and 800 people and that Tambuzi, Vamizi and Muichanga islands had the highest numbers of fishers (Table 29). During the fieldwork it was found that migrants from Mocimboa da Praia, Palma, Nampula and Tanzania inhabit the island camps, which can accommodate as many as 200 households.

Table 29 Population and fishers on islands in the study area per district from IDPPE (2004)

District	Island	Population (INE census data)	Number of Fishers (IDPPE data)
Palma	Quiriamimbi		N/D
	Vamizi	348	> 800
	Tecomaje		< 100
	Comezi		N/A
	Rongui		N/D
	Vumba		< 100
	Metundo		> 300
	Quifuqui		> 200
Mocimboa da Praia	Tambuzi	742	> 300
	Muichanga	52	< 100
	Nhonge		< 100
	Suavo		< 100
	Niuni		< 100
	Mejumbe		< 100
	Quissanga		< 100
	Namadoro		< 100
	Muissune		< 300
	Quirianhune		< 100
Macomia	Macaloe		100 – 200
	Quifula		< 100
	Rolas		< 100

5.6.4 Economic activities in the province

The majority of the population in the study area is involved in agriculture, fishing and livestock rearing (mainly goats and chicken, but also sheep, doves, ducks, cattle, pigs and rabbits) as key economic activities (District Government, 2008). Agriculture, forestry and fisheries sector is the largest (92%) and of specific importance in areas further away from the coast (Table 30).

Table 30 Population per Economic activity in Cabo Delgado from INE (2007) (preliminary data)

Sector	Total		
	Total	**Men**	**Women**
N (000)	589,343	286461	302,882
Total	100%	100%	100%
Agriculture, forestry and fisheries	92%	86%	97.76%
Commerce and finances	2.41%	4.30%	0.63%
Manufacturing industry	1.70%	3.13%	0.34%
Administrative services	1.48%	2.65%	0.37%
Construction	1.21%	2.16%	0.31%
Unknown	0.47%	0.55%	0.40%
Transport and communications	0.34%	0.66%	0.04%
Other services	0.31%	0.56%	0.07%
Mineral extraction	0.2%	0.23%	0.08%
Energy	0.1%	0.10%	0.01%

There are two key food and income generation systems in the Cabo Delgado Province:

- The first is composed of dry land farming systems mainly located inland from the study area, and comprises a combination of crop production, livestock rearing and trading. Rain-fed crop production is susceptible to climatic variability and exposed to risks of prolonged dry seasons. The access to potential markets is poor and in some areas commercial transactions do not involve money, while in others Tanzanian currency is used.

- The second system is practiced in the lowland and coastal areas located along the coast and major rivers, such as the Rovuma River. This system consists of a combination of fishing, crop production, and rearing and trading livestock, with fishing being the most important.

The second system is of relevance to the project, as the study area does not include areas of the first type.

The Fisheries Baseline Study (FBS) found that men from the mainland villages in the study area spend approximately 60% of their time catching, processing, and selling fish. Women, who traditionally spend more time on agriculture, spend approximately 40% of their time on these fishing related activities. Soil conditions on the islands are not suitable for agriculture, which is rarely practiced on a larger scale than subsistence vegetable plots. Here, both men and women spend approximately 80% of their time on fishing-related activities. The importance of the fishing activities in the livelihoods of people in the study area is further discussed in Section 5.6.6.

5.6.5 Tourism in the Study Area

This project is proposed to take place beyond the 200m bathymetric line, where no tourism operators are active. However, due to the importance of the islands located in the vicinity of the project area (some as close as 3.8km) to the country´s economy in terms of revenues and due to the unlikely possibility of these islands being affected by non-routine events such as oil spills (as shown by an hypothetical oil modeling undertaken and discussed below), this section has been included.

5.6.5.1 Regional context

Mozambique can be divided into three geographical regions, the North (Cabo Delgado, Nampula, and Niassa Provinces), the Centre (Sofala, Manica, Zambézia, and Tete Provinces) and the South (consisting of the provinces of Maputo, Gaza, and Inhambane). Geo-physical characteristics, socio-economic development, and tourism profiles differ between the three regions, and distances between the three regions are significant (with Cabo Delgado Province being in the order of 1,500 km away from Maputo.

As indicated, the study area falls within the Cabo Delgado Province and therefore also in the Northern Region. This Region has not only historical significance, but also abundant marine life. The Quirimbas Archipelago is a very valued resource, as are the wilderness areas of the Niassa Reserve, and the unique biodiversity of Lake Niassa. All of these aspects are well promoted by the tourism industry, making them an economically important natural resource (MITUR: 2003).

The areas of the country visited by tourists appear to be concentrated in the South. Approximately 60% of tourist arrivals were concentrated on Maputo City and the Maputo Province, with the remaining 40% shared by the other 10 provinces (INE: 2002). In 2001, the Provinces of Nampula, Cabo Delgado, and Niassa shared less than 25% of the total registered accommodation units, and less than 10% of total bed nights spent in the country. Key reasons for the low number of bed nights are distance, logistics in terms of transport, and poor road infrastructure.

5.6.5.2 Quirimbas Archipelago as a tourism destination

The Quirimbas Archipelago provides MITUR's so-called 'Blue' product line and addresses a strategic niche by providing diving, deep sea fishing, eco-tourism, adventure tourism, high-yield 'island' tourism, and cultural tourism.

Despite being in its 'tourism infancy', the Quirimbas Archipelago is rapidly becoming a sought-after international tourism destination.

According to one of the largest travel agencies in Pemba (Kazkazini Tourism Services), there has been a rapid increase in the number of business tourists visiting the Quirimbas Archipelago (when comparing the first four months of 2007 with same period of 2008), while at the same time, numbers of leisure tourists showed only slight variation (Table 31 and Figures 66 to 68).

Table 31 Leisure tourists vs. business tourists for the first four months of 2007 and 2008.

Year	January			February			March			April		
	Leisure	Business	Total	Leisure	Business	Total	Leisure	Business	Total	Leisure	Business	Total
2007	169	25	**194**	70	0	**70**	45	52	**96**	219	8	**227**
2008	174	171	**345**	55	123	**178**	186	230	**416**	147	118	**265**
Change	+3%	+584%	**+78%**	-21%		**+154%**	+313%	+342%	**+333%**	-33%	+1,375%	**+17%**

Data from one of the largest travel agencies in Pemba, Kazkazini Tourism Services

Although the figures in the Table 31 are not definitive[53], it provides a certain indication of current tourism trends. As far as the number of leisure tourists is concerned, there appear to be months when the numbers of tourists have decreased between 2007 and 2008. However, seasonality must be borne in mind, e.g. the calendar position of Easter, which usually has a significant influence on March and April bookings. When the totals for March and April combined are compared between the two years, it shows a 36% increase in leisure tourists for these months. Overall across the four months, there was a 12% increase in leisure tourists (Figure 66).

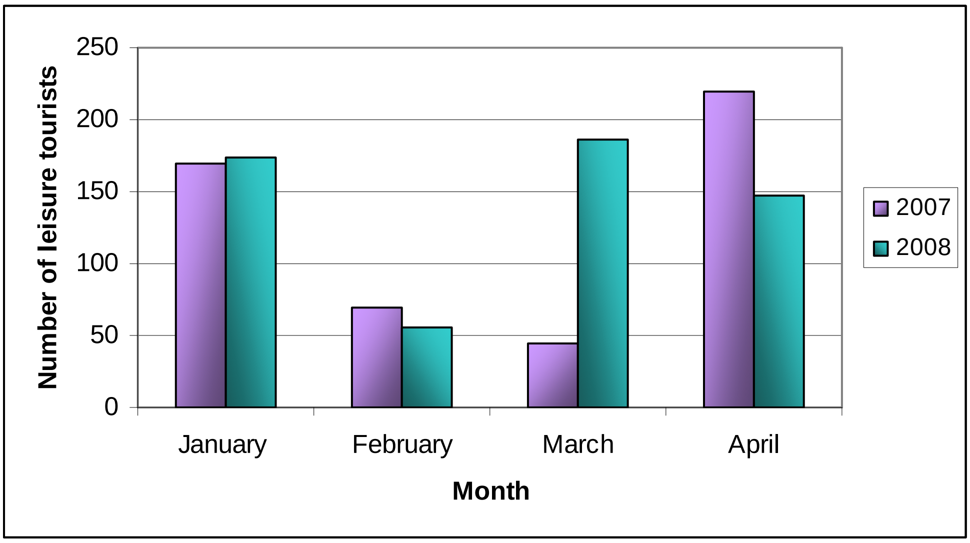


Figure 66 Number of leisure tourists for the first four months of 2007 and 2008

Similarly to the leisure tourists, business travellers (here referred to as business tourists) numbers have also increased in 2008 when compared to 2007. Figure 67 below shows the overall increase of business tourists for the first four months of 2007 and 2008.

[53] Albeit from one of the largest, the figures only represent one travel agency's bookings.

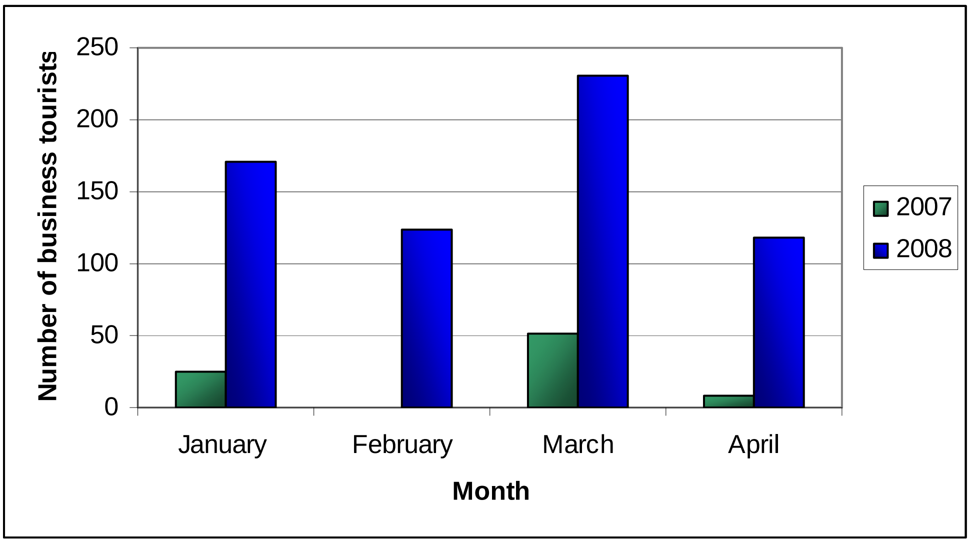


Figure 67 Number of business tourists for the first four months of 2007 and 2008

Based on the figures in Table 31, it becomes clear that there has been a radical increase in the number of business tourists visiting the area from 2007 to 2008. Again, there are certain months where higher or lower numbers were noted, but the increases per month are all more than 300%, with an overall increase when the four months are compared between 2007 and 2008, of 65% (Figure 67 above).

The main reason for the extraordinary increase in the number of business tourists can be ascribed to the presence of a number of petroleum exploration companies in the area. StatoilHydro has established a presence in Pemba and has completed their seismic acquisition in 2007, AMA1 and ENI have just completed their respective deep water acquisitions, and Artumas are currently in the process of surveying their on-shore area. Business tourism numbers are bound to decrease again after May/June, as all on-going off-shore acquisition would have been completed.

Thus, over the short to medium term, these increases will have a positive effect on certain tourism operators in Cabo Delgado. It is, however, important to note that although the figures were provided by one of largest tourism agencies in Pemba, it is only from one agency and should thus be seen as indicative only.

Figure 68 below shows the total number of tourists for the first four months of 2007 and 2008, indicating that overall across the four months; the number of tourists has increased fro 2007 to 2008.

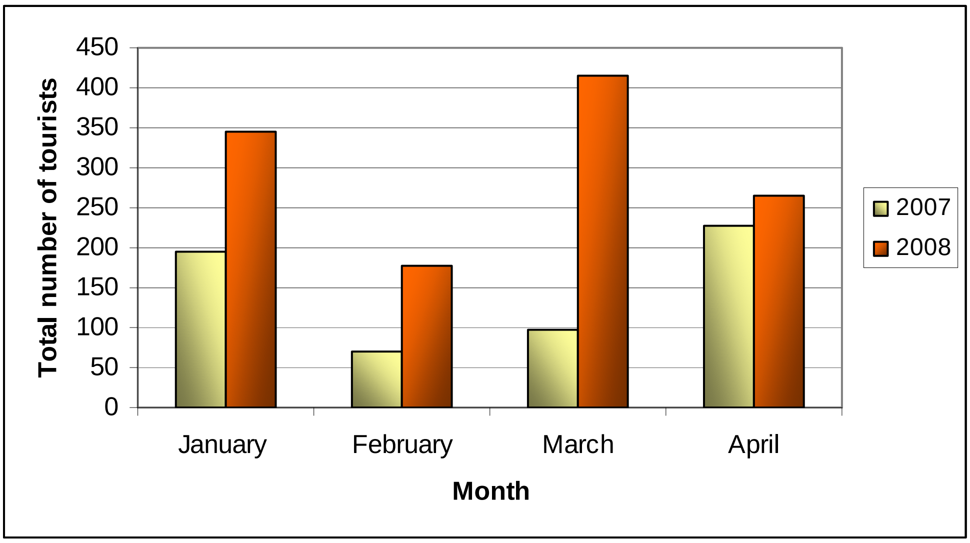


Figure 68 Total number of tourists for the first four months of 2007 and 2008

5.6.5.3 Tourism operators in the study area

No tourism businesses operate directly in the AMA1 Offshore Concession Area. However, several tourism operators are located such that drilling structures could be in sight of their clients. Also their operations could be affected by competition for supplies and services purchased onshore or non-routine events such as oil spills.

Tourism operators in the study area can be divided into two main categories:

- Accommodation Only Operators (AO Operators [54]) - who provide accommodation facilities only. These operators are predominantly based on the mainland.
- Leisure and Accommodation Operators (L&A Operators) - who provide tourism leisure activities, such as diving and sport fishing, as well as accommodation. These operators are predominantly island-based lodge operators.

There are no Leisure Only Operators (LO Operators), providing tourism leisure activities only, e.g. dive charters and fishing charters, in the study area.

ACCOMMODATION ONLY (AO) OPERATORS

Tourism facilities providing accommodation only are very limited in the study area. They are all located either in Mocimboa da Praia or Pangane. These establishments provide accommodation only, with configurations of bed only, bed and breakfast, or full board. Table 32 provides information on AO Operators. There is also a camping ground in Pangane, but it does not provide other formal accommodation. There are no formal accommodation operators in Palma. Although there are number of

[54] The acronyms for the different types of tourism operators are used for ease of reference.

establishments calling themselves ‘hotels’, they are merely restaurant and bar facilities frequented by locals, with no accommodation facilities.

Table 32 Information on AO Operators

Location	Name of operator	Bed nights	Rate/per person (Mtn)[55]	Number of employees	Employee remuneration (Mtn)
Mocimboa da Praia	Chez Natalie	9	1850.00	7	1550.00
	Pensao Mira-Mar	4	350.00	3	1550.00
	Pensao Magido[56]	n/a	n/a	n/a	n/a
Palma	No formal AO operators.	n/a	n/a	n/a	n/a
Pangane	Casa Suk	14	800.00	4	1350.00
	Restaurante/Bar Pangane[57]	1	400.00	2	1300.00

From Table 32 it is clear that there are a limited number of AO Operators in the study area, with a very small number of bed nights available. According to the operators, the average duration of stay for guests is three nights, but a large number of visitors merely pass through, staying a single night. Peak tourist season is largely dependant on the rainy season (November to April), as, at times during the rainy season, it becomes extremely difficult for visitors to reach Mocimboa da Praia and Pangane.

The main countries of origin of guests of AO Operators are Mozambique, Italy, South Africa, and the United Kingdom, with a significant number of guests coming from Mozambique.

LEISURE AND ACCOMMODATION (L&A) OPERATORS

At the time of the study, there were two L&A Operators operational within the study area, namely, the Rani Group and the Maluane Group (Figure 69)[58].

The Rani Group currently operates the Medjumbe and Matemo[59] Island Resorts. The Maluane Group currently has one operational lodge on Vamizi Island, but is in the process of establishing new lodges on Macaloe and Rongui Islands.

[55] Rates quoted in the table were valid for May 2008 and seem to remain fairly fixed throughout the year, with very little seasonal fluctuation.
[56] The whole guesthouse is currently permanently rented by a road maintenance company on a long term rental agreement.
[57] Also provides camping facilities.
[58] It is important to note that there are number of new lodges currently being constructed on some of the islands. These were not operational at the time of the study, and are therefore included in Section 3.4.6 below.
[59] Although Matemo Island does not fall within Area 1, it is far enough north in Area 2 to be potentially affected by the proposed drilling project, and is therefore included.

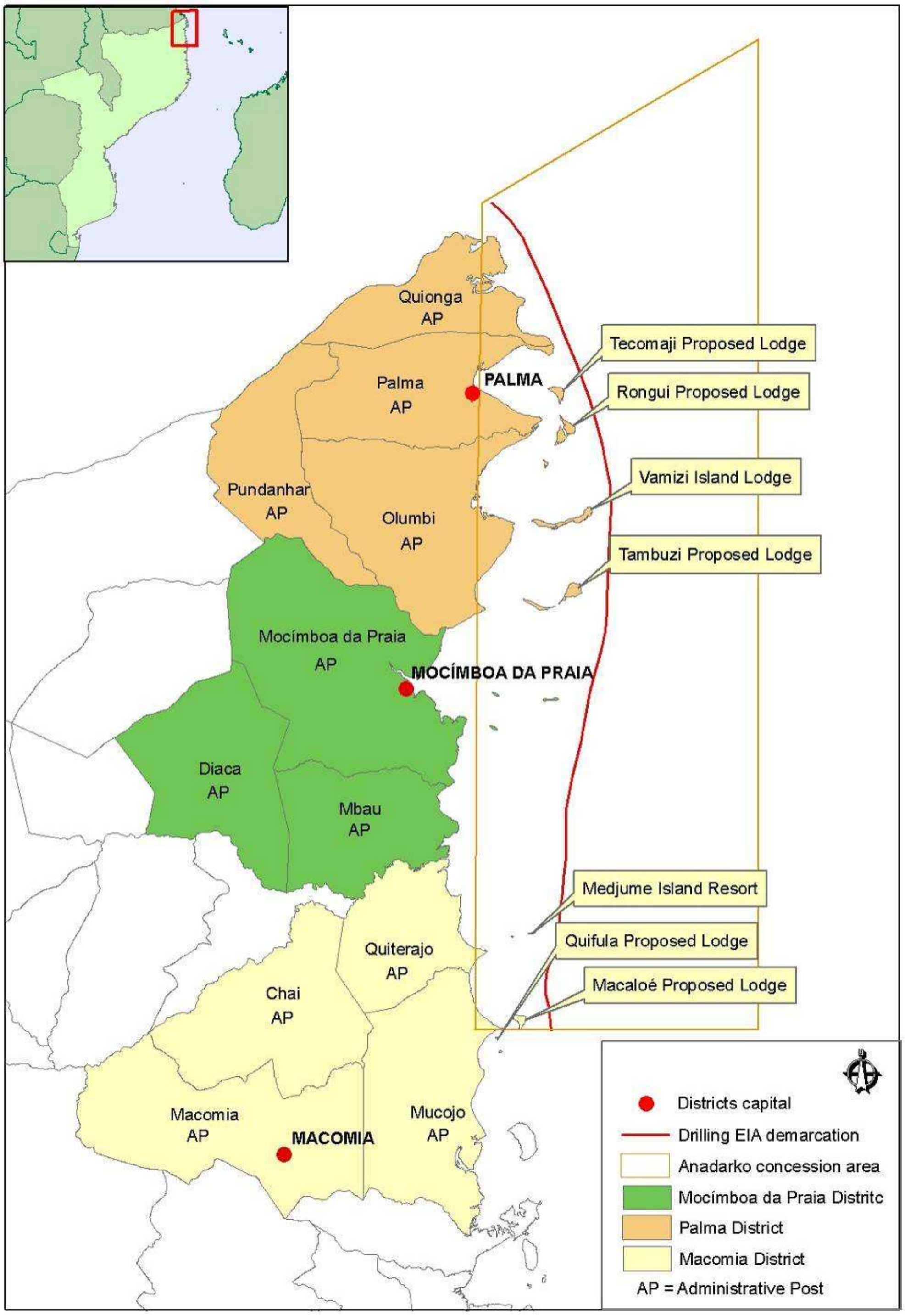


Figure 69 Location of existing and proposed tourism resorts in relation to the project area

Table 33 outlines the number of bed nights and average duration of stay for guests visiting these lodges. According to the operators, peak occupancy seasons are predominantly December to January, and again during March and/or April, depending on where the Easter weekend falls on the calendar. June to November is often less busy than during these two periods, but there are still a fair number of guests. During these peak seasons, lodges have historically been between 60% and 70% full. However, all operators indicated that due to the fact that they have not been operational very long e.g. Vamizi Lodge opened in December 2005 and Medjumbe Lodge early in 2006, occupancy levels are still on the increase, as marketing strategies start to take effect.

Table 33 Bed nights, occupancy and duration of stay at L&A Operators

Operator	Bed nights available	Bed nights per month	Average duration of stay (nights)
Matemo Island	50	1,520	6
Medjumbe Island	28	851	4
Vamizi Island	24	720	7
Total	**102**	**3,091**	**(Average: 5)**

The main countries of origin of guests visiting L&A facilities are the United Kingdom, Europe (predominantly Italy), South Africa, and Mozambique. South Africans and Mozambicans using these facilities make up a fairly small portion of annual visitors when compared to the composition of visitors to other parts of the country.

Although all L&A Operators reported steady increases in their occupation numbers, it would appear as if these operators are not affected by the increase in business tourism. A reasonable explanation is that they tend to provide a high-end, luxury retreat, at a level not really required by the average business tourist.

5.6.5.4 Employment, wages and local purchases

Employment, wages, and local purchases are dealt with separately from the preceding discussion, since a number of calculations based on multipliers, as well as certain extrapolations, are made. These are grouped together for ease of comparison.

Based on information provided by L&A Operators, there are a total of 265 people permanently employed and 46 people seasonally employed at the four lodges (Table 34). Approximately 84% of the permanent employees are local, that is from Cabo Delgado Province, and mostly from surrounding villages and settlements. The other 16% comprises Mozambicans from elsewhere in the country, and expatriates.

According to TechnoServe, a Non Governmental Organisation (Rose, M. Personal Communication), the average multiplier that is used to calculate indirect employment opportunities for the tourism industry in the area is based on a ration of 1:2, i.e. two indirect employment opportunities for every one direct opportunity. These calculations are done on the total number of employees, regardless of their origin. However, due to the small number of AO Operators, as well as the small scale on which they operate, these are not included in the calculations presented in Table 34 which is focused only on L&A Operators.

Table 34 Direct (permanent and seasonal) and indirect employment provided by L&A Operators

Operator	Permanent employees		Seasonal employees	Indirect opportunities[60]	Total (perm +indirect)
	Local employees	Other[61]			
Vamizi Island	94	16	25	220	355
Matemo Island	89	14	15	206	324
Medjumbe Island	41	11	6	104	162
Total	**224**	**41**	**46**	**530**	**841**

According to Techno Serve (Rose, M. Personal Communication), the dependency ratio used for the area can be as high as 1:20. This implies that one salary earned by a local employee potentially supports up to 20 people (Table 34)

Using only the local component of direct permanent employees for the dependency ratio calculation[62], these 224 salaries potentially support up to 4,480 people. However, indirect employment opportunities are seen to be predominantly local, thus the 530 indirect employment opportunities are estimated to support 10,600 people. Thus, when the numbers of people potentially supported by direct local employees are added to the total number of people potentially supported by indirect employees, it calculates to 15,080 people. This implies that the tourism industry in the study area potentially supports up to 15,080 people.

Note that these figures are only indicative (as shown in the textbox below). Even if the ratio is changed from 1:20 (as it stands at the moment) to 1:10 or even 1:5, it would still only raise the amounts to US$ 0.58/day or US$ 1.16 per person per day.

It is very important to note that these figures should be seen as indicative only and not as definitive, as they are based on assumptions.

Based on information indicated in Tables 33 to 34, it can be calculated that the number of permanent employees per bed night is essentially 1:2.6, i.e. 2.6 staff members per guest.

[60] Based on the total number of permanent employees.
[61] ‘Other’ refers to Mozambicans from elsewhere in the country, as well as expatriates.
[62] Mozambicans from elsewhere in the country may not support the same range of people as locals.

LOCAL WAGES AND PURCHASES

The total amounts reportedly spent annually by L&A Operators on purchases and wages are outlined in Table 35 [63]. This shows that these operators spend approximately US$ 1,124,963.00 in the study area per annum, which implies an average of US$ 93,746.00 per month.

Table 35 Total annual local[64] wages and purchases by L&A Operators

Local wages	Local purchases	Total
US$ 1,015,336.00	US$ 109,627.00	US$ 1,124,963.00

Please note that the amount does not only refer to wages but also to local purchases made from local people, mostly in the form of fish, fruit and vegetables, building materials, etc.

5.6.5.5 Leisure activities provided in the study area

The L&A Operators provide a range of recreational activities to guests. These include:

- Scuba diving and snorkelling.
- Game/Offshore sport fishing.
- Surf- and fly-fishing.
- Whale watching.
- Cultural and historical tours.

SCUBA DIVING AND SNORKELLING

Snorkelling takes place around the islands, and on reefs and banks in between the islands. According to L&A Operators, the main scuba diving season coincides with the peak tourism season between December and April. An average of two dives takes place per day, with an average of between six and eight divers per dive. The majority of dives take place in water with a depth of less than 20m, since depths greater than this are usually limited to advanced divers.

RECREATIONAL SPORT FISHING

All L&A Operators cater for offshore sport fishing. Most sport fishing activities take place between 3 and 15 nautical miles offshore, with the majority of fishing trips moving in a north/south or south/north direction along the Quirimbas archipelago, rather than far out to sea.

Fishing areas are spread out across the study area, and are usually some distance apart. The study area is also used as a route to other fishing ground such as the Saint Lazarus Bank, located at approximately 40Km from the study area.

[63] The amounts given are aggregated from actual amounts provided by the L&A Operators.
[64] Excluding expatriates and people from elsewhere in Mozambique.

5.6.5.6 Planned development or extension

As indicated earlier, the tourism industry in the study area is in its infancy. There are numerous developments that are at various stages in the planning process (all within the AMA1 block – refer to Figure 69 above). These include, but are not limited to:

- Quifula Island – An international private developer is currently building six 2-sleeper bungalows on the island, and eight more on the mainland directly opposite the island (just south of Pangane).
- Macaloe Island – The Maluane Group (who operates Vamizi Island to the north of the study area) is planning one of the largest investments in the Quirimbas to date. The aim is to become operational during 2009.
- Vumba Island – A Mozambican private developer is currently building six bungalows, four 2-sleepers and two 4-sleepers, on the island.
- Quisibo Island – A South African based tourism group is intending to develop tourism facilities on the island, but is still in negotiations with the local inhabitants.
- Mogondula Island – The operator of Ibo Island Lodge has secured a concession for the island, and plans to develop a 20 bed, high-end, luxury lodge.
- Rongui Island – The Maluane Group is also planning a small lodge on Rongui Island. Six bungalows with 12 to 24 beds are planned.
- Tecomaji – A group of South African developers is building a fairly large development, initially with five large luxury chalets (4 to 6-sleepers), with plans to extend this up to 14 luxury chalets.

Completion of developments currently underway on Vumba, Tecomaji, Quifula, and Tambuzi are all aimed at December 2008 or early 2009. Thus, although no more information than the number of bed nights is currently available, these developments could potentially be affected by the exploration programme early in 2009.

This implies that by the time the project is implemented, there could be at least an additional 2,250 bed nights per month available on islands in the study area, which would effectively increase the number of available bed nights by more than 60%.

5.6.5.7 Tourism associations

In February 2007, the Cabo Delgado Tourism Association (CDTUR) was established, effectively replacing the Quirimbas Tourism Association (QTA) (established in 2006 by a number of larger tourism operators in the study area). At present CDTUR has in the order of 30 members, including the larger operators, as well as a number of smaller lodges and guesthouses. The main objectives of CDTUR are to promote the province, especially the Quirimbas, as a destination, promote long-term investment, and look after the interests of its members.

5.6.6 Artisanal Fisheries and Fishing Activities in the Study Area

Fish is the second largest single export from Mozambique after aluminum, and accounts for 10% to 15% of all exports. It constitutes approximately 2% of Gross Domestic Products (GDP). According to World Bank estimates, income from natural resources in Mozambique will increase annually from "…US$30 million to US$67 million until the year of 2015 if development and fiscal policies are effectively implemented" (World Bank, 2005).

Fishing activities in Mozambique can be classified into three categories:

- Artisanal fishing by communities along the coast and around inland water bodies. Catches are used for both subsistence and sale.
- Semi-industrial fishing by intermediate size boats, mainly involved in shallow water shrimp fisheries offshore and Kapenta fisheries on Cahora Bassa Dam. Catches are used for both local consumption and export.
- Industrial fishing with larger vessels fishing for shallow water shrimp and fish species in deeper waters. Catches are used mainly for export.

Artisanal fishers yield in the order of 127,000 tons of fish per year, while semi-industrial and industrial fleets yield approximately 14,800 tons and 9,200 tons, respectively (Minister of Fisheries, 2007). Artisanal fishing provides an important source of animal protein and income, especially to people living close to the coast. It is estimated that in Cabo Delgado province, artisanal fisheries land approximately 12,000 tons of fish (Minister of Fisheries, 2007). There are more than 25,000 people involved in artisanal fishing in the Cabo Delgado province.

5.6.6.1 Fisheries management and institutional issues

The '*Master Plan for the Fisheries Sector*' (MPFS) compiled by the Ministério das Pescas (MdP) (Ministry of Fisheries) in 1996, set three key objectives for the industry:

- Improvement of the domestic supply of fish in order to make up for a part of the country's food deficit.
- Increased net foreign exchange earnings for the sector.
- Raised standard of living for the fishing communities.

In Cabo Delgado fishery licensing is administered by the provincial fishery department. It is responsible for fishery control in collaboration with the Maritime Administration. However, these agencies are poorly represented outside the provincial capital and thus the incidences of illegal fishing are common along the coast. In the case of national parks additional personnel are sometimes made available to assist in fishery control but the relations between park rangers and the other agencies must be clarified (Johnston, 2004).

ACCESS FOR FISHING AND MANAGEMENT STRATEGY

The access to the fishing resource has been subject to a series of formal rules to control the fishing areas. Some of those measures have been enforced through the process of revision of the recent fishing regulation. This regulation provides a comprehensive demarcation of fishing grounds for artisanal, industrial and semi-industrial fisheries and other rules related to fishing activities. Fishing without license, Use of small mesh nets like mosquito net, shark nets («rede choque», gillnets), netting over coral beds are among others the most important management measures for artisanal fisheries management.

The level of compliance of those rules along the coastal zone is still low, due to the lack of a consistent maritime patrol system. Local Maritime administration in Palma and Mocimboa has 2 boats which have been used for patrol purposes. However due to the lack of fuel because of the low financial capacity, the maritime administration have very occasional contact with the fishers along the year. People are fishing with mosquito nets and large plastic bags, harvesting everything on their passage causing destruction of the seabed. Large quantities of small fish, fingerlings, larvae, and basic aquatic plants (food for all types of aquatic species) are probably being harvested. A dangerous practice of poisoning fish using pesticides has also been referred to occur up to north, along the Rovuma River. Also, it is reported that fishers from Tanzania do fish without licenses.

The Fisheries and Environment Coordination sectors have been engaged in community mobilization activities under the artisanal fisheries co-management programme. The suggested mechanism consists on the promotion of community committees (composed by local fishers and community leaders), which form another political body. The general objective of these committees is to guarantee that the fishing resources area exploited at sustainable basis.

According to the Fisheries Maritime General Regulation the fisheries co-management arrangements are chaired by the National Fisheries Administration Commission (NFAC) and implemented at provincial level by the provincial co-management committee (PCC) chaired by the provincial directorate of fisheries (Figure 70).

The Fisheries Community Councils (FCC) is the main fisheries social mobilization body at community level. They can participate in fishing control, licensing and technology development activities. They are composed by community leaders, fisheries using different fishing gears, women and youth living in fishing villages. They might participate in the PPC session provincial co-management.

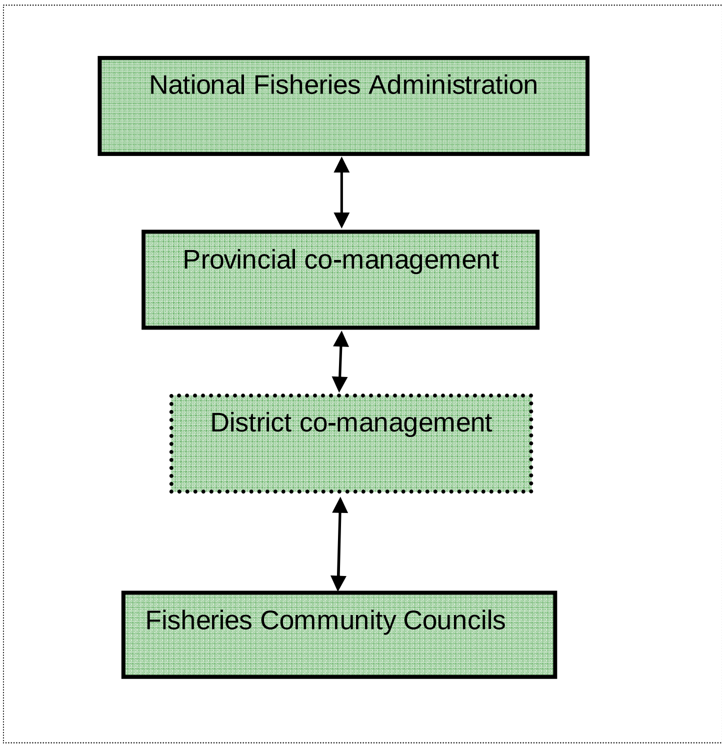


Figure 70 Fisheries co-management structure

In terms of extension officers, IDPPE has placed 12 of them in the districts where the study area is located (Table 25 above)

5.6.6.2 Role payers and stakeholders in the artisanal fishing sector

The artisanal fishing sector in the study area can be divided into four main groupings, based on their activities in the sector:

- The primary producers, who are involved in the actual fish catch with or without a vessel
- Processors/traders, who process fish to preserve it for a longer period by sun drying, smoking, salting and drying, before selling the fish
- Traders, which include fishers selling fish to consumers and fishers selling fish to other traders
- Fishing supporters, who build and/or supply boats, nets and other inputs such as fishing lines to the fishers.

THE PRIMARY PRODUCERS

Producers are involved in the actual catching of fish, which is then consumed or sold as fresh or processed fish. This group may be divided into two sub-groups, namely:

- producers who fish without boat, and
- those who use boats for fishing

The numbers of gears which do not use boats for fishing are indicated in the Table 36 and these make 46% of the total fishing gears existing in the study area (IDPPE, 2007). These gears are used by youths, oldest men or women in areas fairly close to their homesteads. Production from these fishing unities is consumed in full. There are also who collect fish resources without using any specific fishing gear. The collectors represent 35% in the group of those who do not use boat for fishing and are mainly composed by women.

Table 36 Type of fishing which do not use boat from IDPPE, 2007 (Preliminary data)

Traditional Gear	Macomia	Mocimboa da Praia	Palma	Total
Hand line (Traditional)	453	348	433	1,234
Harpoon (without diving)	193	139	202	534
Traps and other traditional gear	504	551	1005	2,060
Collectors	1024	1067	2016	2,060
Total	2,174	2,105	3,656	5,888

In the study area there are 2,341 artisanal fishing boats, being the canoes, the most abundant type (Table 37). Only 0.43% of the artisanal fishing boats are motorized. There are 10 motorized boats in the study area, among which 7 in Mocimboa da Praia, 2 in Macomia and 1 in Palma (IDPPE, 2007). Most of the motorized boat uses pursing and gillnets for fishing.

Table 37 Artisanal fishing boats from IDPPE, 2007 (Preliminary data)

Vessel	Macomia	Mocimboa da Praia	Palma	Total	
Canoes	685	526	617	1,828	78%
Lancha	119	178	213	510	22%
Others	-	2	1	3	0.13%
Total	804	706	831	2,341	100%

The most important fishing gears used in association with boat are the beach seine, Gillnets, pursing nets, hand lines and diving for fish. Each of these fishing gears will be described deeply below. We will start describing the fishing nets and then the others (diving, hand lines and others).

Beach Seine, Gillnet and Pursing Nets

The Table 38 provides the number of beach seine, gillnets and pursing nets, per district in the study area, showing that gillnets are main type of fishing net used in the three districts, followed by beach seine. It also shows that these nets are mostly used in Mocímboa da Praia. The same Table shows that beach seine is more important in Macomia than in Palma, where gillnets are most commonly used. Each of these fishing gears belong mostly to one or more adult males who do not often go to sea themselves. They remain on land selling their fish and other commodities while their workers go fishing.

Table 38 Number and most important types of fishing nets used in association with boat per district in the study area from IDPPE, 2007 (Preliminary data)

Type of Net	Macomia	Mocimboa da Praia	Palma	Total
Beach seine	103	148	94	345
Gillnet	132	197	164	493
Pursing nets	2	4	6	12
Total	237	349	264	850

The number of '*workers'* within these fishing unities ranges between 7 and 17. 'Workers' can be part-time or full-time, but both groups are paid in fish (see Box 1 below). According to the IDPPE census (IDPPE: 2007), approximately 11% of people involved directly in fishing work on a part-time basis. Recent studies on beach seine operations indicate that crew members generally remain with one specific fishing net throughout the season and will not move between nets or work two or more nets simultaneously (Wilson, 2007). Most of these fishing unities operate on average 5 days per week, with low tides being most productive. However, if the productivity is high fishers can fish all the week in the same area.

Box 1 – Payment of fishing teams

Beach seine, gillnets and pursing nets are usually done by a specialized crew which includes the owner, the fishing master, and a team. The composition of a pursing net team is very similar. However, there are a number of divers who specialize in fish identification during the fishing operation. The payment to the workers involved with these types of fishing gear is made on a daily basis, upon completion of the fishing operation. In most instances, the following formula is applied.

1) $S_{owner} = Q_{kg} \times 50\% - S_{master}$

2) $S_{master} = \underline{Q_{kg} \times 16\%}$

3) $S_{crew} = Q_{kg} \times 50\%$

The following is represented in these formula:

- S_{owner} = payment to the owner.
- S_{master} = payment to the master.
- S_{crew} = payment to the crew.
- Q_{kg} = quantity of catch per day.

Therefore, after landing the catch, 50% of the days catch ($Q_{kg)}$ will be handed to the crew. The remaining 50% will be divided into three parts, from which one part (one-third) will be handed to the fishing master while the remaining two-thirds remain with the owner of the gear. Where the owner is renting part of his equipment, e.g. a boat, 50% of his takings will be handed across to the owner of the equipment.

Source: Focus groups ad individual interviews (2008)

Diving for fish and fishing with hand lines

Diving for fish is a very popular artisanal fishing practice. The IDPPE (2007) estimated a total number of 1.404 divers in Cabo Delgado, 1.036 (74%) of which are in the study area (Table 39). Divers use spears/harpoons made by local craftsmen from a variety of steel and iron rods. There are two types of divers in the study area, i.e. those who dive from boats and those who do not as indicated previously. The latter group is more concentrated in the mainland fishing centers, and the former operates around the islands. Small canoes are used to reach the target area. It was recently reconfirmed that divers who use boats go out as far as four nautical miles (approximately 7km) east of the islands, and dive in waters up to 40m deep. However, most of the divers interviewed as part of the FBS indicated that they are comfortable at depths not exceeding 30m.

Table 39 Number of artisanal divers and hand line fishers within the study area from IDPPE, 2007 (Preliminary data)

Technique	Macomia	Mocimboa da Praia	Palma	Total
Hand line	529	301	505	1,335
Diving	180	106	750	1,036
Total	709	407	1,255	2,371

Divers generally operate on coral reefs and catch, among others, crayfish, octopus, rays and squid. Divers in the study area originate from Tanzania and Mozambique. The Tanzanians are usually described as being more efficient than local Mozambican divers due to the quality of equipment used, as well as using better skills and tactics. They dive up to 40m deep and often enter into Mozambican waters to dive. They seem to be less specialized to a single fishing gear.

Most hand liners which operate with boats use canoes, with some reportedly going out as far as 6 nautical miles (approximately 11km) east of the islands and fish in depths of up to 400m. However, more often than not, hand line fishers operate over coral reefs. Different from fishing net users, divers and hand liners do not have crews and, therefore, the entire catch remains with the fisherman. Most divers and hand liners also practice some form of informal trading, alternating between fishing and trading depending on weather conditions.

FISH PROCESSORS

In Cabo Delgado, there are approximately 1,102 people engaged in fish processing, most of whom are based in Palma (Table 40). Although a large part of the daily catch is consumed, sold, or bartered fresh to local and neighboring communities and nearby urban settlements, a portion is also preserved by sun drying, smoking, salting and drying. When compared to the rest of the province, the 468 processors in the study area comprise approximately 42% of the overall number of processors in the Province. Women are also involved in processing activities. The IDPPE census of 2007 (IDPPE: 2007) indicated that approximately 14% of the processors identified in Cabo Delgado are women. However, only 6% of 468 processors found by the census in the study area are women. This is due to the fact that women in this area are also potentially involved in trade and agriculture activities, which may consume most of their time.

Table 40 Processors by gender and district from IDPPE, 2007 (Preliminary data)

Processors	Macomia	Mocimboa da Praia	Palma	Total
Male	119	119	203	441
Female	0	18	9	27
Total	119	137	212	468

Due to a lack of infrastructure, a very small portion of artisanal catches in the study area are iced or frozen. Oysters, octopus and sea cucumber are also sold either fresh or dried. Salt-drying is the most common practice, and is divided into first, second and third grade species. However, the weight ratio between fresh and processed fish is quite low, generally 3:1 i.e. three kilograms of fresh fish would produce one kilogram of processed fish. However, processing increases the shelf life of the fish product, e.g. salt-dried products can last up to five months.

FISH TRADERS

Fish traders can be grouped into two main categories, i.e. fishers selling to consumers, and fishers selling to traders.

Sale to consumers takes place at the landing sites where fishers bring in the catch after a fishing trip, and occurs at all the fishing centers. The catch sold usually consists of fresh fish, octopus and sea cucumbers.

Sale to traders includes the same type of catch, but is found more on the islands. Traders from the mainland frequently travel to the islands to purchase fish. These traders then either process the fish on the island, or take it back to the mainland for selling as fresh or processed fish. Buyers from Tanzania frequent Mocimboa da Praia and buy large quantities of dried fish, which are taken back to Tanzania by road or boat.

In Palma the largest buyer of first and second grade fish, as well as sea cucumbers, squids, crayfish and octopus, is the Complexo Pesqueiro de Palma (CPP). Constructed in 2002 as part of a joint programme between IDPPE and the Spanish Government, the CPP buys in the order of 70% of fish landed in Palma-sede and neighboring fishing centers such as Maganja, Quiwia, Manhenahele, Vamizi and other islands. The CPP has the necessary cooling and freezing facilities to store fish, which then get sold in Pemba, Nampula, and even Maputo. There are also a substantial number of informal traders which also form an important link between the islands and the mainland.

In Mocimboa da Praia and Macomia (Pangane and Quiterajo), informal traders operate on the same basis. There is also a market in Mocimboa da Praia Sede, where large quantities of fish are sold to intermediaries from Nampula, Pemba and Tanzania. Tanzania is probably the largest market for fish from Mocimboa da Praia. Tanzanian traders export dried fish to Tanzania by hired truck or by boat via the local port, although there are also those who export fish illegally via sea routes. However, no information could be gathered through the FBS about the number of Tanzanian fish traders, or the quantity of fish they purchase. More detail regarding fish quantities and prices are provided under Section 5.6.6.3.

FISHING SUPPORTERS

The supporting industry to the fishing sector provides boats, nets and other inputs such as fishing line. Of these, the boat building industry is the most important in the study area. There is no updated statistic data regarding to supporting fishing industry. However, according to the IDPPE (2004)[65], there were 103 master boat builders and 66 apprentices in the districts comprising the study area (Table 41). These masters

[65] No updated data is available in relation to this issue.

and apprentices are based in fishing villages that are equipped with the infrastructure for boat building.

There are no community-based suppliers of fishing inputs in the study area, although articles such as fishing line are sometimes sold at local informal markets. The main sources of inputs are located in Pemba, Nacala, Nampula, Maputo, and even as far a field as Tanzania and Malawi. Fishers in the northern part of the study area (Macomia and Quissanga) predominantly buy their inputs from Tanzania and Malawi. No updated data regarding to the number of Supporting fishing industry was found, and for that reason, the census done by the IDPPE (2004) will be used as reference.

Table 41 The number of master and apprentice boat builders in the study area per district from IDPPE (2004)

District	Masters	Learners	Total
Palma	40	42	82
Mocimboa da Praia	28	16	44
Macomia	35	8	43
Total in the study area	**103**	**66**	**169**

5.6.6.3 Trading in fish

Fish supply and demand are determined by the dry and rainy season cycles, type of product, location of the market, and the level of development of boat landing sites. Fishers indicated that during the rainy season (November – April) the catches are substantially higher than in the dry season. However, the profits in the rainy season are much lower, due to demand and price decreasing. The reason for the decrease in demand has a lot to do with the local road infrastructure, which for large parts of the rainy season becomes almost impassable due to heavy rains. This then prevents bulk traders from accessing fishing villages, and single traders from selling fish in the interior.

Prices of fresh fish are determined by grade, based on size and weight. Prices in the study area paid to the primary producers range between 10.00 Mtn and 12.00 Mtn per kg for Grade 1 fish. However, some differences were found between the price received by intermediaries who sell their product in the main towns, and those who sell fish at the secondary markets. Prices may have doubled or tripled by the time the product reaches the main urban centres. Prices of various types of catch in Mocimboa da Praia and Palma are listed in Table 42, and in Macomia are listed in Table 43.

Table 42 Average income per trader type (Mtn/kg) (Mocimboa da Praia and Palma) (collected from focus groups)

Type of catch	Mtn/kg received by the primary producers	Mtn/kg received by the intermediates in the main towns	Mtn/kg received by intermediates in the secondary markets
Fresh fish			
Grade one	12.00	45.50	40.50
Grade two	11.80	25.00	22.00
Grade three	10.50	12.00	11.50
Dried/salted fish			
Grade one	10.00	47.50	40.50
Grade two	10.00	35.00	30.00
Grade three	10.00	19.50	19.50
Squid			
Fresh	10.00	16.00	15.00
Dried	35.00	40.00	39.00
Octopus			
Fresh	12.50	35.00	35.00
Dried	10.00	37.50	37.50
Crab	10.00	17.50	17.50
Crayfish	65.00	140.00	140.00
Ray	10.00	12.00	12.00

Table 43 Average income per trader type (Mtn/kg) in Macomia (collected from focus groups)

Type of catch	Mtn/kg received by the primary producers	Mtn/kg generally received by intermediates
Fresh fish		
Grade one	10.00	29.38
Grade two	10.00	13.00
Grade three	10.00	8.00
Dried/salted fish		
Grade one	10.00	47.50
Grade two	10.00	35.00
Grade three	10.00	19.50
Squid		
Fresh	10.00	15.00
Dried	35.00	40.00
Octopus		
Fresh	12.50	15.00
Dried	10.00	40.00
Crabs	10.00	17.50
Crayfish	35.00	100.00

5.6.6.4 Income from fishing

There is very little existing information, and few previous baseline studies have been conducted regarding mean annual household and per capita income in fishing communities in the study area. One of the most recent studies was conducted as part of the *Projecto da Pesca Artisanal em Nampula e Cabo Delgado* (PPANCD) by IDPPE. The study concluded that, on average, households dependent on artisanal fishing are extremely poor. It identified three socio-economic groupings within these communities, namely, boat and fishing gear owners, 'workers' and collectors/gatherers. Between these groups, boat and gear owners had the highest mean annual household income, while the lower category was shared by the 'workers' and/or fish collectors (IDPPE, 2006).

In a survey conducted by Rousselot (2005) on Quirimba Island, it was noted that the beach seine owners earned a gross income of approximately US$ 200.00 per month in the dry season, while their 'workers' earned approximately US$ 40.00 per month in the same season. This implies that an owner's annual gross income would be approximately US$ 2,400.00 and that of 'workers' approximately US$ 480.00. The same study found that line fish operators might earn around US$ 60.00 per month, and an annual average of US$ 720.00.

In order to get an indicative estimate of average income per type fishing gear, the FBS adopted a specific methodology during focus group discussion and individual interviews. Firstly, the volume of daily catch was calculated. Secondly, the gross value of the catch was calculated, based on the price received by the primary producers on 'good' as well as 'bad' fishing days (Tables 44 and 45)[66]. The main reason for using the primary producer price was to get an estimate of the income of those fishers which may be the subject of compensation, if any negative impact on the catch occurs as a result of the exploration programme.

For each estimate, only the most important fish commodity per gear type was considered. These are as follows:

- Beach seine: second and third grade fish.
- Pursing nets and hand line fishing: first grade fish.
- Divers: crayfish, squid and first grade fish.

No cost component was included in any of the calculations, although it became clear through discussions that the cost to operate any of the gear types was no more than 40% of its gross catch value.

Table 44 Daily average income per fishing unit of primary producers in Palma and Mocimboa da Praia (collected from focus groups)

Gear type	**Ave catch/day(kg)**		**Average price (Mtn/kg)**		**Average gross value/day (Mtn)**	
	Good day	**Bad day**	**Good day**	**Bad day**	**Good day**	**Bad day**
Beach seine	100	30	10.00	10.00	1,000	300
Pursing net	90	40	10.00	10.00	900	400
Gillnet	80	30	10.00	10.00	800	300
Hand line	70	20	10.00	10.00	700	200
Divers	70	15	11.50	11.50	805	173

[66] It is important to bear in mind that the amounts per type of net fishing included in the tables are not earnings per individual fisher, but for the gear type.

Table 45 Daily average income per fishing unit of primary producers in Palma and Mocimboa da Praia (collected from individual interviews)

Gear type	Ave catch/day(kg)		Average price (Mtn)		Average gross value/day (Mtn)	
	Good day	Bad day	Good day	Bad day	Good day	Bad day
Beach seine	300	100	10.00	10.00	3,000	1,000
Pursing net	150	76	10.00	10.00	1,500	760
Gillnet	80	30	10.00	10.00	800	300
Hand line	100	40	10.00	10.00	1,00	400
Divers	80	30	11.50	11.50	902	345

From the Tables 44 and 45 above it is possible to see that when interviewed individually, the people indicated having a higher daily average catch and income than when the data was collected in focus groups, especially in relation to beach seine and pursing net.

Diving and hand line fishing are the gear types with the lowest operating cost; according to respondents, approximately 80% of their gross output can be profit. Gear such as beach seine and pursing nets may generate proportionately high levels of income, but they are also costly to maintain and the most difficult to operate.

Of importance is that none of the Mozambicans interviewed as part of the FBS indicated that reinvestment in new fishing gear when the old ones wear out is important. Most of the income is spent on daily gear repair activities. In some case the problem is not necessarily a low level of daily income, but unwillingness to take a risk on reinvestment. Many respondents interviewed lacked the capacity to manage their finances, and many tend to spend their income on immediate consumption, e.g. on food and alcoholic drinks.

5.6.6.5 Fishing areas and the movement of fishers

Fishing areas

The majority of fishing activities still take place close to the islands, or between the islands and the mainland. The high productivity of fishing grounds around the islands is the main attraction to fishers from the mainland. Depending on the island destination, one leg of the journey could take between 2.5 and 5 hours. On such excursions, fishers overnight on the islands in a fishing camp. The key factors influencing fishing decisions are weather conditions and the number of other fishing vessels in a particular area on a specific day.

The artisanal fishers from the study area travel as far as 7 nautical miles offshore (approximately 13km) east of the islands. However, only a small minority of fishers go this far out. The hand line fishers are those who may fish in waters with a maximum depth of 400m. The divers may dive in waters of 40m deep and they cannot go further than 5 miles (9km). Refer to Figure 71 below for the fishing movements.

Table 46 outlines the most important fishing areas per district, as well as alternative fishing areas. A number of GPS reference points are also provided.

Table 46 Fishing areas per zone

District	Most important fishing areas	Alternative fishing areas		Reference
		Area	Location	
Palma	Mbwizi (mainland)	No alternatives		
	Tecomaji Island	Tecomaji coral reefs	Around Tecomaji	
	Ngambo (mainland)	No alternatives		
	Nsemo Bank	Iwangos Bank	Near Nsengo	
	Quiramimbi Island	Quiramimbi coral reefs	Near Quiramimbi island	
	Vamizi Island	Vamizi´s coral reefs	Around Vamizi	
		Saint Lazarus Bank	Saint Lazarus Bank	12º 06'00" S 12º 17'00" S 41º25'32" E 41º 26'00" E”
		Iwala Bank	West Vamizi	
	Nondos Bank	Nondos Bank	Near Nondo fishing center	
	Muivumbas Island,	No alternatives		
	Quissungure (bank)	No alternatives		
	Nkifuke (island)	No alternatives		
Mocimboa da Praia	Tembuzi Island	Tchungulomo coral reef		
		Tembuzibank	Around Tambuzi Island	
		Wantambulo coral reef – west of Tambuzi and north of Muissune Island		
	Kirianhune Island	Kabacar Bank – northeast Kirianhune		S 11º 36` 41 `` EO 40º 33` 20``
		Nanguo coral reefs – northwest		S 11º 34` 19.9 `` EO 40º 35` 57.2``
Macomia	Near Macaloe Island	Near Kissanga Island	Distant from Medjumbe Island: 3.5 miles	S 12º 05´ E 40º 40´

District	Most important fishing areas	Alternative fishing areas		Reference
		Area	**Location**	
	Massassa Bank	Massassa Bank	East of Matemo	
			Near Medjumbe Island	
			Kwela Bank	

Movement and migration of fishers

The main movement and migration of fishers can be classified as follows (Figure 71):

- From Tanzania, to the study area.
- From Nampula and other Mozambican provinces, to the study area.
- From the mainland fishing centres in the study area, to the islands.

Focus groups highlighted two types of Tanzanian fishers, i.e. legal, those who arrive in the study area via local ports, and those who are illegal and make their way into the study area via sea routes. The first group includes traders, fishers and/or people who want to start businesses in Mozambique, which occurs more frequently during the dry season. The latter group primarily consists of fishers and fish traders. They move mainly on or around the islands, using several different types of fishing gear, and are commonly seen as violating the local rules. This situation, and the fact that they often have large boats and better fishing gear, often leads to conflict with the local fishers. Generally, fishers from Nampula spend more time on the islands. They may stay away from their homes for up to a year, and some even travel with their families or marry locals.

Movements from the mainland to the islands (Figure 71) are the most important and clear forms of geographical movement which occurs throughout the year, but with greater frequency during the rainy season when the catches are relatively high. In Palma the most important islands are Tecomaji and Vamizi Islands; in Mocimboa da Praia, Kirianhune and Tembuzi Islands, and in Macomia the most important areas are Medjumbe and Macaloe. Fishers also use these islands as bases, and stay in fishing camps for short periods while fishing around other islands. Table 47 provides an indication of some of the main movements of fishers.

No evidence was found through the FBS of fishers moving from the islands to fish along the mainland coast. The relatively high productivity of the fishing grounds in the islands appears to be the reason for this.

Movements of fishing vessels in and out of the drilling area for fishing are shown in Figure 71.

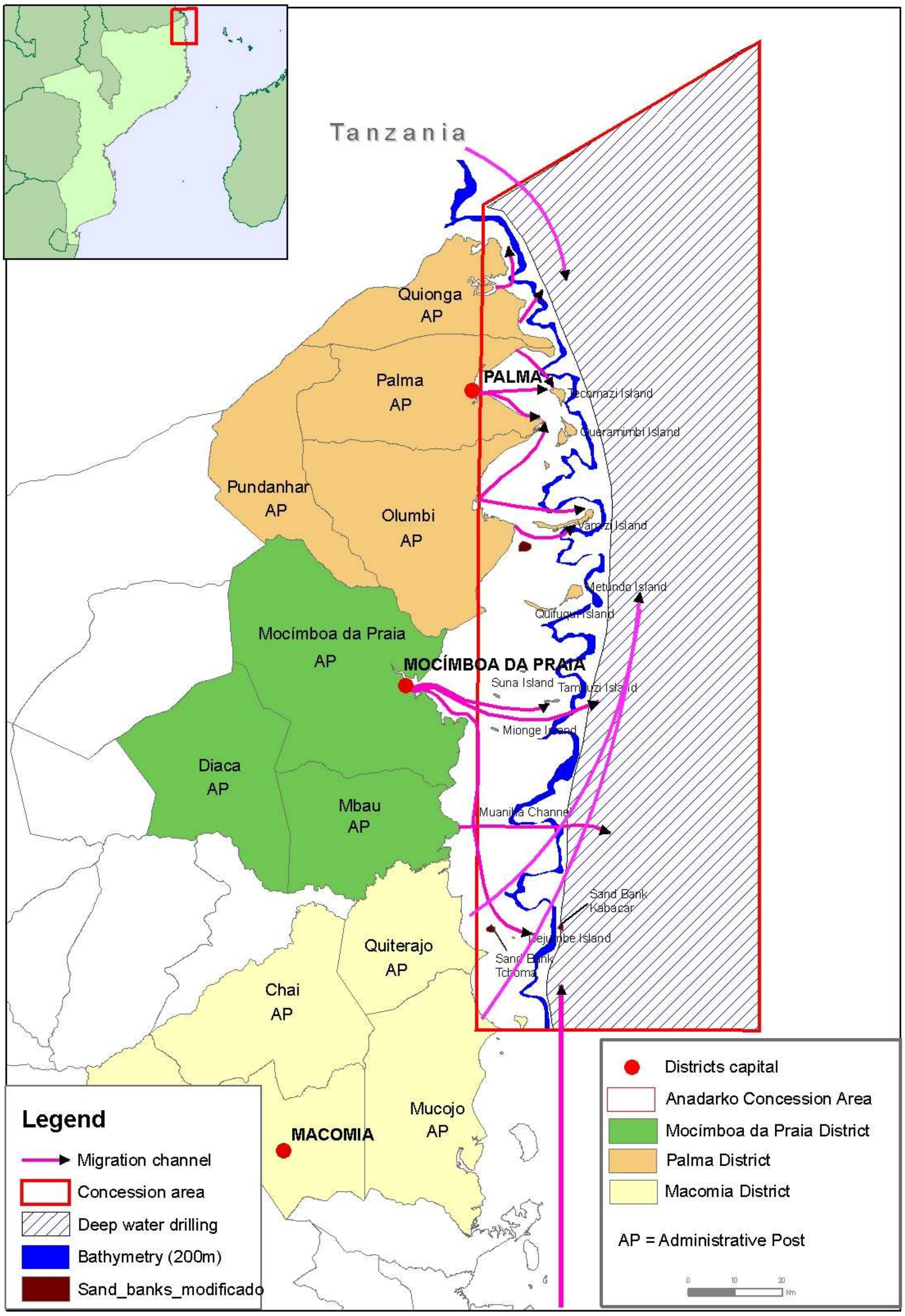


Figure 71 Fishers movements from the mainland

Table 47 Fisher movements

<table>
<tr><th>District</th><th>From</th><th>To</th><th>Associated bank and coral reef fishing area</th></tr>
<tr><td rowspan="9">Palma</td><td rowspan="7">Quiuia, Quirinde, Palma-sede, Maganja and Monjane</td><td>Mbwizi (mainland)</td><td>No associations</td></tr>
<tr><td>Tecomaji Island</td><td>Tecomaji coral reefs – around Tecomaji</td></tr>
<tr><td>Ngambo (mainland)</td><td>No associations</td></tr>
<tr><td>Nsemo (bank),</td><td>Iwangos bank – front of Nsengo</td></tr>
<tr><td>Quiramimbi Island</td><td>Quiramimbi coral reefs – around Quiramimbi</td></tr>
<tr><td>Vamizi Island</td><td>Vamizi's coral reefs – around Vamizi's
Sao Lazaro Bank – northeast Vamizi</td></tr>
<tr><td>Iwalas Bank – west Vamizi Island</td><td>Iwalas Bank – west Vamizi</td></tr>
<tr><td rowspan="2">Olumbe, Kammambwe, Lalane and Msangue</td><td>Nondos Bank</td><td>Nondos Bank – Nondo</td></tr>
<tr><td>Muivumbas Island, Quissungure (bank) and Nkifuke Island</td><td></td></tr>
<tr><td rowspan="14">Mocimboa da Praia</td><td rowspan="14">Mocimboa da Praia-sede, Malinde, Nsangue, Luchete, Ulo</td><td rowspan="3">Tembuzi Island</td><td>Tchungulomo coral reef – East</td></tr>
<tr><td>Tembuzi's Bank – around Tambuzi Island</td></tr>
<tr><td>Wantambulo coral reef – west of Tambuzi and north of Muissune Island</td></tr>
<tr><td>Muichanga Island</td><td>No associations</td></tr>
<tr><td>Nhonje Island</td><td>No associations</td></tr>
<tr><td rowspan="9">Kirianhune Island</td><td>Kabacar Bank – northeast Kirianhune</td></tr>
<tr><td>Nanguo coral reefs – northwest Kirianhune</td></tr>
<tr><td>Tchumi</td></tr>
<tr><td>Nanguo</td></tr>
<tr><td>Abacar</td></tr>
<tr><td>Careca</td></tr>
<tr><td>Nansisi</td></tr>
<tr><td>Lifinga</td></tr>
<tr><td>Mambanhune</td></tr>
<tr><td rowspan="3">Macomia</td><td>Near Macaloe Island</td><td>Near Kissanga Island</td><td></td></tr>
<tr><td rowspan="2">Massassa Bank</td><td>Massassa Bank</td><td></td></tr>
<tr><td>Kirianhune, Medjumbe</td><td></td></tr>
</table>

5.6.7 Commercial Fisheries

5.6.7.1 Overview

Fishing activity in Mozambique plays an important role in the economy of the country, with fish being Mozambique's second-largest export product after aluminium; this resource contributes close to 14.3% to total exports and makes up approximately 1.5% of Gross Domestic Product (GDP).

Along the Mozambican coast, both subsistence (non-industrial) and commercial (semi-industrial and industrial) fisheries are practiced. The subsistence fishery is one of the most important socio-economic activities for the communities along the Cabo Delgado coast and was discussed in Section 5.6.6 above.

The most important fishing industry for the country's economy is the shallow- and deep-water shrimp fishery, with the main fishing areas being situated to the south of latitude 15°S. Deep-sea fishing of large pelagic species (including tuna, swordfish and shark) occur along nearly the entire coast.

Commercial fishing in waters under the jurisdiction of the Republic of Mozambique is subject to prior licensing. The fishing fleet for pelagic species is, without exception, foreign-owned and operated by foreign firms. Foreign vessels are to operate within the framework of agreements signed between the Ministry of Fisheries and the states or international co-operation organisations, under the appropriate license. In exceptional circumstances, fishing licenses may be granted to foreign vessels which do not operate within the framework of an agreement.

Contracts are also signed (outside of the fishing agreements) with foreign fishing companies, where one specifies the number of vessels authorised to operate, the areas, the volume, and the fishing or related conditions and operations. Most of the times, these foreign companies enter into partnership with a Mozambican firm, in order to facilitate licensing.

5.6.7.2 Commercial Fishing in the AMA1 Concession Area

There are no national (Mozambican registered) commercial fisheries activity in the Area 1 concession - the most significant national commercial fisheries, namely those for shallow water shrimp, deepwater shrimp, and line fishing are generally confined to grounds to the south of latitude 16˚S, a considerable distance from the southern limit of Area 1. There may be some sporadic fishing effort north of 16˚S in the line fishery, but this will normally be limited to water depths of 25m-200m (Almeida 2005), and therefore not within of the potential drilling area.

There are international commercial fisheries interests in the area. In this regard, there is a significant fishery for large pelagic species (tunas, swordfish and sharks) that is particularly active in the northern part of Mozambique's Exclusive Economic Zone (EEZ), and which is periodically focussed on fishing grounds within Area 1. The fishery for large pelagics in the western Indian Ocean is one where vessels will pursue target fish species along annual migratory routes, travelling through several EEZs including Mozambique, Tanzania, France, Comoros, Madagascar, Mauritius, Seychelles and South Africa. Not only are vessels from this fishery therefore not present in any one EEZ all year round, but when they are present their location will depend upon the position that year of the principle concentrations of target species. This will be influenced primarily by the location and abundance of food resources (small pelagic fish, cephalopods and pelagic crustaceans[67]). In the case of Mozambique there is evidence to suggest that the location and abundance of target food resources can change dramatically from year to year, and this is discussed further below.

The fleets involved in this fishery are comprised entirely of foreign owned and operated vessels, national participation being limited to Mozambican agents acting on behalf of owners to obtain fishing licenses. The fleet fishing for large pelagics is divided between those vessels operating under the EC-Mozambique fisheries partnership agreement and those operating outside of the agreement (generally Asian flagged)[68]. Within both of these segments there are two distinct types of vessel, namely Purse Seiners and Surface Longliners. These two vessel types fish with fundamentally gears targeting different pelagic fish for specific markets. The structure of the licensed large pelagic fleet is summarised in Table 48 below.

Table 48 Large Pelagic Fleet 2008

Type / Fleet	EC FPA[69]	Direct License	Total
Purse Seine	37	10	47
Longline	25	62	87
Total	62	72	134

It should be noted that the fisheries agreement with Mozambique gives opportunity for a total of 89 vessels from the EC to fish in Mozambican waters (44 seiners + 45 longliners), *but for 2008 these have not all been taken up*, as detailed in Table 48. In 2007, under the same agreement, a total of 66 vessels were licensed. The Ministry of Fisheries sets no limit to the number of vessels that may be directly licensed, but good practise[70] would indicate that any vessel licensed should be on the IOTC[71]'s list of approved vessels as a global mechanism to control overall fishing effort.

[67] Ref Potier et al 2004
[68] All licenses in the tuna fishery are taken either by foreign vessels fishing under the EC agreement, or by foreign vessels licensed directly by MdP or by foreign vessels licensed by MdP via a local agent.
[69] Licensed vessels as at 4/08.
[70] Mozambique is not a member of the IOTC and is therefore not legally bound by its conditions
[71] IOCT - Indian Ocean Tuna Commission

5.6.7.3 Licensed companies

The companies licensed to fish in the large pelagic fishery are summarised in Table 49 below and detailed in Appendix 4.

Table 49 Operating Companies

Regime	Fishery	Nº Companies
EC FPA	Purse Seine Longline	13 23
Direct License	Purse Seine Longline	Unknown

Note that in the Purse Seine fishery most companies are operating three or more vessels, whilst in the Longline fleet most companies operate only one vessel.

<u>Purse Seine Fishery</u>

a) Fleets

The fleet of currently licensed purse seiners is dominated by vessels from the EC and is detailed in the following table.

Table 50 Purse Seine Fleet 2008

Regime	FLAG	Purse seiners
EC FPA	France (EC) Italy (EC) Spain (EC)	17 1 19
Direct license	Undefined	10
Total		**47**

The average vessel capacity is 1673 GRT, significantly larger than the longliners (see below). Seiners will target surface schools of tuna and land them for mass markets, primarily canneries.

b) Effort

As indicated above both the amount of time that the fleet will stay in Mozambican waters and the location of their primary fishing grounds will vary significantly from year to year. Figure 72 below shows the distribution of total effort in the purse seine fishery in Mozambique from 1983-2006. In the context of total effort in the fishery, Area 1 does not appear to be particularly significant, the main long term focus being concentrated further south between 13˚S and 16˚S.

The relative unimportance of Area 1 to the fishery under normal conditions is supported by satellite tracking (VMS) data from the part of the seiner fleet which indicates transit through Area 1, but no fishing activity.

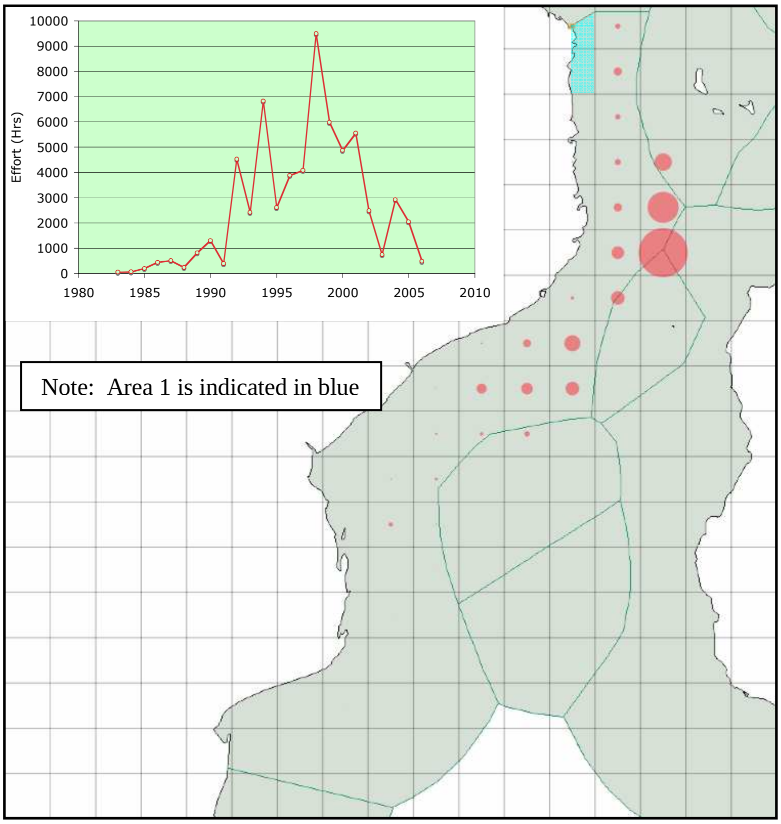
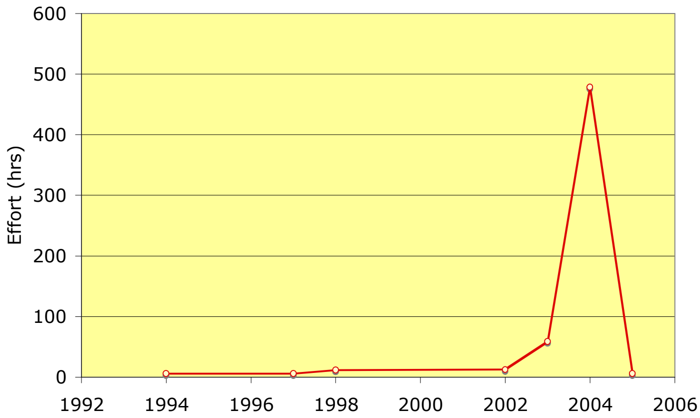


Figure 72 Purse Seine Effort 1983-2006 adapted from IOTC Catch Effort Database

However IOTC data, supported by partial fleet VMS data for 2004, indicates that Area 1 is not always insignificant and there are years where the conditions are such that Area 1 becomes the focus of fishing activity moves to the vicinity of Area 1. The causes of such fundamental changes in the migratory patterns of tuna are not very well understood, but are thought to be closely correlated to changes in the abundance of key crustacean prey, namely the swimming crab *Charbdyis smithii* and the stomatopods *Natosquilla investigatoris* and *Oratosquilla investigatoris* (Romanov 2007, Loose Merrit 1971). *C. smithii* is consistently found in the pelagic zone and forms a regular part of yellow fin tuna diet. The stomatopods however appear in the pelagic zone in irregular and infrequent population explosions, which have been registered in 1906, 1933, 1944, 1965-7, 1971-4 and 2000-5 (Romanov 2007, Potier, Marsac et al n.d.).

Although the mechanism which causes these outbursts is poorly understood (Romanov 2007), the consequences are reasonably well documented (IOTC 2007).

Over 2002-4 there was a significant shift of effort to the west in the Western Indian Ocean (WIO) purse seine fleet, and corresponding peaks in both catch and effort in Tanzania and Mozambique, especially in 2004. The peak in effort in Area 1, illustrated in Figure 73, exceeds 450 fishing hours/year, eclipsing normal values for the same area of 5-60 hrs/yr. In Mozambican waters, this short term effort peak has clearly been focussed on Area 1 and the adjoining blocks to the east and south (Areas 2, 4, 5), as shown in Figure 74. This should be compared to the normal distribution of effort illustrated in Figure 73.



Source: IOTC Catch Effort Database

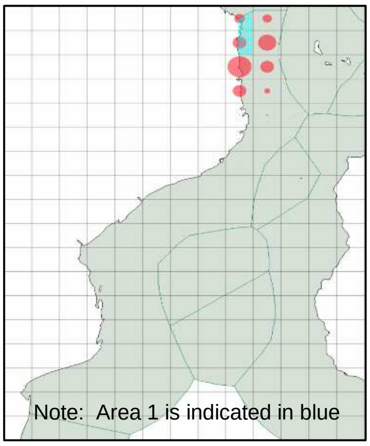
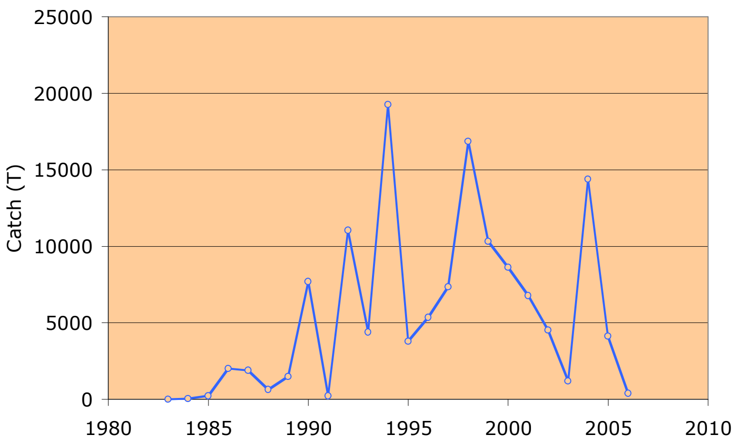


Figure 73 Purse Seine Effort, Area 1, 1994-2005

Figure 74 Purse Seine Effort, Mozambique adapted from EEZ, 2004

c) Catches

Catches from the purse seine fleet follow a broadly similar pattern to that of effort. In the Mozambican EEZ historical catches have been focused in the eastern boundary between 13˚S and 16˚S and total catch, as with effort, are characterised by large variability. Figure 76 below shows the history of total annual catches from the WIO purse seine fleet reported to the IOTC over the period 1983-2006, as well as the geographical distribution of the total values for the same period. As expected the special distribution of catch is reasonably correlated with that of effort, illustrated in Figure 73 above.



Source: IOTC Catch Effort Database

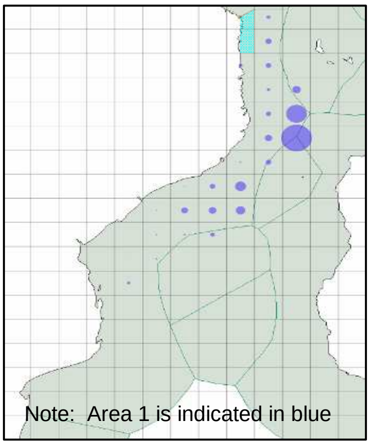
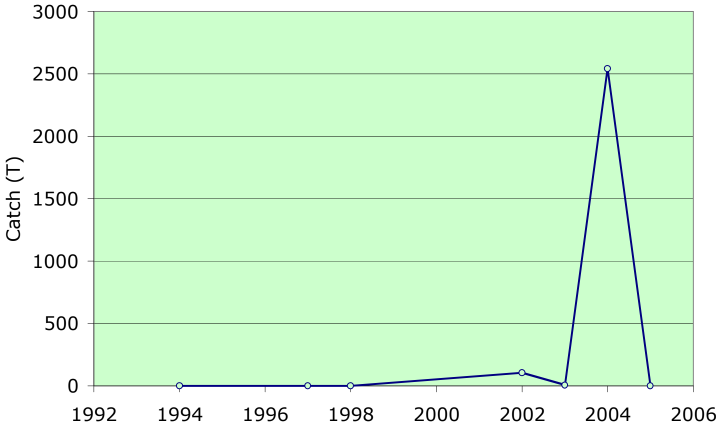


Figure 75 Purse Seine Catches, Mozambique EEZ, 1983-2006

Specifically in Area 1, recorded catches exhibit the same peak in 2004 as shown in the effort data (Figures 73 and 74). Recorded catches in Area 1 reached some 2500 tonnes in 2004, compared to normal values of 105 tonnes or less (Figure 75). Data on the geographic location of catches supports the VMS data for 2004, with 84% of purse seine catches for that year coming from the area between 10˚S and 13˚S (Figures 76 & 77).



Source: IOTC Catch Effort Database

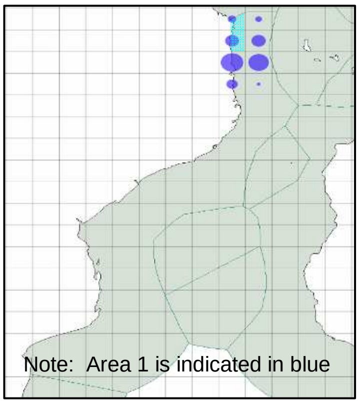


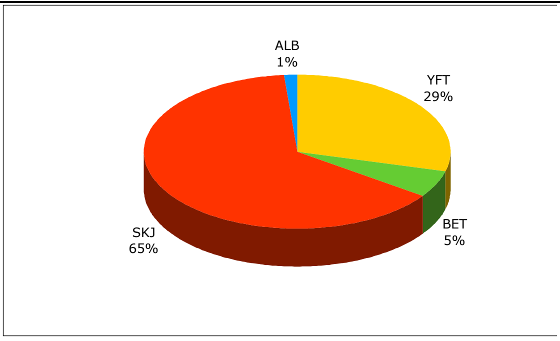
Figure 76 Purse Seine Catches, Mozambique EEZ, 2004

Figure 77 Purse Seine Catches, Area 1, 1994-2005

It should be noted that the structure of both licensing regimes (EC/Mozambique FPA and direct licensing) is such that they encourage under declaration of catches - accurate deceleration could lead to an increase in the fees payable (Wilson, 2008) and it is considered likely that actual catches in Mozambique EEZ are significantly higher than those declared and described above.

d) Composition

The composition of catch in the Purse Seine fleet is illustrated in Figures 78 and 79. In normal years about two thirds of the catch is Skipjack (SKJ), and a little less than one third yellow-fin tuna (YFT). In 2004, the catch composition changed radically and for that year was dominated by yellow fin (three quarters of the total).

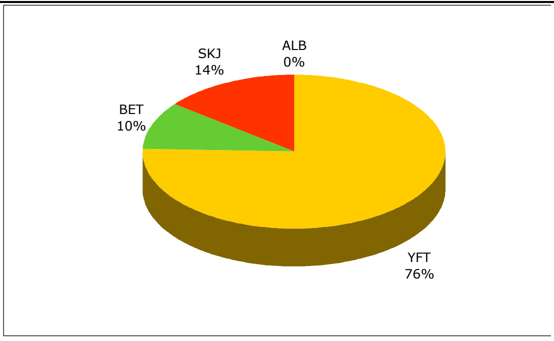


Source: IOTC Catch Effort Database

Legend

SKJ: Skipjack tuna
YFT: Yellowfin tuna
BET: Bigeye tuna
ALB: Albacore tuna

Figure 78 Catch composition 1994-2005



Legend

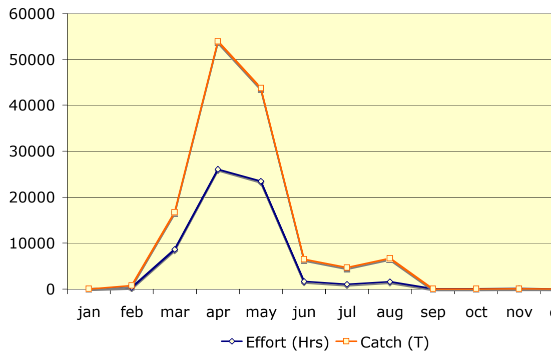
SKJ: Skipjack tuna
YFT: Yellowfin tuna
BET: Bigeye tuna
ALB: Albacore tuna

Figure 79 Catch composition 2004

e) Seasonality

Although the purse seine fishery exhibits highly variable catches and special distribution of effort, the seasonality of catches and effort in Mozambican waters is relatively consistent, with a clear peak in activity from March to June. Figure 80 shows the distribution of <u>total</u> catch and effort for the period 1994-2005 for the purse seine fishery in the Mozambican EEZ.

The pattern outlined above appears to be not true for 2004, a year corresponding to high catches and an outburst of the stomatopod *N. investigatoris*. As illustrated in Figure 80 effort and catch was focussed on between June and August for that year - the only year in record with any significant activity in the Mozambican EEZ in July and August.



Source: IOTC Catch Effort Database

Figure 80 Seasonality 1994-2005

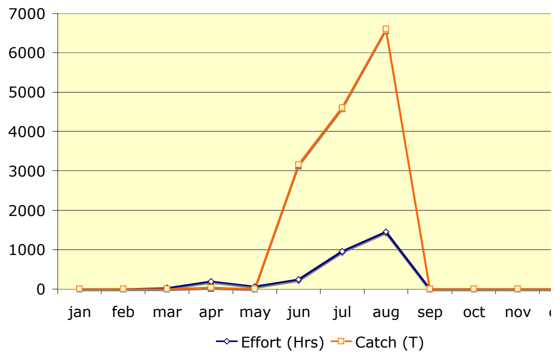


Figure 81 Seasonality 2004

Longline Fishery

a) Fleet

The longline fleet is dominated by vessels fishing under direct license agreements, most of which are from Asian countries including Japan, Taiwan PRC and Korea (Table 51).

Table 51 Longline Fleet 2008

Regime	FLAG	Longliners
EC FPA	Portugal (EC)	1
	Spain (EC)	23
	United Kingdom (EC)	1
Direct License	Undefined	62
	Total	**87**

The average vessel capacity at 262GRT (EC fleet) is significantly smaller than purse seiners. Both target species and target markets are also very different from the purse seine fleet, with longliners targeting other large pelagics in addition to tunas, including swordfish and sharks. Catches per vessel per year are very much smaller than seiners, and product is destined for low quantity high value markets such as that for sachimi.

Data for the longline fishery is relatively poor, and is negatively affected by under or non declaration of catches by vessel operators under both the EC agreement and direct license. As with the purse seine fishery data is complied by the IOTC but at low resolution (5˚x5˚ squares for longliners compared to 1˚x1˚ squares for purse seiners).

b) Effort

The low resolution of collated data makes it impossible to estimate effort in the longline fishery specifically in Mozambican waters. Figure 82 below shows the historical trend and geographical distribution of effort in longline fleet in the Mozambique Channel 1983-2006. Note that the 5˚ analysis grid implies that this data covers effort in French, Malagasy, Comoros, South African and international as well as Mozambican waters.

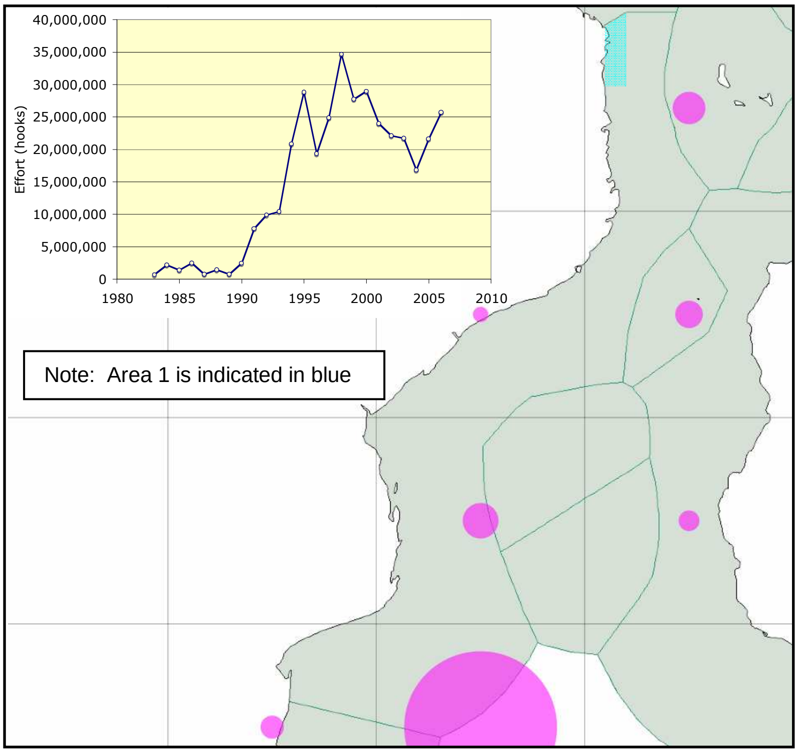


Figure 82 Total Longline Effort 1983- 2006 adapted from : IOTC Catch Effort Database

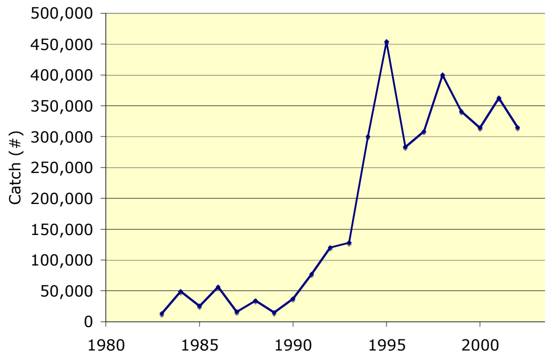
The overview presented by the IOTC data above is supported by short term VMS data for EC longliners, verifying the concentration of fishing effort in the south eastern corner of the EEZ, and indicating some limited effort around the Saint Lazarus Bank to the south east of Area 1.

Unlike the purse seine fishery, the longline catch and effort is unlikely to be affected by stomatopod outbursts, primarily on account of fundamentally different prey profiles of the fish caught by the two fleets. Surface schooling yellow fin, big eye and skipjack tuna have been observed to feed almost exclusively on stomatopods (Potier et al, 2002 and 2004), whilst fish caught at deeper levels on long lines prey more on crab larvae, fish and cephalopods.

Although it is clearly possible that the longline fleet could fish within Area 1, historical data implies that this is very unlikely, even in the event of stomatopod outburst.

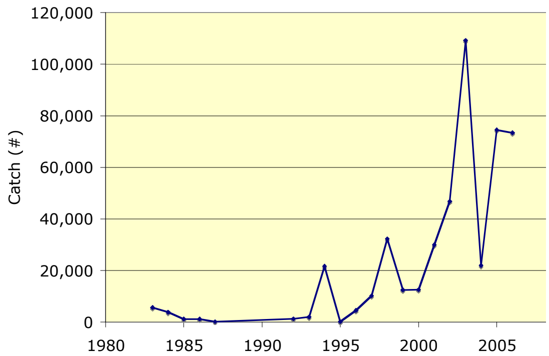
c) Catch

Catch estimations for the longline segment are not easily made, primarily on account of the fact that IOTC data for the fleet records the number of fish caught, with only very few records of weight, and the low geographic resolution of data. Recorded catches (number of fish) for the Mozambique Channel and for the IOTC data block that encompasses Area 1 are shown in Figures 83 and 84, below. Note that Area 1 is only a very small part (about 4%) of the area of the reference IOTC data square.



Source: IOTC Catch Effort Database

Figure 83 Total Longline Catch 1983- 2006



Reference square: 10˚S, 40˚E - 15˚S, 45˚E

Figure 84 Longline Catch, reference square, 1983- 2006

d) Composition

The composition of longline catches in the IOTC reference square which encompasses Area 1 is illustrated in Figure 85. Note that the data is for numbers of fish and if the analysis could be made by weight larger species such as Swordfish would be more significant.

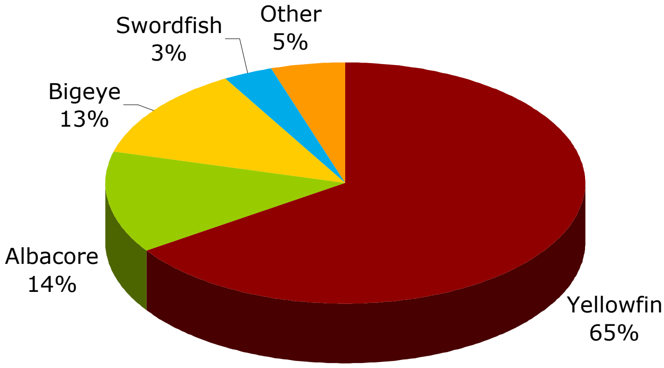


Figure 85 Catch composition (by numbers) 1983-2006 adapted from: IOTC Catch Effort Database

e) Seasonality

The seasonality of longline effort in the IOTC reference square which encompasses Area 1 is illustrated in Figure 86 below, showing a clear peak January - March and a smaller secondary peak in July.

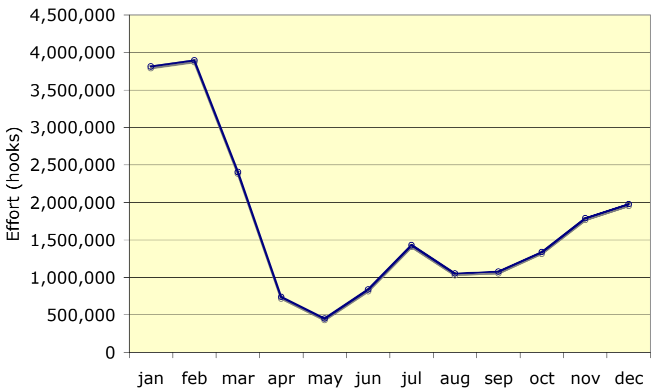


Figure 86 Seasonality of Longline Effort (1983-2006) adapted from: IOTC Catch Effort Database

5.6.8 Shipping (Maritime Traffic)

5.6.8.1 Overview

The Mozambique Channel is situated in the Indian Ocean between the Island of Madagascar and Mozambique, between the latitudes 10º and 25º S, a zone considered *"Zone of Peace"* by a decision of the United Nations General Assembly

Resolution of 16th December, 1971, that declared all the *"Indian Ocean, a Zone of Peace"*[72].

The Channel has a length of approximately 1,000 nautical miles (1.800km) and a width that varies between 250 and 600 nautical miles (450 to 1080km), a minimum width of approximately 287.5 nautical miles (517km) between Angoche *(in Mozambique)* and TambohorYear *(in Madagáscar)*, an average depth of around 3.897m and a maximum depth of 7.455m *(Java Atoll)*[73].

The Mozambique Channel is a preferential navigation route for the maritime links between the North and South America, Persian Gulf, Asia, Southern and East Africa, with Oil Tankers, Containerized Ships as well as General Cargo traffic. Furthermore, the Mozambique Channel is also a route for regional cabotage for the Southern and East Africa as well as for Mozambique domestic cabotage.

By being a historically intensively exploited navigation route, still it has not an officially and formally established system of "Traffic Separation Scheme", with the navigation being made based on *"customary traffic separation schemme"*, although the International Maritime Organization has put in place criteria and guidelines for the establishment of *"traffic separation schemme"*, with provisions incorporated in the IMO International Convention SOLAS 74 in its Chapter V, a chapter dealing with Safety of Navigation, Regulation 8 related to the Organization of Maritime Traffic[74].

The Mozambique Channel became a preferential commercial navigation route even before the arrival of Vasco da Gama in Mozambique (XV Century) on his discovery of the Maritime route to India odyssey, as the Arabic traders were already cruising in the waters of the Mozambique Channel in their commercial trips to the Southern and East Africa region.

With the development of the world economy and the maritime trade, the maritime traffic in the Mozambique Channel kept on, consequently, growing reaching a higher pick with the "boom" of the oil industry in the Persian Gulf, having become the preferential oil tankers route carrying oil from the Persian Gulf to America, Asia and the East and Southern Africa Region.

The Mozambique Channel is not only being cruised by oil tankers but also by Container Carriers and General Cargo (both packaged and bulk) Ships between the areas mentioned above. Fishing activity has also a share on the intensity of traffic in the Mozambique Channel, specially the Tuna Fishing by European and Asian fishing vessels licensed in the various countries of the Eastern and Southern Africa region as well as of the Indian Ocean Islands area.

From the 60ths, considerable portions of the Mozambique Channel were covered by scientific expeditions of diverse nature, including oil exploration seismic surveys, with major incidence in the western part of the Channel (in the jurisdictional waters of South Africa, Mozambique, Tanzania and Kenya).

[72] Source: Resolution No.2832 of Sixtieth Session of the United Nations General Assembly of 16th December, 1971
[73] Source: Wikipédia, Enciclopédia
[74] Source: Convenção SOLAS 74, Edição consolidada de 1997

Recent Developments

An implementation of a *Marine High Way* project is about to start in the Mozambique Channel with the main objective of serving as a platform for the Marine Oil Pollution Prevention but also covering other aspects such as the Management of Maritime Traffic through the establishment of institutionalized "Maritime Traffic Separation Scheme", considering that prevention of accidents is an important aspect of the Marine Oil Pollution Prevention thus, being a potential and significant contribution for the attainment of the *Marine High Way* project main objective that is the Marine Oil Pollution Prevention.

The project is being funded by the World Bank through the GEF (*Global Environment Facility*) funds and it has the following participating and beneficiary countries: South Africa, Comoros, Madagascar, Mauritius, Mozambique, Kenya, Seychelles, Somalia and Tanzania, with South Africa as the funding signatory State on behalf of the group of the participating and beneficiary countries.

The *South African Maritime Authority- SAMSA* is responsible for the project implementation in partnership with the IOC-*Indian Ocean Commission*, under supervision of a Steering Committee composed by representatives of the participating and beneficiary countries. It is important to mention that all preparatory work has already been done and the Funding Agreement between the World Bank and the Government of South Africa signed (in September 2007), marking the project effectiveness[75].

Presently, intense seismic survey activities are taking place along the Mozambique Channel, particularly in the Rovuma Basin (North of Mozambique) in the vicinities of the area concessioned to AMA1 with the objective of carrying out hydrocarbons exploration activities. In total, the Government of Mozambique has given concessions of 7 blocks in the Rovuma Basin to 5 companies from Canada, Italy, Malaysia, Norway and United States of America[76].

This section presents a description of various aspects linked to Maritime Transport and Movement of Ships applicable or related to the proposed project.

5.6.8.2 Review of the information on maritime traffic within area 1

According to Mozambican legislation, INAMAR - the National Maritime Institute is the institution with the mandate for the management of maritime traffic in the waters under the jurisdiction of the Republic of Mozambique, on its capacity as The Maritime Authority. In the execution of its mandate, INAMAR counts on the contribution of INAHINA – the National Institute of Hydrography and Navigation which plays a key role in the component of Safety of Navigation. This institution is responsible for Hydrographic Surveys, Nautical Charting, Oceanography and Sea Marking. Also refer to Section 2 for competencies of these two institutions.

Contacts were made with the above-mentioned institutions as well as with other agencies with a stake in the maritime industry such as Port Operations, Shipping, Shipping Agents, among many others, with the objective of sensing their role-play in

[75] Source: World Bank Report on the project
[76] Source: INP – National Petroleum Institute, Mozambique

the maritime traffic management along the Mozambique Channel in general, and in the project area concessioned to AMA1.

Information collected in regard to ships movements in the Port of Pemba covering the period between 2001 and 2007 is illustrated in Tables 52 and 53 below.

Table 52 Movement of Ships in the Port of Pemba: 2001 to 2007

Year	2001	2002	2003	2004	2005	2006	2007	Monthly Average 2007
Number of ships	67	66	63	63	78	85	96	8

Source: CFM Anual Reports - Statistics

Table 53 Movement of Ships in the Port of Pemba for the years 2006 and 2007

YEAR	2006	2007	Monthly Average
Number of Long Course Ships	45	55	4.6
Number of Cabotage Ships	40	41	3.4
Total of Ships	**85**	**96**	**4.0**

Source: Maritime Administration - Pemba/CFM Office Pemba Branch

According to the Maritime Authority representative in Mocímboa da Praia, during the field survey period, the Port of Mocímboa da Praia has been called by a single ship named *"M/V THORHANNE"*, of Chinese nationality and registered in Barbados, with a Net tonnage of 1967 tons, carrying containerized timber.

Other types of traffic that have been witnessed by the field team in the area of jurisdiction of the Mocímboa da Praia Maritime Delegation are composed of Seismic Vessels together with the respective Supply and Support Vessels as well as some Tourism Yachts and Cruise Ships visiting the Islands in the Quirimbas Archipelago, with their control being made from Pemba. Table 54 presents the movement of Ships during the year 2007 for The Port of Mocímboa da Praia.

Table 54 Movement of Ships in the Port of Mocímboa da Praia during the year 2007

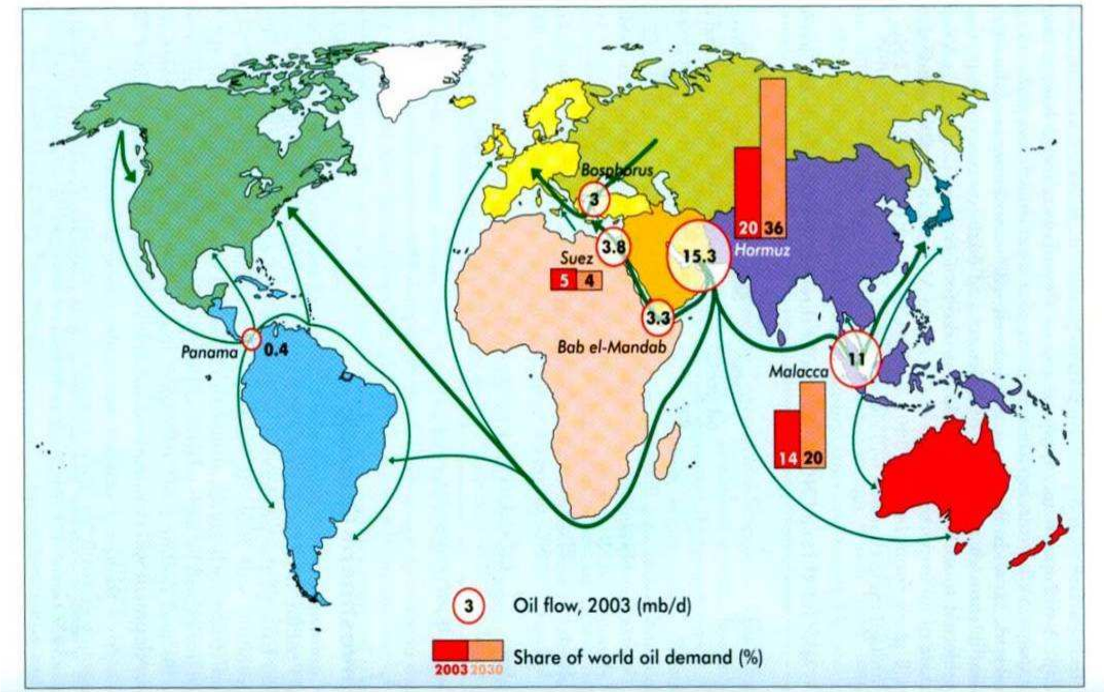
YEAR	2007	Monthly Average
Number of Ships	16	1.3

Source: Maritime Delegation - Mocímboa da Praia/Customs Office - Mocímboa da Praia

5.6.8.3 Identification and Mapping of the Main Navigation Routes in the Project Area

Present Navigation Routes in the Mozambique Channel

There are some records and Mapping on the movement of ships in the Mozambique Channel; information collected and processed by some companies, organizations and associations linked to the shipping industry that have been collecting statistic data/information. These are shown in Figure 87 below.



Source: Marine High Way Project in the Mozambique Channel

Figure 87 Traditional Maritime Traffic Routes, mainly Oil Tankers, in Transit in the Mozambique Channel

The traditional and present route of Maritime Traffic in the Mozambique Channel interferes with the project and study area (Area 1 in the Rovuma Basin) approximately at parallel 16, as it passes at around 35 Nautical Miles off the coast of Mozambique. Besides that fact, the project area is also demanded by national and regional cabotage shipping, with traffic to and from Madagascar, Comoros, Tanzania and Kenya, linking up with the Ports of Pemba and Mocímboa da Praia, even if such traffic is not intense.

As mentioned above, there has been some traffic of Seismic Vessels together with the respective Supply and Support Vessels as well as some Tourism Yachts and Cruise Ships visiting the Islands in the Quirimbas Archipelago.

However, it is important to mention that the various maritime traffic routes currently in use are not officially approved, but they have been safely used, especially the route used by oil tankers along the Mozambique Channel, with the respective detail shown in Figure 88, as well as the route of the domestic cabotage in Figure 89.

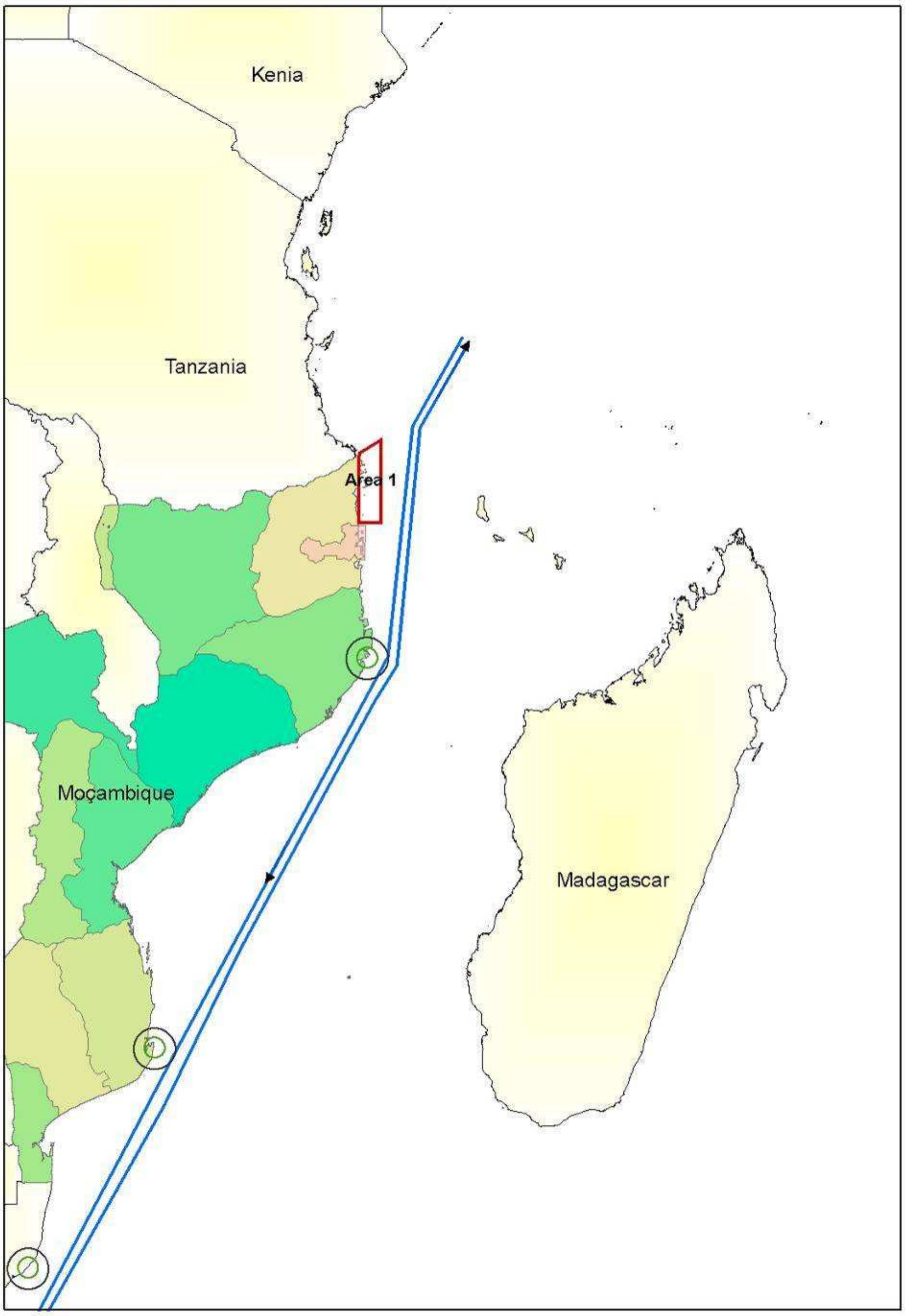


Figure 88 Detail of the Traditional Maritime Traffic Routes, especially used by oil tankers in Transit along the Mozambique Channel, adapted from INAMAR (2008)

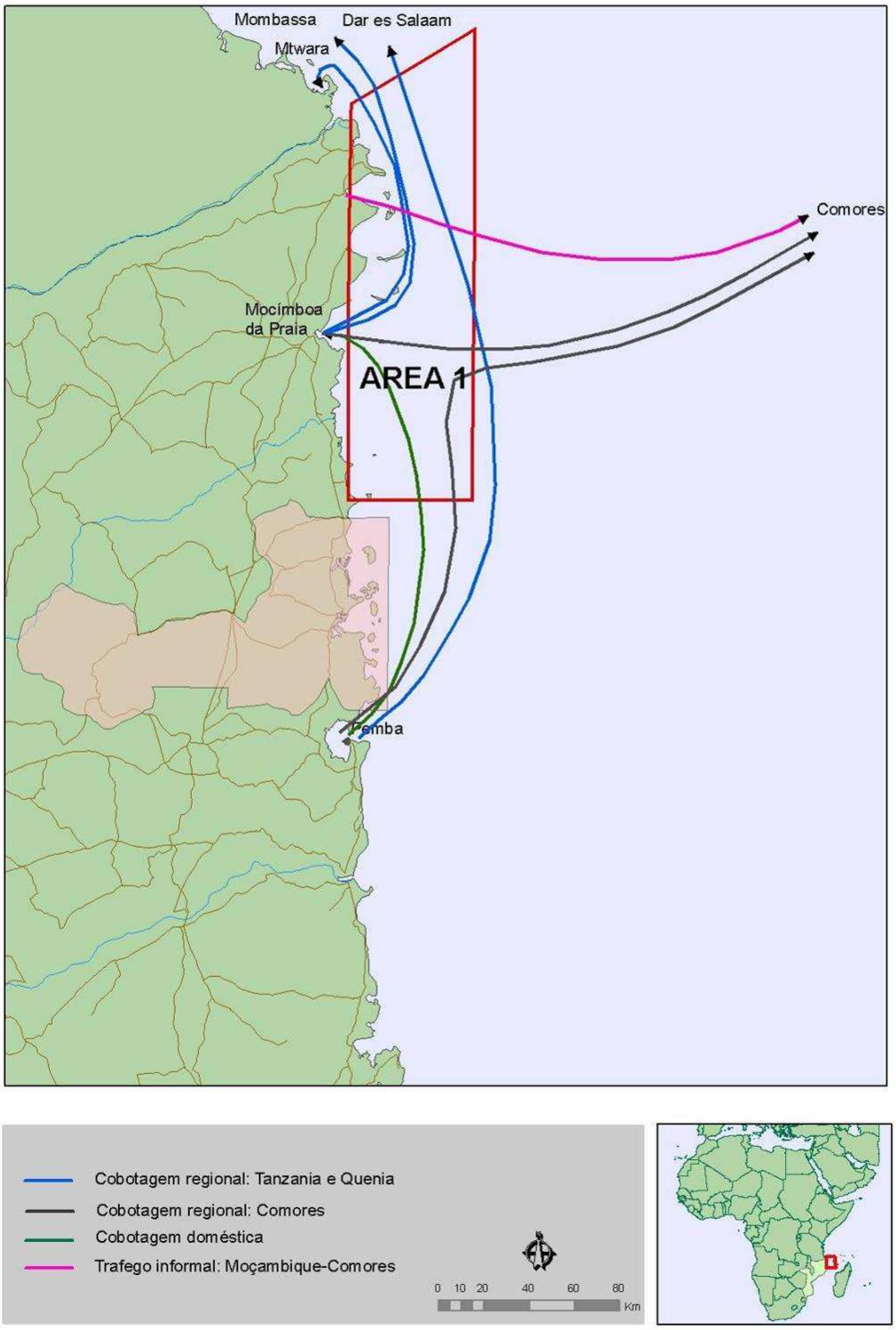


Figure 89 Routes National and Regional Cabotage that run across Area 1 of the Rovuma Basin from INAMAR (2008)

These routes, as mentioned before, are not officially approved but they have a *"tacit blessing"* of the Maritime Authorities of the Region and up to now there is no record of an accident merely linked to their use.

Proposed Navigation Routes

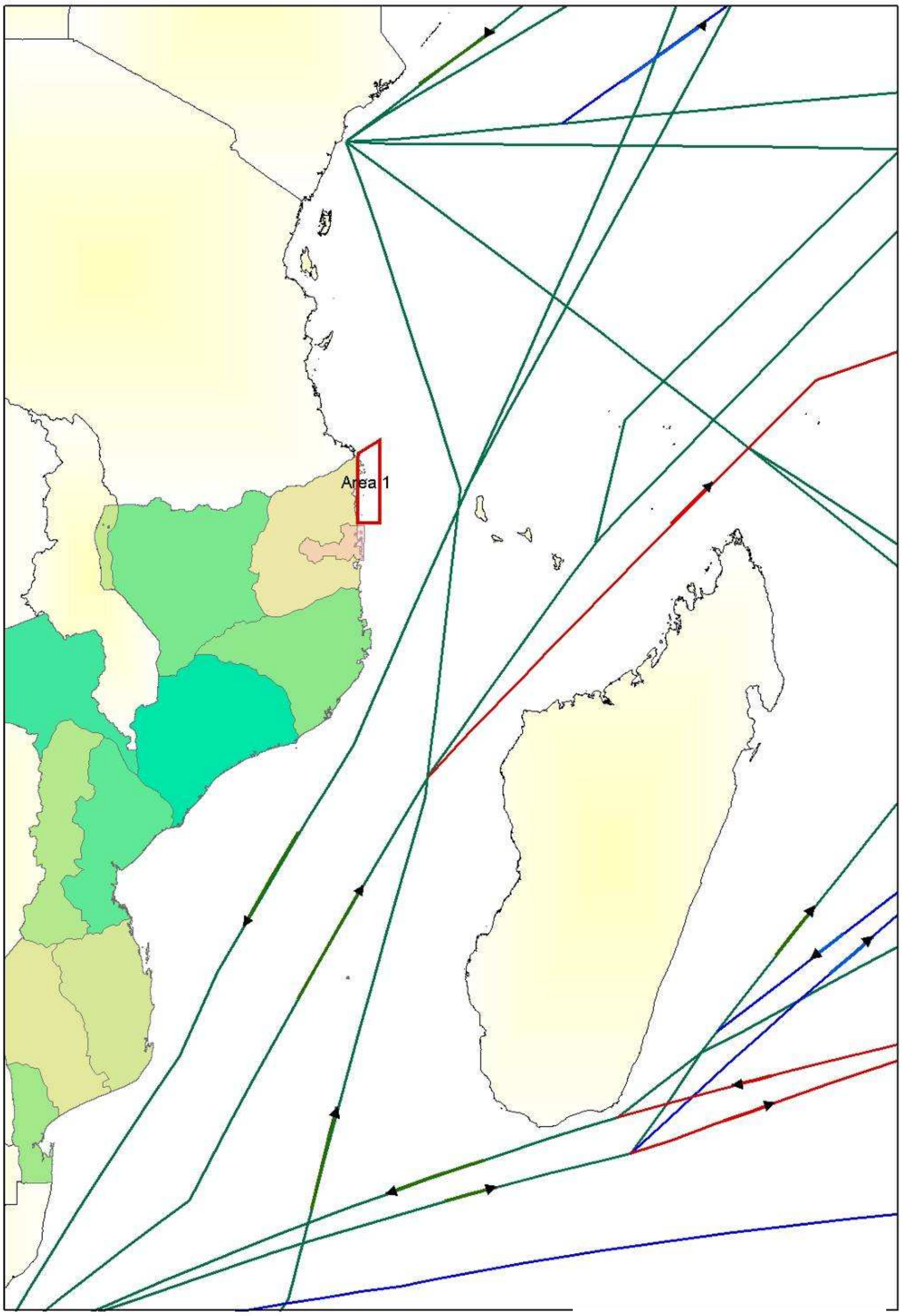
The *Marine Highway Project* in the Mozambique Channel intends to work based in three options, aiming at dividing the traffic by classes of ships according to their type and use: tankers, chemical ships, nuclear ships, general cargo ships, bulk cargo ships, container ships, passenger ships and navy vessels. The project also considers the possibility of establishing navigation lanes in the each route, based on the criteria mentioned above that takes the ship type and use for the division of transitability. The Three options to be possibly adopted are described as follows:

Option 1 - This is an option conceived with the assumption that it should be established with the minimum distance of 20 nautical miles from the continent coastline, with a distance of 10 nautical miles of separation between the navigation lanes in each direction. This option has the disadvantage of passing at a very close distance of the continent coastline, a situation which increases the degree of pollution exposure in case of the occurrence of an accident involving oil tankers. The option is an extension of the South African Route and it has a minimum depth of 1,000m.

Option 2 - This is an option conceived with the assumption that it should be established with the minimum distance of 50 nautical miles from the nearest point from the continent coastline, with a distance of 10 nautical miles of separation between the navigation lanes in each direction. This option is seen as the safest one as it passes far away from the continent coastline. It has a slight disadvantage as it passes far from the continent coastline and in case of the occurrence of an emergency, it makes the search and rescue operations more difficult.

Option 3 - This option was conceived as a result of the combination of the previous two options (1 and 2) with the disadvantage of passing at a distance 35 nautical miles of the nearest point of the continent coastline (a distance relatively long and far away from the coastline). It also maintains the 10 nautical miles distance of separation between the navigation lanes in each direction as well as a minimum depth of 1,000m.

The proposed “Future Maritime Traffic Distribution Routes” for the Mozambique Channel are shown in Figure 90 below.



Source: INAMAR, 2008

Figure 90 Proposed "Future Maritime Traffic Distribution Routes" for the Mozambique Channel adapted from INAMAR (2008)

An analysis of the data and information collected during the research shows that the drilling activities scheduled to take place in Area1 will have some impact on the common activities in the same area, particularly on the maritime traffic of the national and regional cabotage, as well as on commercial and artisanal fishing in the north of Cabo Delgado Province.

The present navigation routes along the Mozambique Channel do pass through the project area at distances that vary between 15 to 35 nautical miles off the coast of Mozambique. In normal circumstances, this traffic would not interfere that much with the project activities, but it is always important to take into account adverse weather conditions that may force some traffic to get closer to the coastline of Mozambique.

If we consider the fact that Area 1 where the drilling will take place is an offshore site, the most probable interference will come from the maritime traffic of the national and regional cabotage, commercial and artisanal fishing, as well as from tourism Yachts that call the Port of Pemba and Quirimbas archipelago.

5.6.9 Coastal Industries

Coastal industries are not located in the drilling area. However, some of the industries are located on the shoreline and could potentially be affected by non-routine events.

5.6.9.1 National industrial context

Industrial activities in Mozambique are in law and regulations classified into four major sub-groups: micro, small, medium and large scale, where a principal line of division is defined by the size of initial capital, installed capacity (potency - *KvA*) and potential or current number of employees.

In 2007 there were approximately 8,724 industrial units in Mozambique, among which 7.860 were micro, 577 small, 59 medium, 9 Large and 217 of other types (Republic of Mozambique, 2007). Regional differences were substantial with respect of the type of industries as well as basic facilities for industrial development. The central part of the country participated with the highest number of micro- industries (43%) while the southern part had a highest number of small (59%), medium (52%) and large (89%) industries. The northern part of the country participates with 26% of micro-industries, 24% of small, and 47% of medium. No large scale industry is found in these figures (Table 55).

Table 55 Micro, small, medium, large and other industries in Mozambique (2007) from Republic of Mozambique: 2007

Location	Micro	Small	Medium	Large	Other	Total	
Maputo-city	1,821	51	9	4	-	1,885	22%
Maputo-Province	390	270	20	4	0	684	8%
Gaza	228	2	0	0		230	3%
Inhambane	42	18	1	0	48	109	1%
Percentage of total	32%	59%	52%	89%	22%	33%	
Sofala	842	0	0	0	169	1,011	12%
Manica	892	68	0	0		960	11%
Tete	770	7	0	1	0	778	9%
Zambezia	843	24	1	0	0	868	10%

Location	Micro	Small	Medium	Large	Other	Total	
Percentage of total	43%	17%	2%	11%	78%	41%	
Nampula	1114	80	24	0	0	1,218	14%
Cabo Delgado	379	58	3	0	0	440	5%
Niassa	539	1	0	0	0	540	6%
Percentage of total	26%	24%	47%	0%	0%	25%	
Total	7,861	580	59	10	218	8,724	100%

Over the past ten years, the size of the manufacturing sector has been dramatically influenced with the completion of Mozal, a major aluminum smelter. Mozal is located in Maputo and is considered to be the largest industrial project ever undertaken in Mozambique. Aluminum alone accounts for more than 70 percent of the total industrial output in Mozambique in 2006 (Figure 91). Growth in other capital intensive manufacturing subsectors (beverages and cement) as well as labor-intensive (food and cigarettes) is also considerable, whereas agro-industries have been recording a relatively low performance. From the figure below one can also see that in 2004, Mozal accounted for almost a 100% of the total industry input.

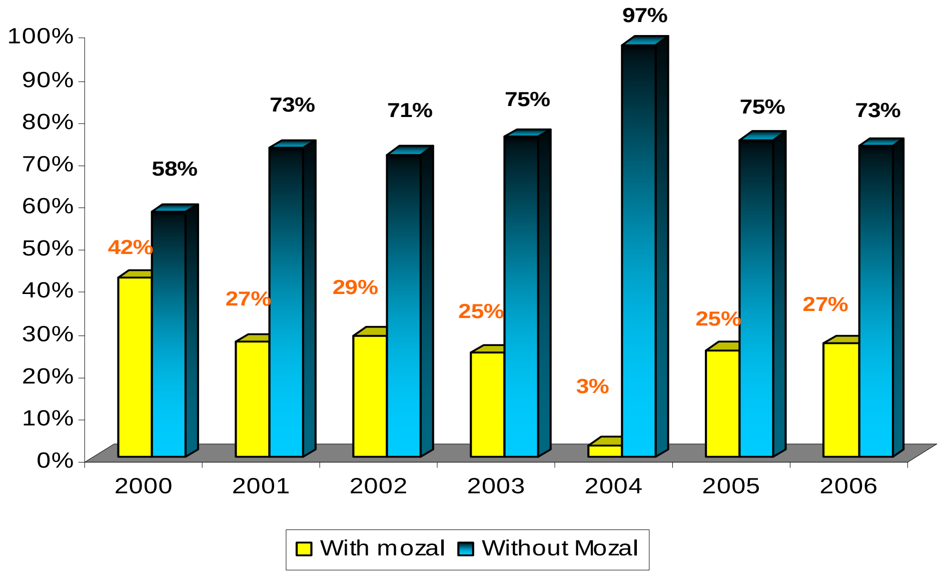


Figure 91 Percentage of production value from industries between 2000 and 2006 from Republic of Mozambique: 2007

Commonly, the industrial activities are concentrated in large and small towns. The rural areas are still very poor, although effort has been done to mobilize the implantation of at least micro and small industries through projects locally funded by the distrital governments. In 2006, the industry sector in Mozambique employed approximately 16,742 people in Mozambique among which 33.5% by large scale, 33.4% by the small scale, 23.1% by the medium scale and 10% by micro scale (Table 56).

Table 56 Employment by type of industry in Mozambique (2006) from Republic of Mozambique: 2007

	Micro	Small	Medium	Large	Total
Number of employees	**1673**	**5594**	**3872**	**5603**	**16,742**
Employment	**10.0%**	**33.4%**	**23.1%**	**33.5%**	**100.0%**

The main constraints of industrial development are: lack of organizational and management capacity, poor human resources capacity, lack of adequate technology and technical capacity/knowledge to diversify and utilize less accessible resources for subsistence and market oriented production, poor road and other basic infrastructures, limited market access, high costs of inputs in local market, and others.

5.6.9.2 Policy and Master Plan for the development of the industrial sector in Mozambique (July 2007)

The Policy and Master Plan for the industrial sector was adopted by the Government of Mozambique in July 2007. The sectoral mission is to improve the linkage between the state and the private sector in the creation of an appropriate environment for business development. The specific objectives of the Policy and Master Plan for industrial sector may be summarized by the following pillars:

- Improvement of the number of industrial initiatives;
- Mobilization of finance, public and private resources for supporting the expansion and growth of industrial initiatives at rural and peri-urban areas;
- Development of a favorable environment for industrial operations; and
- Creation of appropriate conditions to equip the private initiatives with capacity for rehabilitation of the paralyzed industrial park.

The Policy and Master Plan specifically describes the roles of the public and private sectors. The State is responsible for ensuring that the benefits coming from these activities are maximized by the country (Republic of Mozambique, 2007). The priorities for industrial development are oriented to the improvement of the micro, small and medium scale industries in rural and peri-urban areas. Craftwork, cashew processing and furniture manufacture are defined as opportunities and priorities for the next five years in Cabo Delgado Province (Republic of Mozambique, 2007). To materialize this vision, the government has decentralized all administrative and finance systems, creating local opportunities for funding and supporting private economic development initiatives.

5.6.9.3 Industrial operators in the study area

The industrial sector in Cabo Delgado is dominated by the micro and small scale industries (Table 57). There are 440 industries in Cabo Delgado, among which 68 (or 5%) in the study area.

Table 57 Number of industries per size in Cabo Delgado. Data from the District Authorities

	Micro	Small	Medium	Large	Other	Total
Macomia	15	7	1	0	0	23
Mocimboa da Praia	21	7	0	0	0	28
Palma	13	4	0	0	0	17
Total study area	49	18	1	0	0	68
Total Cabo Delgado	379	58	3	0	0	440
National	7,861	580	59	10	218	8,724
Ratios (%)						
Provincial in relation to national level	13%	31%	33%	0%	0%	15%
Study area in relation to provincial level	5%	10%	5%	0%	0%	5%

The most important activities developed by the industries from the study area are: maize flour mills, cashew processing, carpentries, cold storages, timber exploration unities, salt production and furniture manufacture. 41% of the industries are located in Mocimboa da Praia, while 34% were found in Macomia. Some of the mills have been financed by the government funds (*Fundos de Investimento de Iniciativas Locais* – FILL) and may employ in average 5 workers. The average income per unity sold by a mill is not clear, however, the price per kilo, for example of maize to be milled is approximately 2, 00 Mt, and a mill may process between 50 and 100kg per good day. The mills are all located in almost all villages especially in those areas with highest cereals production. Each mill costs approximately 180.000 Mt, according to the local governments.

The salt pans are all located along the coast (less than 2km from the shore line) and they may employ a maximum of 10 workers. Focus groups discussion made in Mocimboa da Praia and Macomia mentioned that the salt pans are now working, but they still do not sell any produce. The programmed price per 25kg will be between 30 and 50 Mt and they are planning to sell locally and in neighboring districts. The cold storage, mineral water as well as carpentry unities were not approached. Table 58 is an indication of the type and number of micro, small and medium industries in study area.

Table 58 Micro, small and medium scale industries in study area. Data from District governments: 2008

	Mills (*moageira*)	**Rice processing**	**Mineral water**	**Carpentry**	**Cold stores**	**Salt pans**	**Cal production**	**Total**	
Macomia	15	3	1	-	3	1	0	23	33%
Mocímboa da Praia	21	1	-	2	2	2	0	28	41%
Palma	13	1	-	-	1	2	1	18	26%
Total study area	49	5	1	2	6	5	1	69	100%

5.6.9.4 Planned development or extension

There is no clear planned development and extension in terms of industries in the area. However, local governments have funds to support local initiatives which may be expanded depending on the number of project proposals submitted by the local communities. In Palma district the government approved almost 120 projects (fisheries, livestock, agriculture and trade) which may be financed during the year of 2008.

5.6.9.4 Aquaculture

General aspects

The policy for the development of the fishery sector includes the promotion of aquaculture for crustaceans, fish and bivalve mollusks. The first inventory of development zones for marine shrimp between 1988 and 1990 identified Maputo, Beira and Quelimane cities and their surroundings as having potential for aquaculture (Norwegian School of Fisheries: 1999). For this reason the Government of Mozambique approved an 8 year Master Plan (2008-2017) which gives emphasis on the development of aquaculture, both in coastal areas and in the hinterland. The Master plan also identified some suitable and priority areas for aquaculture development in the country and in Cabo Delgado province, Pemba, Macomia and Mecufi were mentioned as the most important (Government of Mozambique: 2007).

Aquaculture in the study area

Until recently, aquaculture hardly existed in the study area and it may not yet be considered a sustainable activity or as an important contributor to subsistence. The seaweed culture is the only aquaculture activity reported in the study area. These cultures were introduced by the multinational called Copenhagen Pectin and continued by the AGA KHAN Foundation. However, there are reports that the AGA KHAN Foundation has also stopped with the project, meaning that, at moment, no seaweed project is in place.

Technology of seaweed production

The production process introduced in Cabo Delgado is based on artisanal technologies which utilizes sticks, strings and nylon line as inputs and seeds, as raw materials. All inputs, except the sticks (which are obtained locally) are imported, actually from Tanzania. The seeds are planted and harvested during the high-ebb-tides (*maré vazante*) by women, men and children and both processes do not involve diving. The process of seaweed growing until its harvesting takes 35 days and the productivity is higher during summer time due to the high water salinity levels. After the harvest the seaweed is dried (about 2 or 3 days) and then sold at the price of 5 meticais per kilo. Generally one humid seaweed has in average 8kg, and it may loose more than 90% of its weight after dried. The seaweed farming has been developed under the AGA KHAN Project in Macomia district (*Pangane, Messano, Lumwamwa, Naunde and Kirimize).* The seaweed farms are located between 0 to 3 miles depending on the coastal configuration, but not further than 6m water depths. There are approximately 2000 households involved in seaweed production.

Benefits from seaweds production

Differently from the other sectors such as fisheries and agriculture, where the producers are the totally responsible for all investments and costs, in the seaweed farming, the time and the effort applied by each producer is the most important condition. In the current production system, AGA-KHAN has been providing all inputs to the producers, and in return this organization buys the final output from the households. During 2007, approximately 1,400 households were involved in Macomia (≈ 800), Quissanga, Pemba and Mecúfi. Approximately 30 tones were produced by this period.

5.6.10. Summary of Public Consultation Findings

The main issues related specifically to the *exploration drilling operations* raised in the first round of meetings are related to:

- Location of wells and drilling calendar;
- Impact identification and assessment without knowing the exact well locations;
- Sensitivity areas;
- Impact Monitoring;
- Types of drilling muds to be used;
- Use and recycling of drilling muds;
- Ship waste management;
- Employment;
- Potential impacts and significance;
- Reduced fish catches due to noise;
- CO_2 emissions; and
- Compatibility between drilling operations and tourism.

The main issues raised during the second round of public meetings are related to:

- Employment for Mozambican people;
- Visual impacts caused by rig and flames during well testing;
- Quantification of CO_2 emissions;
- The possible requirement of additional studies other than muds and cuttings dispersion modelling and oil spills trajectory modelling;
- The maintenance of exclusion zones;
- The absence of a discussion about sensitivity areas;
- The potential interference with tourism and conservation activities;
- Dissemination of information/Communcation Plan (including after completion of the project);
- Compensation Plan and Grievance Procedure;
- Climate effects on the project;
- The lack of capacity for effective monitoring and inspection of the project activities by the Government;
- Discharge of waste;
- Effective means for emergency response; e
- Potential damage of the geological structure due to the drilling equipment.

For detailed information, refer to the Public Participation Report in Volume III.

5.7. EXISTING IMPACTS IN THE AREA

The present EIA looked for existing impacts in the area, such as existing wells and seismic data, abandoned cables, ship-borne pollution, off-shore dumping grounds, natural oil seeps and over-fishing. However, almost no information was available.

Information on existing impacts in the area would, *inter alia*, support the assessment of cumulative impacts.

5.7.1 Existing Wells and Seismic Data

Exploration for hydrocarbons in Mozambique goes back to 1904 when the early explorers discovered thick sedimentary basins onshore Mozambique. Poor technology and lack of funds halted those early exploration attempts (http://www.inp.gov.mz).

From 1948 onwards international oil companies moved into Mozambique and carried out extensive exploration, mainly onshore with limited activity offshore. Exploration activity declined in the early 1970's due to political unrest.

A total of 97 wells were drilled to date in Mozambique. 61 wildcats, 24 appraisals and 12 production wells:

- 15 wells located offshore;
- 16 wells over the Pande Gas Field and 18 wells in the Temane Gas Field;

- wells over the Inhassoro Gas Field;
- wells located offshore Zambezi Delta;
- **1 well drilled in the Rovuma Basin onshore**.

The only well drilled in the Mozambican part of the Rovuma basin was drilled onshore in Mocímboa da Praia by Esso in 1986. It had strong gas shows, and possibly condensate in Albian sands. No well was drilled offshore (http://www.inp.gov.mz).

Since early 1980's there have been acquisitions of several extensive 2D seismic surveys - in the offshore and onshore part of Mozambique and Rovuma Basins, using new technology to enhance the data quality. The new data, together with well data and earlier geophysical data, provide a good basis for further exploration.

About 85 000 line km of 2D seismic were acquired from 1950´s to 2003. All modern seismic data are stored in an updated and modern data centre managed by the Institute National Petroleum (INP).

Specifically with regards to the vicinity of the project area in the offshore Rovuma Basin, research has recently been carried out for: Offshore Area 1 (AMA1 – Anadarko); Offshore Area 4 (Eni and Galp) and offshore Areas 2 and 5 (StatoilHydro).

Both for Area 1 and Area 4, the seismic activities have been completed, but the results are still not available as they will first be processed and analysed. For none of the above, drilling operations have taken place.

5.7.2. Abandoned Cables

No information has been obtained regarding the existence of abandoned cables in the project area.

5.7.3 Ship-borne Pollution

There are no records of ship-borne pollution in the project area.

The Pemba Port authorities have no register of any pollution event that has taken place and were not able to tell how the vessels deal with their waste (both liquid and solid). The Port has never received a request related to the discharge or incidental spill of ballast water, oil, etc.

Anadarko's seismic vessels have contracted an Agent (e.g. Sturrock Shipping Mozambique, Ltd) to collect their solid waste from the Pemba Port and to dispose of the wastes appropriately in Pemba.

5.7.4 Offshore Dumping Grounds (Waste)

No information was obtained.

5.7.5 Natural Oil Seeps

Natural oil seeps are leaks from hydrocarbon reservoirs through natural conduits to the earth's surface. Natural oil seeps are the main source of hydrocarbons, in comparison to the oil extraction and transportation of oil and other accidents and leaks from pipelines. According to the National Petroleum Institute (INP), natural oil seeps contribute with 50% of the pollution worldwide.

According to the American (extracted from the Manual Impacto and INP produced for a Course on Environment and Hydrocarbon Prospecting, 2007), the percentage of oil in the North America Waters (1990 – 1999) coming from drilling activities is only 1%, whereas *63% comes from natural seeps* (Figure 92 below). According to the same figure, 33% derives from spills by petroleum users, which may include individual car and boat owners, non-tank vessels, or runoff from increasingly paved urban areas or stormwater streams, i.e. land based anthropogenic sources are the second major contributor of hydrocarbons to the North American Waters after natural seeps.

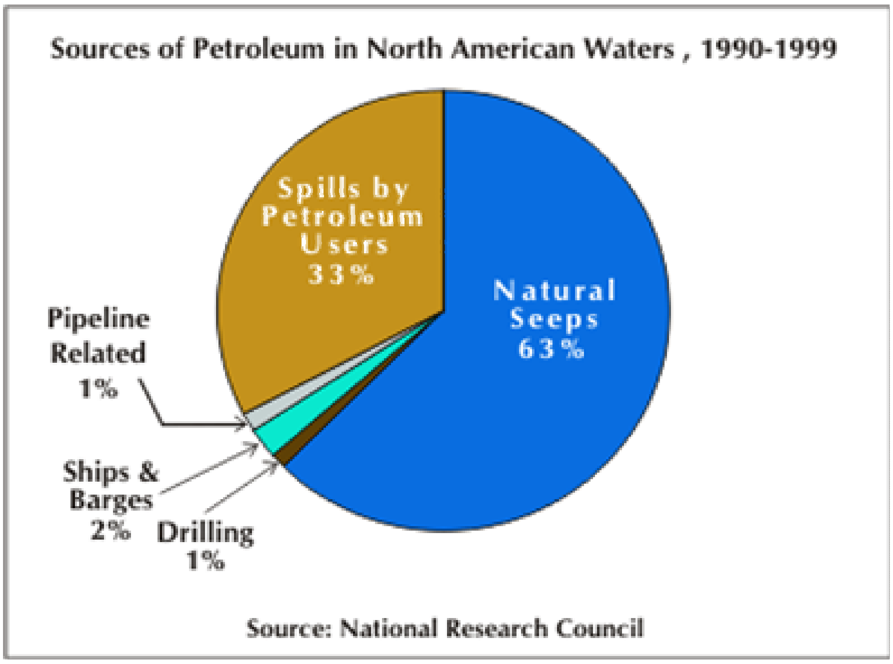


Figure 92 The contribution natural seeps and other sources of oil in the sea waters

However, worldwide natural seeps are responsible for 47%, marine transportation 33% and Municipal/industrial waste and runoff 12% of petroleum input in the world's marine environment (NRC, 2002). The remaining percentages come from offshore oil and gas developments (4%) and atmospheric fallout from consumption.

A number of oil and gas seeps have been identified in both the Mozambican and Tanzanian part of the Rovuma basin, proving active petroleum systems. During 2000, field work was undertaken in the onshore part of the Rovuma basin. Several oil & gas seeps were sampled and analyzed, showing that the oils are of natural origin, having two distinct oil types, and being interpreted to have Jurassic age or older (http://www.inp.gov.mz).

Figure 93 below shows areas where oil seeps have been sampled and reported and gas seeps sampled in the Rovuma Basin. It shows that none took place in Area 1.

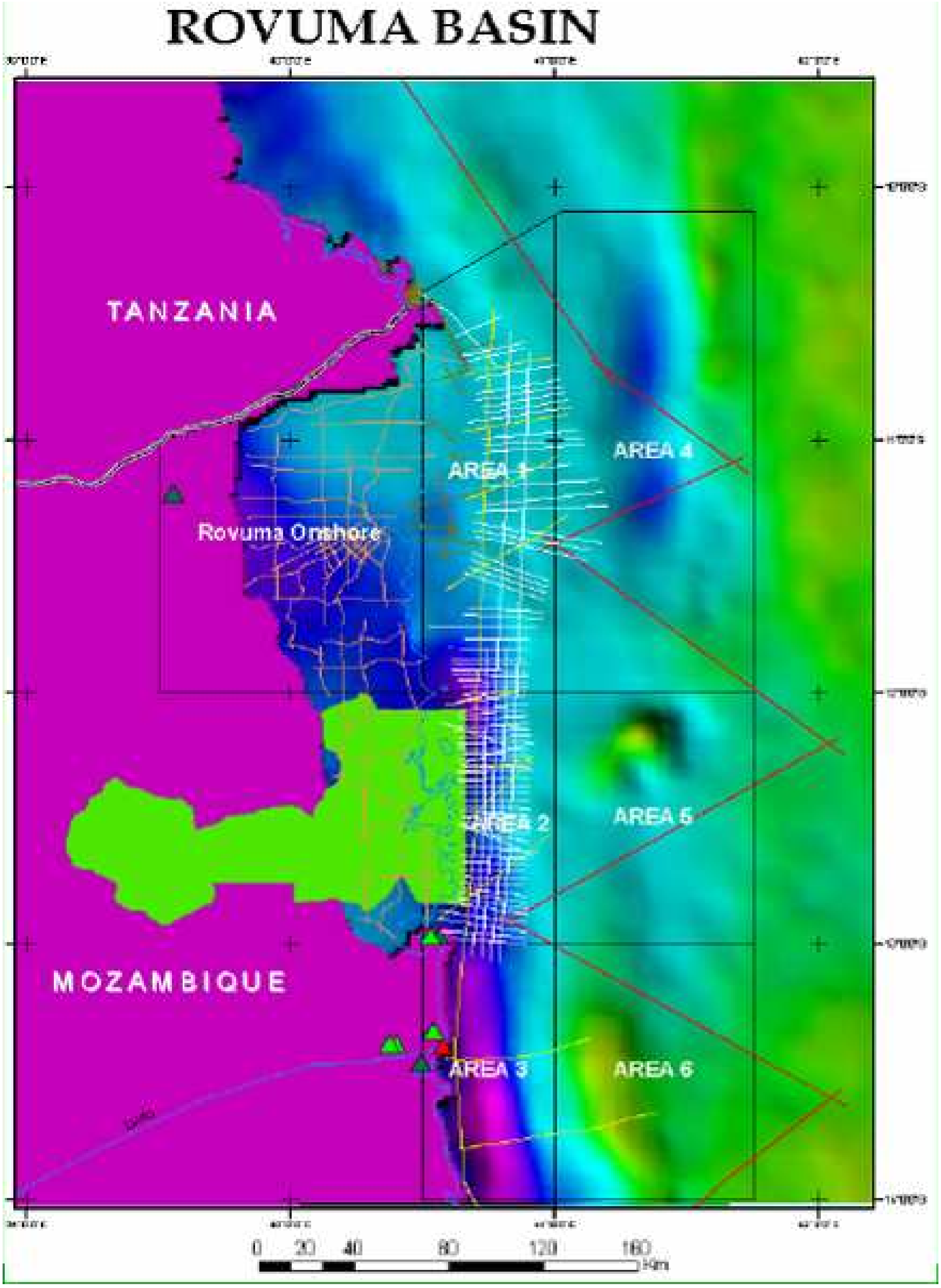


Figure 93 Natural seeps in the Rovuma Basin from INP (2007)

5.7.6 Overfishing

Over-fishing has not been reported.

5.8. KEY ENVIRONMENTAL COMPONENTS

For the purpose of evaluation of environmental impacts, the receiving environment is divided into important components called Environmental Components (EC).

An EC can be defined as any part of the environment or society that is considered important by the developer, operator, general public, or any non-governmental or governmental organisation involved in the assessment process. Importance is determined on the basis of cultural values and/or scientific and public concern. To support the impact assessment, the concept of ECs will be used as a tool to highlight individuals or groups, which could suffer beneficial and/or adverse impacts from the project aspects.

Based on the assessment of the environmental and social conditions in the study area (as described in the earlier sections of this Chapter), the ECs identified for this project are listed by category in Table 59.

Table 59 Environmental Component Identification

Category	Environmental Component	Importance
Air	Air Quality	Link to human / animal and plant health Link to Climate change
Water	Water quality	Link to fauna and flora
	Water resources	Link to population/fishing/tourism/ recreational activities
Ecology and Biodiversity	Flora (mangroves, seagrass beds)	Biodiversity value Breeding/nursery value
	Macrobenthic Communities (coral reefs, etc)	Biodiversity value
	Fauna (marine mammals, turtles, fish)	Biodiversity value
	Protected Areas	Biodiversity value Conservation value (Quirimba National Park/ East African Marine Ecoregion)
Human Environment and Economic Activities	Population	Living conditions
	Artisanal fisheries	Living conditions
	Commercial Fisheries	Mozambique's economy
	Tourism	Mozambique's economy
	Navigation	International navigation route
	Coastal Industries	Local and Country's economy

6.0 ENVIRONMENTAL IMPACT ASSESSMENT

6.1 IMPACT ASSESSMENT METHODOLOGY

6.1.1. General Methodology

The impact assessment process starts with a procedure to identify the activities from the project description detailed in Chapter 3 that could interact with the environment (Table 8 above). In parallel to that procedure, an identification focused on the key environmental and social features from the baseline information detailed in Chapter 5 is undertaken, aimed at identifying the key biological, physical and human components of the project area (Table 59 above).

The potential positive and negative changes resulting from the defined project activities are then predicted for the study area and for the entire project lifecycle. These predicted changes (impacts) are then evaluated using a significance ranking process.

An outline of the impact assessment procedure is as follows:

- Identification of the key project activities;
- Identification of the environmental components;
- Impact identification;
- Impact evaluation; and
- Significance ranking

6.1.2. Environmental Aspects

An environmental aspect is an element of an organisation's activities, products or services that can interact with the environment. The environmental aspects of the proposed Drilling Program have been identified based on an analysis of the project activities and are listed in Table 60 below.

Table 60 Environmental Aspects Register/Project Components

Project Component	Environmental Aspect
Equipment mobilization	Vessel movements along the access route
Site Preparation	Pre-drilling assessment of shallow geohazards
Drilling Program	Personnel accommodation and management
	Drilling
	Well evaluation
	Waste (solid, liquid, gaseous) Management
Decommissioning	Well abandonment
	Demobilization (move rig off location)
Non-routine Events	Leaks and spills
	Blowout
	Fire and explosions
	Collision with other vessels

These environmental aspects may affect the physical or socio-economic environment in adverse or beneficial ways, either within or outside the study area. As described in this EIA, the environmental aspects of the proposed drilling program have been used to identify and evaluate the significance of potential impacts and to develop appropriate mitigation recommendations.

6.1.3. Environmental Components

For the purpose of evaluating environmental impacts, the receiving environment is divided into Environmental Components (EC). An EC can be defined as any part of the environment or society that is considered important by the developer, operator, general public, or any non-governmental or governmental organisation involved in the assessment process.

Inherent to the identification of a particular environmental component is the understanding that preservation of the component is desirable; in other words, any diminishment in its value is undesirable. However, it is recognised that some ECs may be considered to have greater importance than others, and therefore a simple evaluation of each EC is made to determine its relative importance. The EC characterisation value is obtained by taking into consideration the fragility, quality and social values of each component. It also represents the sensitivity of the receptor to potential impacts together with any local, national or international designations, where appropriate. This importance rating is classified as Very Low, Low, Medium, High or Very High (Table 61), and ensures that the more important ECs are afforded a greater weighting in the impact evaluation process. The same aspect can generate a higher impact on an EC categorised as High than on an EC categorised as Low.

Table 61 Environmental Component Categorisation

EC CATEGORISATION	VL	L	M	H	VH
Increasing environmental and social value and/or fragility	→				

The environmental components for the proposed project are listed by category in Table 62, together with the assigned EC value and a description of why the EC is important.

Table 62 Environmental Component (EC) Categorisation

Category	EC	EC Categorisation	Why is it Important?
Air	Air quality	Medium	Health implications on neighbouring communities. Ecological implications for neighbouring areas. Cumulative impacts in combination with other industries in the region.
Water	Marine water quality	Very High	Indirect impacts to marine wildlife and human users of the sea (including use by desalination plants from lodges). Cumulative impacts in combination with other industries in the region.
Ecology and Biodiversity	Flora (mangrove forest)	High	Impacts on an important breeding/ nursery area and habitat for a variety of bird species, crustaceans, fish, and molluscs.

Category	**EC**	**EC Categorisation**	**Why is it Important?**
	Shallow Water Macrobenthic Communities (Coral reefs and seagrass)	Very High	Impacts on these will affect breeding and feeding grounds of a vast array of animal species. Indirect impacts on the livelihoods of the local populations as coral reefs are important in terms of nursery areas for the juvenile life stages of reef fishes and invertebrates harvested by artisanal fishers along the reef line. Indirect impacts on the local tourism industries through impacts on the recreational activities such as scuba diving and snorkelling. Impacts on the conservation value.
	Deep Water Macrobenthic Communities (echinoderms, molluscs, arthropods, etc)	Low	Deep water macrobenthic communities are important in the biological processes of the sea floor, food chain and biodiversity.
	Fauna (marine mammals, turtles, fish)	High	Fauna species are important for their biodiversity value and conservation status in the project area.
	Protected Areas	Very High	Very important due to their intrinsic conservation value.
Human Environment and Economic Activities	Population and local economy	Medium	There are no inhabited islands in the study area. However the population living in the coastline/islands use depend upon the coastal/marine resources for living.

Category	EC	EC Categorisation	Why is it Important?
	Artisanal Fisheries	High	Impact on an important source of protein and income generation in the study area for the poor people living in Macomia, Mocímboa da Praia and Palma coastal areas (it is the main source of income).
	Commercial Fisheries	Medium	Impact on Mozambique's economy as purse seine fishery for large pelagic species (tunas, swordfish and sharks) is periodically focussed on fishing grounds within Area 1.
	Tourism	High	Impact on Mozambique's economy as the northern region is considered to be one of the most important due to its historical past, rich marine life and unique biodiversity.
	Navigation	Very Low	Impact on national and regional cabotage shipping, with traffic to and from Madagascar, Comoros, Tanzania and Kenya, linking up with the Ports of Pemba and Mocímboa da Praia.
	Coastal industries	Very Low	Impact on local and country's economy, especially if the industries located on the shoreline such as salt pans and aquaculture projects are affected.

6.1.4. Impact Identification Process

There are several standard techniques that can be used to aid impact identification. The aim is to take account of all of the important environmental/project impacts and interactions, making sure that impacts which may be potentially significant are not inadvertently omitted. Over time, a number of EIA methodologies and tools have been developed for use in impact identification. In practice, relatively simple methodologies and tools are applied to impact identification (as compared to more complex, data-demanding methods which may be used in impact assessment).

Experience indicates these simple methods are of proven value for undertaking a systematic approach to impact identification (UNEP 2002[77]). The most common formal methods used for impact identification are:

- checklists;
- matrices;
- networks;
- overlays and geographic information systems (GIS);
- expert systems; and
- professional judgement

For the impact identification of this project, professional judgement and the use of a matrix were the techniques used.

A matrix is a grid-like table that is used to identify the interaction between project activities (Environmental Aspects), which are displayed along one axis, and environmental characteristics (Environmental Components), which are displayed along the other axis. Using the table, environment-activity interactions can be noted in the appropriate cells or intersecting points in the grid.

6.1.5. Impact Evaluation Process

The significance of each potential impact will depend on the EC category and the project activities. The impact evaluation will be conducted using the following criteria based on internationally accepted criteria and compliant with Decree 45/2004:

- Nature of impact – negative or positive (beneficial);
- Magnitude (Intensity) of impact – Describes the quantity of the resource potentially affected by the project activity (i.e., very small, small, moderate, large and very large)
- Extent of impact – an assessment of the geographic extent of an impact (i.e., site specific, local, regional, national, or trans-boundary);
- Duration of impact – how long the impact would last (i.e., will effects be short term, medium term, long term, or permanent);
- Type of Impact: Direct or Indirect. When the resource is affected directly by the activity, it is considered to be a direct impact. When the resource is affected through another resource that has been previously affected by the activity, it is considered to be an indirect impact.
- Cumulative. Cumulative effects may be considered significant if an impact is added to existing or future similar impacts.

[77] UNEP 2002: EIA Training Resources Manual

- Reversibility. An impact is considered reversible when the affected resource can revert to its previous state. An impact is considered irreversible when the affected resource can not return to its previous state.
- Probability of occurrence – very unlikely, unlikely, probable, or highly likely/certain.

The impact evaluation is conducted using two sets of criteria described as basic and supplementary (Bojórquez – Tapia, *et al*., 1998).

Basic Criteria:

- Magnitude;
- Spatial extent; and
- Duration.

The impact **Magnitude** is measured on an ordinal scale corresponding to the proportion of the EC affected by each project activity. This evaluation may require the participation of environmental experts in each area, as the magnitude of a given impact will vary as a function of various factors (e.g., fragility, scarcity, location) of an Environmental Component. A blanket or generalised estimation of the magnitude on an impacted resource will not always apply. Depending on the activity and the impacted resource, the magnitude will be assigned to a scale from one to five corresponding to the following descriptions: very small (1), small (2), moderate (3), large (4), and very large (5).

The **Spatial Extent** of an impact is allocated one of the following categories:
Very Small (1) – local scale impact in the immediate area of the activity
Small (2) – local impact in the study area
Moderate (3) – regional scale impact
Large (4) – national scale impact
Very Large (5) – trans-boundary impact

The **Duration** of an impact is described by one of the following categories:
Very Short (1) – less than one year
Short (2) – one to five years
Moderate (3) – six to ten years
Long (4) – greater than ten years / duration of the project's lifetime
Very Long (5) – permanent

Where there is uncertainty between two values during evaluation, the higher figure is assigned in order to reduce the chance of underestimating an impact (i.e., the precautionary principle is applied), thereby minimising risk (Crowfoot, *et al.* 1990).

The Basic Impact Index is obtained by averaging the three values assigned to Magnitude, Spatial Extent and Duration (rounded up), to obtain a whole number between 1 and 5 (Table 63).

Table 63 Basic Impact Index

BASIC IMPACT INDEX	VL	L	M	H	VH
Average of Magnitude, Spatial Extent and Duration	1	2	3	4	5

Supplemental Criteria:

- Type of Impact
- Cumulative
- Reversibility

Type of Impact. Direct or Indirect. When the resource is affected directly by the activity, it is considered to be a direct impact. When the resource is affected through another resource that has been previously affected by the activity, it is considered to be an indirect impact. No additional value is assigned, as the type of impact has no bearing on significance.

Cumulative Effects Cumulative impacts result from a combination of a proposed project's impacts and those from other existing, or realistic future, developments. Cumulative impacts can also include situations where two or more potential impacts from a single project, while individually insignificant, could produce more severe impacts when considered together. Cumulative effects are evaluated using the following parameters:

Nil – No effect
Low – unlikely to contribute to a cumulative effect
Medium – likely to contribute to a cumulative effect
High – highly likely/certain to contribute to a cumulative effect

Reversibility. An impact is considered reversible when the affected resource can revert to its previous state. An impact is considered irreversible when the affected resource can not return to its previous state. Reversibility is assessed as follows:
Reversible – likely to be reversible in the medium term. Reversible impacts are assigned a value of Low or Medium.
Irreversible – likely to be irreversible. Irreversible impacts are assigned a value of High.

The Total Impact Index is a combination of the basic and supplementary criteria. The Total Impact Index will be equal to the Basic Impact Index, except where one or more of the supplementary criteria are High or both are Medium. In this case the Total Impact Index will be increased to the next category.

6.1.6 Impact Significance Assessment

The final impact significance (adverse or beneficial) is the result of the combination of the Total Impact Index and the Environmental Component categorisation, as shown in Table 64. This results in one of the following impact significance classifications: Insignificant (IN), Minor (MI), Moderate (MO) or Major (MA).

Table 64 Impact Significance

	Total Impact Index				
EC Categorisation	VL	L	M	H	VH
VL	IN	IN	MI	MI	MO
L	IN	MI	MI	MO	MO
M	MI	MI	MO	MO	MA
H	MI	MO	MO	MA	MA
VH	MO	MO	MA	MA	MA

Table 65 defines the impact significance as assessed above.

Table 65 Definition of the Impact Significance

Impact Significance	Description
Beneficial	Likely to cause some enhancement to the environment or socio-economic benefits.
Insignificant	No changes, or changes that are unlikely to be noticed or measurable against background activities.
Minor	Minimal adverse effects on environmental resources, which will not require any modification in project plans or specific mitigation measures.
Moderate	Significant. Project activity will have measurable effects on environmental resources. These impacts may require modifications to the project design and/or implementation of effective mitigation measures.
Major	Severe. Will have a major effect on environmental resources. Such potential impacts may represent fatal flaws in the project and will require modifications to the project design and implementation of mitigation measures.

The immediate aim of an EIA is to inform the process of decision-making by identifying the potentially significant environmental effects and the risks of development proposals (UNEP 2002). Discussed up to this point in this section has been the assessment of the effects of project activities assuming they definitely occur. This approach allows for the preparation of preventive measures that otherwise could be deemed unnecessary. Nevertheless, some events, while severe if they occur, are highly unlikely to take place. This is especially true for non-routine events. Each impact is therefore evaluated in terms of its probability of occurrence to complement the impact significance assessment.

The **probability** of occurrence for a particular event can be categorised as follows:

Very unlikely – remote chance of occurrence within the lifetime of the project
Unlikely – Unlikely to occur during the lifetime of the project
Probable – likely to occur at least once during the lifetime of the project
Highly likely/certain – will occur one or more times during the lifetime of the project

6.2. IMPACT IDENTIFICATION

The identification process utilizes the Environmental Aspects and the Environmental Components to identify the impacts that could be originated by a certain activity. Table 66 presents the results of that identification process in the form of a matrix where Environmental Aspects and Environmental Components are shown in rows and columns respectively and the impacts are shown as a highlight where a certain Environmental Aspect potentially affects an Environmental Component (adverse and beneficial aspects are not distinguished).

Table 66 Impact Identification Matrix

Environmental Aspects		Air	Ecology and Biodiversity						Human Environment and Economic Activities					
		Air Quality	Water Quality	Flora	Deep Water Macrobenthic Communities	Shallow Water Macrobenthic Communities	Fauna	Protected Areas	Population	Artisanal fisheries	Commercial fisheries	Tourism	Navigation	Coastal industries
Equipment mobilization	Vessel movements along the access route													
Site preparation	Pre-drilling assessment of shallow geohazards													
Drilling program	Personnel accommodation and management													
	Drilling													
	Well evaluation													
	Waste management													
Decommissioning	Well abandonment													
	Demobilization													
Non- routine events	Leaks & Spills													
	Blowout													
	Fire and explosion													
	Collision with other vessels													

6.3 IMPACT ASSESSMENT

Environmental impacts can affect one or more Environmental Components (ECs) or cause a large environmental change directly, indirectly, or cumulatively. The following sections describe impacts predicted as the result of environmental aspects (Section 6.3.1) and are grouped by EC to clarify how each environmental component can be impacted, particularly by the cumulative effect of one or more environmental aspects.

Mitigation measures are presented in Section 7 of this document, together with the residual impact analysis. Those detailed procedures have been prepared based on legal requirements, industry standards and best practices. The primary goal of the mitigation recommendations is to avoid, minimise or remedy the predicted impacts from the proposed project activities.

Impacts from routine events are summarised in Table 72, Section 6.4.

Impacts from non-routine events are discussed in Section 6.3.2 and predicted impacts are summarised in Table 73 Section 6.5

In the specific case of this project the following factors should be taken into consideration:

- The project is an exploratory activity;
- Well locations are still undecided;
- The duration of the drilling activity is temporary (up to 2 months per well)
- While the drilling locations are not known, the geographical scope of this EIA is limited to drilling activities located beyond the 200m bathymetric line, beyond the mangroves, seagrass beds or coral reefs of the area.

6.3.1. IMPACT ASSESSMENT FOR ROUTINE OPERATIONS

6.3.1.1. PHYSICAL ENVIRONMENT

6.3.1.1.1 Air

Potential Impact 1: Reduction in air quality due to project emissions

Emissions to air will be made during the movement of vessels to and from the drilling site and will be the products of the combustion of diesel oil. The contribution of these emissions to air is unlikely to have a significant effect on local air quality. They will make a small contribution to global greenhouse gases, with CO_2 being one of the combustion products released. This is assessed as of low significance as can be seen from the following calculations:

50m3 (50 000 litres) of fuel per day releases about 133 metric tonnes of CO_2 per day (http://www.epa.gov/OMS/climate/420f05001.htm#calculating). During 60 days (for drilling each well), approximately 8000 metric tonnes of CO_2 will be released per well.

According to the website of the Energy Information Administration, which shows the Official Energy Statistics from the US Government (http://www.eia.doe.gov/pub/international/iealf/tableh2co2.xls), the project (each well site) will contribute with 0,42% of the yearly total Mozambique emissions; 0.0019% of the total Africa emissions and 0.0000728% of the total World emissions resulting from the consumption of Petroleum (using the latest figures available:2005).

During drilling operations, the main emissions to the atmosphere from the drilling rig will be exhaust gases from the diesel power generators. These generators will be operational 24 h a day. Emissions from the generators will comprise combustion products such as CO_2 and water vapor, with lower concentrations of NOx, SO_2, unburned hydrocarbons and particulates.

Emissions will also result from supply and support vessels and helicopter activities and emissions resulting from flaring and venting of hydrocarbons (if applicable), as well as fugitive emissions. Flaring of oil during testing would release CO_2, CO, NOx and unburned hydrocarbons. These compounds are known to contribute to atmospheric conditions such as the greenhouse effect and ozone depletion (and consequently to climate change). Some SO_2 emissions could also be released during flaring of gas and emission levels would depend on the sulphur content; however, flaring will only be conducted for a short time period and as such the volume of gases likely to be emitted to the atmosphere will be limited.

From an ecological perspective, the most significant components of emissions from flaring activities are nitrogen and sulfur oxides, carbon monoxide, and the products resulting from incomplete combustion. These can interact with atmospheric moisture, transform under the influence of solar radiation, and, when in sufficient quantities, precipitate onto the land and sea surfaces causing local and regional pollution. Although certain to occur and have a direct, negative effect on local air quality, they will be rapidly dispersed (SO2 will persist only for approximately 1-2 days; Mortensen, 2008). Receptors that are likely to experience the effects of these emissions include the workforce of the drilling rig/support vessels and therefore this should be treated as an occupational health issue. It is not considered that a localized, essentially short-lived reduction in air quality will cause any notable effects**. Impacts as a result of a reduction in air quality are therefore considered to be of minor significance.**

6.3.1.1.2. Water

Potential Impact 2: Reduced water quality due to the discharge of drilling muds and cuttings

The main routine project activity to impact water quality will be the disposal of drilling muds and cuttings. Two types of drilling mud are planned during the proposed exploratory drilling in Area 1; water-based muds (WBMs) and synthetic-based muds (SBMs).

Water-based muds for use in the offshore oil and gas industry comprise mainly seawater (approximately 75 %) with the addition of barite and bentonite to control mud density. Other compounds are added as necessary to achieve the desired properties for a particular situation (OGP, 2003). WBMs are generally used to drill the upper portions of a well where conditions are less demanding on the properties of the mud. WBMs are also relatively cheap compared to other mud types and are generally considered to be the least toxic of the drilling muds (Patin, 1999). However, WBMs do contain heavy metals in the barite component, which have the potential to pollute the marine environment should they be discharged.

Crecelius *et al.* (2007) conducted a study to investigate if metals contained within the low-metal barite used in water-based drilling fluids dissolve readily into seawater or the pore-water of marine sediments. The laboratory tests indicated that mercury and other trace metals are not released in significant quantities into seawater or pore-water, and concluded the following:

> "Mercury (Hg), cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn) are the primary metals of marine environmental concern in barite because these metals can, in some situations, be enriched by more than an order of magnitude compared to marine sediment. In addition, the USEPA water quality criteria for these metals are relatively low. A relatively small amount of these five metals in barite are soluble in seawater in the pH range of 7.3 to 8.3. During one week exposure of barite in seawater, less than 1 percent of the Cu, Hg and Pb, 3 percent of the Zn, and 15 percent of the Cd dissolved from the barite. Because low-metal barite releases little of these metals to seawater, it is not likely that low-metal barite will cause environmental effects to organisms living in the water column."

Due to the absence of a riser system during the drilling of the uppermost portions of a well, drill cuttings and muds will be discharged directly to the seabed. This discharge to sea is standard industry practice and is largely accepted by environmental protection authorities globally, providing certain criteria are met. For example the United States Environmental Protection Agency (USEPA) stipulates that the concentration of mercury and cadmium in the barite used in water-based drilling fluids must not exceed 1 mg/L and 3 mg/L respectively. It is assumed that the barite used in this drilling programme will comply with this specification.

In deeper portions of a well, or where deviated drilling is required, WBMs are often not able to provide the requisite properties to drill efficiently and safely. In these cases, non-aqueous drilling fluids (NADFs) are used. NADFs include oil-based muds (OBMs) and SBMs. Historically, OBMs were used and comprised crude oil, oil products and other mixtures of organic substances. However, due to environmental concerns over the use of OBMs, many countries prohibited their use and this lead to the development of alternative drilling fluids, which comprised less toxic synthetic components in place of the diesel and other oil products traditionally used (Patin, 1999). Synthetic components include esters, paraffins and olefins and are generally less toxic due to reduced concentrations of aromatic compounds. They are also less persistent in the environment (OGP, 2003). The SBMs expected to be used during this exploratory drilling program are Group III NADFs. These fluids are characterised by a polyaromatic hydrocarbon (PAH) content of less than 0.001 % and a total aromatic content of less than 0.5 % (OGP, 2003).

Once the initial portions of a well have been drilled, a riser will be installed, which allows material (drilling muds and cuttings) to be returned to the drilling rig. Due to the increased cost of SBMs and environmental considerations, SBMs are recovered to the rig for recycling. This recycling process involves separating the muds from the cuttings using vibrating screens known as shale shakers. Some drilling fluids will remain adhered to the cuttings but the majority will be separated by the shale shakers and returned to the drilling fluid system, which will be continuously re-circulated, while the cuttings will be discharged to the sea.

Water quality could potentially be affected in two ways through the disposal of drilling muds and cuttings: increased turbidity, and contamination.

Water-based muds and cuttings from drilling the upper parts of the well will be discharged directly to the seafloor, where they are unlikely to affect the turbidity of the water column above (the density of the mixture will lead to particles settling to the sea floor).

Cuttings separated from SBMs will still be “wet” when discharged from the rig and will tend to clump together and settle quickly to the seabed. As a result of rapid settling, SBM cuttings do not disperse in the water column or significantly increase water column turbidity (Neff *et al,* 2000). According to Neff *et al*. (1987, cited in ERM, 2006), beyond the immediate vicinity of the drill site the concentrations of suspended sediments introduced into the environment by drilling operations are typically less than the naturally occurring suspended sediments in the water column.

With regard to the potential contamination of the water column, experimental and field studies have shown that acute toxic effects of WBMs can be manifested only at high concentrations (Patin, 1998, cited in Patin 1999). Such concentrations can only be found within a few metres of the discharge point (Patin, 1999).

Toxicity is usually evaluated using an LC_{50} test. This determines the concentration of a substance that is lethal to 50 % of a population within a given exposure period (usually

48 or 96 hours). Laboratory and field studies of 60 samples of SBMs showed that toxicity was lower than the limit set by the USEPA (96 h LC_{50} must exceed 30 000 mg/L). Almost 80 % of the samples tested were considered practically non-toxic because the LC_{50} exceeded 1 000 000 mg/L (Patin, 1999).

The impacts on the water column from the discharge of SBM cuttings are generally considered to be negligible due to the following (OGP, 2003):

- Low solubility of synthetic fluids in seawater;
- Low water column dispersion and residence time due to rapid settling; and
- Drilling discharges are intermittent and transient.

The specific constituents of the drilling muds (especially SBM) to be used during this drilling program have not yet been finalised. It is anticipated that the mud components will be of inherently low toxicity and that it is therefore highly unlikely that significant negative impacts to water quality will occur as a direct result of routine project activities. Until the final mud formulations are determined, however, this conclusion cannot be stated definitively.

The discharge of WBMs may temporarily reduce water quality, but this is likely to be restricted to the duration of the discharge, approximately the initial 15% of the well, and localised to the well-site. Although the SBM will not be discharged in bulk to the sea, the drill cuttings will retain some of the mud following separation. The precise chemicals to be used in the SBM will determine the effect that these residues could have on the environment. **Therefore impacts on water quality associated with exploratory drilling activities are considered to be of moderate significance at this stage.**

Potential Impact 3: Reduction in water quality due to deck drainage, bilge water and sewage discharge

Deck

Deck water includes drainage water from precipitation, sea spray or routine operations such as deck and equipment cleaning. This water could contain small amounts of oils, solvents, cleaners or other similar products that can reduce marine water quality. Oily-water separators will be present onboard the rig and will therefore reduce the quantity of contaminants released into the water column.

Deck drainage is certain to occur but the small quantities of contaminants likely to be mobilised and the presence of oily-water separators means the impact is likely to be very small. Deck drainage will be also be quickly dispersed and diluted in the water column, meaning any reduction in water quality will be limited to the point of discharge.

Bilge

With regard to water from the machinery space, small quantities of hydrocarbons such as diesel from the engines, lubricants, and grease used onboard the drilling rig have the potential to contaminate the water column. This impact is probable, but is expected to only affect a limited area in the immediate vicinity of the drilling rig and the currents would ensure rapid dispersal/dilution of the contaminants.

Sewage

Sewage includes grey and black water from showers, toilets and kitchen facilities, which, if discharged into the sea untreated, can pose an organic and bacterial load on natural degradation processes. Because many marine micro-organisms (e.g. bacteria) metabolise sewage, it could lead to a local rise in bacterial levels in the water and consequent increased demand for oxygen. If discharge occurs close to the coast in shallow water, the rapid proliferation of bacteria and algae utilising the effluent as a nutrient source can cause anoxic conditions, which can diminish the biodiversity of an area.

With respect to this drilling program, the drilling rig will be equipped with a sewage treatment system certified to international standards and treated sewage will only be discharged to the sea in locations greater than 3nm from the coast (as per Marpol 73/78 requirements). The treated effluent is expected to be rapidly dispersed/diluted by the currents and biologically degraded by bacteria in the water column.

The discharge of deck drainage, bilge water and sewage is a common activity on large vessels. It is anticipated that only very small quantities of potential contaminants will be mobilised in the discharge and, in the case of sewage, treatment and disposal will be in line with MARPOL (73/78) regulations. **It is therefore considered that impacts from these sources will be minor to insignificant.**

Potential Impact 4: Reduction in water quality due to solid waste disposal

Kitchen (food) waste will be the only solid waste discharged offshore and this will be in accordance with MARPOL (73/78) regulations. Food waste will be readily consumed and biodegraded in the marine environment and as such is not deemed to pose a risk to water quality. **Impacts due the disposal of food waste are therefore considered to be insignificant.**

Potential Impact 5: Reduction in water quality due to produced water

During well-flow testing (if drilling successfully encounters oil) a small amount of formation water can be brought up to the drilling vessel with the oil. This “produced water” will be sent to the flare together with the oil. The flaring process then burns off the hydrocarbons, and the water fraction remaining is discharged to sea. This water may contain unburned hydrocarbons, dissolved salts, metals, and low concentrations of naturally occurring radioactive material (NORM) from the reservoir. The amount of formation water produced during exploratory well-testing is small (in contrast to the latter stages of production wells) and it will dilute and disperse rapidly in the volume of ocean water. Evaporation and biodegradation of any unburned hydrocarbons will also occur. **It is therefore considered that impacts due to discharge of produced water will be of minor significance.**

6.3.1.2. BIOLOGICAL ENVIRONMENT

6.3.1.2.1 Flora

Potential Impact 6: Impacts of waste disposal (including muds and cuttings) on the coastal mangroves

Patches of mangrove occur on Tecomaji, Rongui and Vamizi Islands with the largest stand on Rongui Island. Mangroves provide habitat for a variety of bird species, crustaceans, fish and molluscs, and are also important as nursing and breeding grounds.

In waters as deep as 200 m where the project will take place, mangroves and/or other relevant flora do not exist. However, mangrove stands are located as close as 3km (Rongui Island) and 3.8 km (Vamizi Island) from the 200 m isobath and could be affected by waste management during drilling operations (especially if these take place close to the western limit or if the supply and support vessels pass near these islands and discharge waste there). However, all vessels involved in the drilling program will comply with MARPOL (73/78) Annex V (which deals with prevention of pollution from garbage). As such, only macerated food waste will be discharged and this will be greater than 3 nm from shore.

As discussed under Potential Impact 2, discharged WBM will be rapidly diluted such that toxic effects will be unlikely more than a few metres from the discharge. SBM will not be discharged in bulk to the sea and residual mud adhering to the discharged cuttings will not be mobilised sufficiently to cause impacts on the mangrove forests. **Impacts on coastal mangroves due to waste disposal are therefore considered to be insignificant if waste is managed as described**.

6.3.1.2.2 Shallow Water Macrobenthic Communities (Seagrass Beds, Coral Reefs and Benthic Macrofauna)

Potential Impact 7: Effects of waste disposal (including drilling muds and cuttings) on coral reefs and seagrass beds.

As with coastal mangroves (discussed under Potential Impact 5), coral reefs and seagrass beds occur in the shallow waters near to the islands. Impacts on water quality have been discussed under Potential Impact 2 and it is not considered likely that the discharge of drilling muds and cuttings will adversely affect the shallow waters because they are unlikely to reach this area under normal circumstances.

Due to the distance of drilling operations from the shallow water habitats, the temporary nature of exploratory drilling and the waste management plans that will be in place, **impacts on shallow water communities are considered to be insignificant.**

6.3.1.2.3 Deepwater Macrobenthic Communities

Potential Impact 8: Effects of pre-drilling assessment on deepwater benthic macrofauna

In order to investigate seabed hazards prior to drilling, a remotely operated vehicle (ROV) inspection will be conducted. The ROV will not impact the benthos as it will not contact the seabed. **It is considered that impacts associated with the pre-drilling survey will be insignificant.**

Potential Impact 9: Effects of drilling on deepwater benthic communities including mooring anchors and chains

During drilling operations, deep water macrobenthic communities are likely to be impacted if a moored drilling rig is used. Should a dynamically positioned rig be used, the impacts on deepwater benthic communities will be negligible as the only contact with the seafloor will be at the wellbore.

When using a moored rig, direct disturbance of habitat in the contact area and direct mortality of sessile seabed organisms would be expected at the anchor locations; however, the area impacted in this manner will be very small and is not anticipated to have a significant impact on the benthic communities of the area.

The pre-drilling ROV scan will also identify any sensitive environments or large congregations of animals such that these areas can be avoided.

Due to the absence of any identified receptors of significance in the deep water and the implementation of a pre-drilling ROV survey, it is considered that any impacts on deep water benthic communities due to mooring chains and anchors will be insignificant.

Potential Impact 10: Effects on deep water benthic macrofauna due to the discharge of drilling muds and cuttings

When drill cuttings are discharged to the sea, the larger fragments sink rapidly to the sea floor forming a cuttings pile, while the finer particles are carried farther afield by the residual currents. The cuttings pile can smother the benthos inhabiting the sea floor around the well-site, regardless of the type of drilling fluid used (WBM or NADF). The shape and depth of the cuttings pile is determined by the quantity and rate of discharge as well as the oceanographic parameters in the region, such as water depth, current speed and current direction. In addition to the smothering effects of the cuttings, NADFs adhering to the cuttings can contaminate the surrounding water and sediment. It is generally believed that the main agents of toxicity in drill cuttings are the oil and oil products characteristic of OBMs (Patin, 1999).

For this drilling operation, only WBM and SBM will be utilized. As SBMs are largely biodegradable organic compounds, deposition of SBM cuttings on the seabed is likely to increase the biological oxygen demand in the underlying sediment. This can lead to anoxic conditions as the organic components of the mud are oxidized. This consumption of available oxygen in the sediments can lead to changes in the benthic systems until the drilling fluid has been sufficiently degraded to allow the re-establishment of the natural biota (OGP, 2003).

For this deep water drilling program in water depths greater than 200 m, sensitive areas such as coral reefs and seagrass beds do not exist. Furthermore, studies in the Norwegian North Sea have shown that where only WBMs and SBMs have been used (as opposed to the more toxic OBMs), the discharges of the cuttings associated with these fluids have little or no effect on benthic fauna more than 250 m from the well (OGP, 2003).

It is also probable that within three to five years of cessation of SBM cuttings discharges, concentrations of synthetic fluids in sediments will have fallen to sufficiently low levels, and oxygen concentrations will have increased adequately throughout the previously affected area, that complete recovery will be possible (Neff *et al.*, 2000, cited in OGP, 2003).

It is certain that smothering of benthic fauna around the well-site will occur but this is likely to be limited in extent and recovery is likely to occur within a few years; however, the impacts will be dependent on the finalized mud constituents. **In view of the deep water location (and associated lack of seagrass beds and corals) it is considered that these impacts will be of moderate significance at this stage.**

6.3.1.2.4 Fauna (Marine Mammals, Turtles, Fish and Seabirds)

Potential Impact 11: Impacts due to the disposal of muds and cuttings on fauna through increased turbidity and contaminant load

The potential impacts on water quality have been discussed under Potential Impact 2. Any reduction in water quality could lead to secondary effects on marine fauna in terms of morbidity or mortality, or simply displacement from preferred feeding or nesting areas.

Due to the fact that the SBM cuttings discharged from the vessel will rapidly fall through the water column, it is not considered that a significant reduction in water column quality will occur.

Seabirds, only ever being in contact with the upper few meters of the water column, are highly unlikely to be affected by the discharge of drill cuttings.

A reduction in bottom water quality is likely to occur, at least in proximity to the deposited cuttings, but this is only likely to affect sedentary benthic organisms. Free swimming organisms will be able to evade any areas where water quality is unfavourable and thereby avoid any negative effects of toxicity. The area affected will be close to the drilling rig and it is unlikely that animals will be displaced from particular feeding grounds, or be unable to reach preferred nesting grounds.

Given the relatively small footprint of the drilling activities and the ability of marine mammals, turtles and fish to move away from areas they find unfavourable, it is considered that any impacts from contaminants or increased turbidity due to the disposal of drilling muds and cuttings will be of minor significance.

Potential Impact 12: Impacts on marine fauna due to deck drainage, bilge water disposal and sewage discharge

The effects of deck drainage, bilge water and sewage on marine water quality have been assessed under Potential Impact 3.

The small quantities of contaminants likely to be discharged with these waste streams will be rapidly diluted, dispersed and degraded in the water column and as such are unlikely to significantly affect marine fauna. Sewage will be treated prior to disposal, and discharge will not take place within 3nm of the coastline, thereby complying with MARPOL (73/78) regulations.

The marine environment off the coast of Mozambique provides habitat for a number of important/protected species including whales. **When considered with the small quantities of contaminants likely to be discharged, the diluting potential of the sea and the small footprint of drilling activities, impacts on marine fauna due to the discharge of deck wash, bilge water and sewage are considered to be of minor significance.**

Potential Impact 13: Impacts on marine fauna due to the discharge of solid food waste

The only solid food waste that will be discharged during routine project activities will be kitchen waste and this will be discharged in accordance with MARPOL (73/78) Annex V. **Impacts on marine fauna are therefore considered to be insignificant.**

It should be noted that waste management plans will be in place in order to help prevent the inappropriate disposal of all wastes.

Potential Impact 14: Impacts due to the introduction of invasive species in ballast water

Ballast water may contain a variety of biological materials, including plants, animals, viruses, and bacteria. These can include non-native species that can have significant ecological and economic impacts to aquatic ecosystems.

For example, the introduction of the European zebra mussel (*Dreissena polymorpha*) into the Great Lakes between Canada and the United States resulted in the need for pollution control and cleaning of fouled underwater structures and waterpipes, which cost billions of dollars (IMO, 2002).

It is assumed that no ballast water exchange will take place in Mozambican waters and that this will prevent negative impacts from occurring. Without confirmation from the drilling contractor that exchange will not take place, however, and in the absence of details pertaining to the volume and source of the ballast that will be onboard, it is not possible at this stage to quantify the potential impacts that could occur. **Impacts due to the introduction of invasive species are therefore considered to be insignificant to major.**

Potential Impact 15: Impacts of noise on marine mammals, turtles and fish

Various impacts can result from noise emissions during well drilling. These include behavioural changes and masking or interference of acoustic communication.

The noise spectrum may range between 0.016 and 0.2 kHz, with tonal reception levels between 167 and 171 dB re 1 µPa @ 1 m (Richardson *et al*, 1995; Evans & Nice, 1996). However, the SASOL EIA prepared for the Offshore Exploration Project in Blocks 16 & 19 (ERM, 2006), indicates 1.2 Hz - 5Hz and 119 – 127 dB re 1 µPa @ 1 m as the frequency and sound pressure, respectively, of noise from drilling (fixed platform). For comparison the noise produced by seismic airguns is usually around 260 dB re 1µPa @ 1m with wide-band frequency components mostly concentrated in the 20-250 Hz range.

Noise emitted underwater during drilling operations is highest for drill-ships and semi-submersibles, followed by bottom-founded rigs such as jack-ups and drill barges. Dynamically positioned vessels are noisier than anchored units due to additional noise from thrusters and propellers. Noise produced by drill ships is similar in range to some supply vessels and fishing trawlers.

The impact of the noise produced during the drilling of the exploration wells depends on the following factors:

- background environmental noise;

- the transmission conditions of the receiving environment; and
- the proximity of animals and their capacity to detect sound frequencies.

Marine animals are already naturally exposed to sounds produced by the wind, waves, rain, echolocation produced by cetaceans, and noise produced by tectonic activities. Sounds from anthropogenic origin (e.g. boats, airplanes) also occur along the Mozambican coast, including in the project area.

Most of the sounds produced during drilling are continuous and of low frequency. The effects of this noise on false whales, seals and dolphins may be considered negligible. Only the true whales (the humpback whale occurs in the project area) are susceptible to medium and low frequency and may react negatively (Davis *et al*, 1990). In this case, these cetaceans will react by moving away, avoiding proximity to the source of noise. In fact, these marine mammals have good detection capacity and mobility to avoid sound disturbance.

It should be noted that the noise from boat movements is more intense and significant than that produced by drilling activities and that marine mammals are more tolerant to noise generated by stationary objects (such as those produced during drilling) than mobile objects (Richardson et al. 1995).

Sea turtles are considered to be less sensitive to noise than marine mammals and the sound levels expected during the drilling program suggests that the impact on turtles as well as fish is not likely to be significant.

Noise duration will be temporary (with a maximum duration of 60 days per well). The noise will be produced directly by the drilling activities and by the support ship movements (engines/manoeuvres), but is unlikely to be of sufficient amplitude to cause significant impacts to marine fauna. **Impacts of noise on marine fauna are therefore deemed to be of minor significance.**

Potential Impact 16: Increased vulnerability of fauna attracted to the rig's lighting/flare

Intensive onboard lighting may encourage various marine species (fish and cephalopods) to gather, and also attract dolphins and sea turtles. Pelagic birds could be disorientated and fish and squid may be drawn to the lights or the flare, where other fish and seabirds may easily prey upon them.

It is likely that this impact will occur but the magnitude and spatial extent are considered very small and the duration very short. **The impacts related to the attraction of fauna due to the rig's lighting/flare are considered to be of minor significance.**

6.3.1.2.5 Protected Areas

Potential Impact 17: Impact of waste management (discharges) on protected areas

Due to the distance of the proposed drilling activities from the nearest protected areas (a minimum of 3.0 km) and the waste management plans that will be in place, significant impacts on protected areas due to the discharge of waste is unlikely to occur. The impacts of drilling muds and cuttings on water quality and coastal mangroves have been discussed in the relevant sections (Potential Impact 2 and Potential Impact 5, respectively) and it is not anticipated that protected areas will be adversely affected by this discharge. **Impacts of routine waste management on protected areas are therefore considered to be insignificant.**

6.3.1.3. HUMAN ENVIRONMENT AND ECONOMIC ACTIVITIES

6.3.1.3.1 Population and Local Economy

Potential Impact 18: Social conflicts due to the presence of foreign workers

All rigs are self-contained with a highly trained and specialized crew. The drilling rig for this program will accommodate two drilling shifts working on a 12-hour rotating basis, as well as daily operational and maintenance staff requirements. A helicopter will transfer the crew from Pemba Airport to the vessel and back and allow for weekly crew changes.

Part of the workforce will have to stay in Pemba during the weekly changes and there are therefore risks in terms of social cohesion and inclusion and in terms of health impacts of transferable disease. Communicable diseases pose a significant public health threat worldwide. Diseases of most concern during the project are sexually-transmitted diseases (STDs), such as HIV/AIDS.

Risks to social cohesion may arise from the introduction of a new population element into an established community. The extent depends on the level to which the community is established, socially homogenous and cohesive, and the staffing strategy for the project.

Due to the exploratory nature of the drilling activities, worker presence in Pemba will be temporary. Any adverse effects caused by cultural differences are therefore likely to be short-term. STDs are of concern even thought the project is temporary and the mobile nature of the workers means STDs could be carried to other locations when the workers return home. **The potential for social conflicts and an increase in STD prevalence is therefore considered to be of moderate significance.**

Potential Impact 19: Increased revenue due to the presence of the crew in Pemba

The presence of the workforce in Pemba, even if temporary, will lead to increased expenditure in the local hotels, restaurants and markets. Crew members and families may even visit local tourist attractions available in the region.

The presence of the workforce would therefore result in a small, temporary, economic boost and impacts are therefore considered to be positive.

6.3.1.3.2 Artisanal Fisheries

Potential Impact 20: Loss of access to fishing grounds due to exclusion zones

Some artisanal fishers from the study area travel as far as 6 nautical miles offshore (approximately 11 km) and hand-line fishers may fish in waters with a maximum depth of 400 m. However, it is by far the minority of fishers who go this far out or fish in waters this deep. Divers may also dive in waters up to 40 m deep, but cannot go farther than 4 nautical miles (7 km) from the coast due to rough sea conditions and the generally poor condition of their boats. Most of the divers interviewed as part of the FBS indicated that they are comfortable at depths not exceeding 30m.

As indicated in Section 5, most fishing activities take place around the islands and on banks and reefs in between the islands, not going beyond the 200m bathymetric line (Refer to Figure 71, in Section 5); however, the small number of artisanal fishers traveling to fishing grounds within the actual drilling operations area may be affected by the safety zone (500 m) which will be maintained around the drilling rig.

The income generated from fishing activities by artisanal fishers is limited, and they work on very small profit margins. The potential disruption to catch volumes may, therefore, lead to a temporary loss of income, not only for the owners of the boats or fishing gear, but also for their workers, who are paid in fish, and whose income is therefore directly related to the volume caught.

This effect will be temporary (no more than two months at a time for any particular well drilled), and, in all likelihood, will only affect a small number of fishers, i.e. those using fishing boats capable of going this far out to sea. As indicated above, most artisanal fishers are only active near to the islands and the small footprint of drilling activities means that those fishers venturing into deeper waters are likely to be able to utilize alternative fishing areas in the vicinity. **Impacts on artisanal fisheries as a result of the drilling rig exclusion zone are therefore considered to be of minor significance.**

Potential Impact 21: Temporary catch decrease due to fish displacement

Artisanal fishers catch reef fish and, in the cases where the boats venture into the deeper waters east of the reefs, pelagic fish, squid and demersal fish. Most artisanal fishers are poorly equipped to catch deep water fish and the condition of their boats does not allow them to venture too far offshore.

Impacts on fish due to waste management and the disposal of drilling muds and cuttings have been discussed under the relevant Potential Impacts above. The free-swimming ability of fish enables them to move away from areas that they find unfavourable, but due to the small zone that is likely to be affected by a reduction in water quality, it is not anticipated that fish will be displaced sufficiently so as to affect artisanal fishers.

The drilling rig will produce low-frequency noise. This noise spectrum may range between 0.5 and 1.2 kHz with pressure levels between 119 and 127dB re 1 µPa @ 1 m (ERM, 2006). Noise will also be produced by the supply vessels. The sources of noise will be from the vessel engines, and during vessel manoeuvring alongside the anchored ship.

Due to the likely distance between the drilling rig and the artisanal fishing grounds surrounding the islands and the relatively low amplitude of the anticipated noise levels, it is not anticipated that fish will be displaced sufficiently to render them unobtainable. **Impacts on artisanal fishing grounds as a result of fish displacement are therefore considered to be of minor significance.**

Potential Impact 22: Effects of noise on artisanal fishery divers

Ambient noise in the ocean originates from a variety of sources over bands of frequencies ranging up to 100 kHz. The major sources of ambient oceanic noise are related to wind and distant shipping. Other sources include rain, oceanic turbulence, sea life, tides, waves, volcanic eruptions, non-industrial seismic activity, and molecular agitation (heating and cooling). Deep ocean background noise attributable to shipping ranges from 82 to 87 dB ref 1µPa @1m (Continental Shelf Associates, Inc.: 1996).

The likely distances involved between the drilling rig and the artisanal diving grounds – most of the divers use canoes to reach their target areas, which do not exceed 6 miles (approximately 11km) from the coast, not going beyond the 200m bathymetric line (Refer to Figure 71) and depths of 30m (very few dive in depths of 40m) – suggests that a diver is unlikely to be disturbed by increased noise levels. **Impacts of the effects of noise on artisanal fishery divers are therefore considered to be insignificant.**

6.3.1.3.3 Commercial Fisheries

Potential Impact 23: Loss of access to fishing grounds due to exclusion zones

A 500m radius safety exclusion zone will be established around the drilling vessel and this will immediately exclude that area from the fishery. The effective exclusion zone however will be significantly bigger due to the nature of purse seining and the effect of currents. It takes up to two hours to set and haul the seine, from the initial encircling of the school from the mother vessel to the emptying and retrieval of the net. During this time the vessel and the net will drift, principally driven by surface currents and wind. The effective exclusion zone will therefore be the area of the static exclusion zone, plus the swept area due to tidal effects:

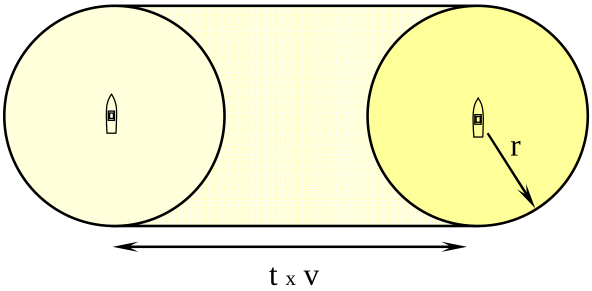


Figure 94 Effective exclusion zone

$$Total \quad Exclusion \quad Zone = \pi r^2 + 2rtv$$

Where

r = radius of the exclusion zone (km)

t = duration to complete a set (hrs)

v = drift velocity during set (km/hr)

Maximum currents in Area 1 are estimated at 1.7 to 2.5 kts (3.1 - 4.6 km/hr) (Nansen FAO, Cutler and Swallow 1984) which would imply a maximum exclusion zone of 10 km^2.

The total surface area of Area 1 beyond 200 m deep is estimated to be about 7 400 km^2 and VMS data suggests that the area corresponds well with the limits fished by seiners during the peak year of 2004. Assuming catches to be distributed evenly throughout Area 1, the exclusion zone would result in a reduction in fishing area of about 0.15%. During normal years, the average recorded catches in Area 1 are less than 105 tonnes per year, which is less than 2 % of total fish catch in Mozambique. Occasionally some years will have abnormally high catches; in 2004, 2 540 tonnes of fish were caught. This equates to approximately 18 % of total fish catch in Mozambique.

Due to the fact that Area 1 is a relatively unproductive region for commercial fisheries and the relatively small footprint of the exclusion zone, impacts on the commercial fishing industry due to exclusion zones is considered to be of minor significance.

Potential Impact 24: Temporary catch decrease due to fish displacement

As Section 5.6.7 above indicates, the impacts of exploratory drilling on commercial fisheries in Area 1 are considered to be confined exclusively to the purse seine fishery. The other commercial fishery that could operate in the area, namely the longline fishery for large pelagics, does not have significant activities in Area 1.

Impacts of waste management and the disposal of drilling muds and cuttings have already been discussed. It is not anticipated that a temporary and localized reduction in water quality will cause fish to move away from the area sufficiently to affect the commercial fishing industry.

Project-generated noise could also result in the displacement of fish. Principle underwater noise sources associated with the drilling vessel will be from:

- The drill itself;
- Dynamic positioning thrusters (if vessel is not anchored);
- Pumps; and
- Support vessels.

Peak expected frequencies for the various sound sources are given in Table 67 below.

Table 67 Noise sources and frequencies

Source	Peak Frequency	Reference
Drill	≈5Hz	Gales 1982 (cited in Richardson *et al* 1995)
DP thrusters	4-5Hz, 18Hz	Hoskins / Wood 1996
Pumps	29Hz	Hoskins / Wood 1996
Support vessel	600-650Hz	Simmonds/Dolman 2004, Vella / Rushforth 2004

No quantifiable losses are expected due to displacement of fish stocks. If tuna is dispersed from the drill site by localised noise, they will still be available to be fished elsewhere. The impact could even be beneficial if stock is driven outside of the exclusion zone and therefore kept accessible to the fishing fleet.

Due to the temporary nature of the drilling program, the relatively low levels of associated noise and the low intensity of commercial fishing in Area 1, potential impacts on the commercial fishing industry due to the displacement of fish stocks are considered to be of minor significance.

Potential Impact 25: Damage to trawl nets caused by surface structures remaining after well suspension/abandonment

AMA1 will permanently abandon the well if commercial volumes of hydrocarbons are not found. The well will be temporarily abandoned if the potential of commercially viable hydrocarbons exists. This means the well can be re-entered and used during future production operations. In either case, the well head and casing will be left on the seafloor, rising no more than 4 meters above the mud line.

A detailed program of abandonment and decommissioning shall be developed in line with the applicable Mozambique Petroleum Regulations/Environmental Guidelines and issued based on results from drilling and evaluation. In all cases, the well will be isolated hydraulically with a minimum of two pressure barriers.

Abandoned wells could have a negative impact on fishing activities, especially bottom-trawling involving the deepwater shrimp fisheries, where nets could be entangled by the surface features of the suspended/abandoned well (refer to Figure 17 above, in Section 3.8). Damage could range from the loss of gear to the sinking of the vessel.

The significance of this impact will depend on the well location and sediment type and the worst case will be if a suspended/abandoned well is located in the middle of a large sandy area potentially good for deep shrimp trawling. There is a significant risk of damage to both the well-head and the trawler should a net become snared on a suspended/abandoned well.

Deep shrimp trawling is undertaken at depths ranging from 200 – 800 m, but is mainly concentrated in the south of the Mozambican EEZ, away from the study area. **The potential damage of trawl nets caused by surface structures remaining after well suspension/abandonment is therefore considered to be of minor significance.**

6.3.1.3.4 Tourism

Potential Impact 26: Reduction in revenue due to a perceived decline in tourist potential

Although the tourism industry in the Quirimbas Archipelago is in its infancy, it is growing rapidly, and is already a sought-after international destination in the high-end tourism market. Tourists visiting the resorts in the study area are predominantly from the UK and Europe, and lodges in the Quirimbas capitalise on the theme of unspoilt wilderness, and luxury holidays in a tropical island paradise. Diving, recreational fishing, and whale watching are integral parts of their branding. Branding becomes very important when targeting a high-end market with consumers who like to think that they are visiting a unique area for a unique experience. If the “unique experience” image is not sustained, tourists could easily go elsewhere. The potential effect of the proposed drilling operation on the image of the Quirimbas is strongly dependent on how activities associated with the drilling are managed.

Potential effects on the image of the Quirimbas are therefore more likely to be related to the possible negative perceptions of potential visitors regarding the presence of drill rigs in the area, than actual direct effects by the operation itself. This is one effect which may have a longer term impact on the socio-economic environment.

Due to the fact that personal perception is entirely subjective, it is impossible to quantify impacts associated with a declining image. This impact assessment is only concerned with exploratory drilling, and potential effects on image are more likely to occur during production phases, where a rig could become a permanent feature for many years. Also, tourism trends in general are influenced by a variety of variables and international factors, such as security issues or weather conditions (recent cyclones).

The following assessment describes the potential impacts that the project could have on existing or future tourist activities.

Air traffic will increase in the area as a result of logistical helicopter support to the drilling operation (Refer to Section 3.6). These will be infrequent and only 2 or 3 flights per week are expected. The visual impact combined with noise generated by helicopters associated with the drilling activities could disturb tourists, but it will be a temporary impact and it is unlikely to cause significant disturbance unless flight paths are directly above the hotels and flights are made at regular intervals.

Light aeroplanes fly up and down the Quirimbas at least twice per day and other charter flights go up to Mocimboa. Thus, if the helicopter flights only take place once or twice a week, they are not likely to add significantly to traffic in the area.

The fact that the drilling rig could be visible from the coastline could also negatively affect tourism in the region. In order to determine the visibility of the different types of drill rigs, a few simple calculations are required. When standing at sea level, the visible horizon for a person of 1.82 m (6 feet) tall is approximately 2.86 nautical miles (approximately 5.3 km)[78] (http://boatsafe.com/tools/horizon.htm).

Table 68 provides the maximum distances that the respective drill rigs would be visible to a person 1.82 m tall standing at sea level[79]. These distances are calculated by extending the same formula to include an object on the horizon, and are based on the heights of the drill rigs provided in Section 2. Derricks are fairly narrow structures, usually comprising a lattice framework that is perched above the derrick floor. Thus, although the height to the tops of the derricks is considerably higher than that of the derrick floors, daytime visibility of the top of the derrick would be limited. However, the top of the derrick would be equipped with safety lights at night, and could then be visible over considerably longer distances.

[78] The distance to the horizon in nautical miles = 1.17 times the square root of your height of eye.

[79] These distances indicate where part of the rig would be visible, as the lower parts disappear below the horizon much sooner.

Table 68 Visible distances of drill vessels

Rig type	**Height from water surface to derrick floor (m)**	**Visible distance (nautical miles & km)**	**Height of water surface to top of Derrick (m)**	**Visible distance (nautical miles & km)**
Jack-up	40	13.39 & 24.7	90	20.08 & 37.18
Drill ship	24	10.37 & 19.25	76	18.45 & 34.16

As indicated previously, the distances from the eastern shores of selected islands to the western boundary of the proposed drilling area vary between 3.8 km (Vamizi) and 11.9 km (Quifula). The drill rig would, therefore, be visible from all the islands when located within 10 km from the western boundary of the area.

With regards to flaring, according to AMA1, in addition to well-testing, gas desorbed from cuttings while drilling would be routed through the rig's flare stack. Typically, these volumes are not generally measurable by conventional means, as they are very small amounts. However, in the event of a so-called 'kick'[80], some volume of gas would need to be flared, although this would be a discrete event. Such a flare would increase the visible distance of the rig considerably, especially at night.

Owing to the temporary nature of the exploratory drilling activities, it is not considered likely that drill rig visibility would adversely affect tourism in anything more than the short term

Recreational offshore sport-fishing activities take place largely amongst the islands or a short distance east of them. However, L&A Operators indicated that they do conduct fishing excursions as far as 12 nautical miles (approximately 22km) to the east. Since the drilling rig would be stationary, with a limited exclusion/safety zone around it, recreational vessels would be able to circumnavigate the rig to gain access to fishing grounds. Also, offshore sport-fishing activities conducted by individual L&A Operators are not restricted to specific fishing areas. Fishing areas are spread out across the study area, and are usually some distance apart. It is also important to note that there are less than 20 recreational fishing boats used by L&A Operators in the study area, which makes the probability of a recreational fishing vessel coming into proximity with a drill rig very low.

Whale watching is carried out in areas close to the islands, the sites depending on whale location. However, tourist do not go more than a few nautical miles from the coast or island and this activity is not likely to take place in the drilling area.

As indicated in Section 5.6.5, there is substantial additional new investment planned in the Quirimbas Archipelago, with a number of existing tourism operators also planning

[80] Where drilling mud hydrostatic is below formation pressure, resulting in gas/fluids entering well bore.

extensions to their current facilities. It would, therefore appear that the seismic acquisition activities conducted by AMA1 and other industry over the past three years have not had any significant effect on current or future development plans.

Due to the temporary nature of the proposed exploratory drilling program and the fact that drilling operations are unlikely to affect recreational activities, any impacts on tourism are likely to be caused due to the visual impact of the rig. The significance of the impact will differ depending on the subjective opinion of the viewer but impacts will be short-term, lasting only for the period that the rig is in the area. It is also not anticipated that the presence of the drilling rig will result in negative impacts of sufficient significance to affect the future potential of Mozambique as a tourist destination. **The potential impact of a reduction in revenue due to a perceived decline in tourist potential is therefore considered to be of minor significance.**

Potential Impact 27: Effects of noise on recreational divers

One of the greatest attractions of the Quirimbas Archipelago as a tourism destination is its isolation and remoteness. Divers visiting the archipelago do so to experience a high level of undisturbed wilderness, which is not possible in other, more populated tourist areas. As the numbers of divers per day outlined earlier shows, there are a fairly small number of divers in the water on any given day. Considering this dive quality, and the reputation of the Quirimbas Archipelago as a wilderness diving destination, industrial noise, audible above ambient ocean noise levels, could potentially be highly intrusive and would be negatively received by divers.

Ambient reef noise levels measured at sites off Hawaii had a broadband, peak frequency of 1.9 kHz, and had a mean SPL of 107 dB ref 1µPa (Boyle and Tricas: 2006). Off Lizard Island in the Great Barrier Reef, levels of broadcast reef sound (broadband 80–4000Hz) were predicted to be 107–109 dB re 1µPa (Leis and Lockett: 2005). Based on this, it can be assumed that the general level of background noise on a reef or in shallow water habitats similar to those of the Quirimbas Archipelago would be in the 107 to 109 dB re 1µPa range.

According to the information provided by dive operators, no diving takes place in water deeper than 50m, and since drilling will only be conducted in water deeper than 200m, access to dive sites will not be affected due to the enforcement of the exclusion/safety zone around the rig. Due to the distances from the islands to the western boundary of the study area, it is not anticipated that a recreational diver will be able to distinguish the drilling noise above ambient noise levels.

Recreational diving should be able to continue uninterrupted throughout the drilling period and it is therefore unlikely that tourism operators would lose revenue due to a loss of bookings. **The potential impacts on recreational divers due to noise from drilling operations are therefore considered to be insignificant.**

Potential Impact 28: Impacts of waste disposal

Tourists on the Mozambican coast could be negatively affected by waste disposal in terms of the visual impact of released waste or reduced water quality. The impacts of routine waste disposal on various environmental components have been discussed under other potential impacts. **Given the distance from shore of the drilling activities, and provided waste management is undertaken as proposed, impacts on tourism as a result of waste disposal are considered to be insignificant**.

6.3.1.3.5 Navigation

Potential Impact 29: Interference with maritime traffic

The rig will be mobilized to site either under tow by a vessel or under its own propulsion in open navigable seaways. The movement of the drilling rig to the drilling site may cause interference with maritime traffic, especially the national and regional cabotage shipping, as well as from private yachts that call at the Port of Pemba and Quirimbas archipelago. The present navigation routes along the Mozambique Channel pass through the project area at distances that range from 15 to 35 nautical miles (27-63km) off the coast of Mozambique. It should be noted that international traffic passes outside the AMA1 Concession Area.

The drilling rig will remain stationary at specific coordinates for up to 60 days during each well operation, with a safety exclusion area of 500 m regardless of the type of rig.

Because traffic is not intense, there are no formally established routes for maritime traffic that would be traversed and because the rig will be stationary at each drilling location during operations, it is not anticipated that it will have adverse effects of other maritime traffic in the region.

Impacts on other maritime traffic in the region due to the presence of the rig are therefore considered to be insignificant.

6.3.2. IMPACT ASSESSMENT FOR NON-ROUTINE EVENTS

The potential non-routine events associated with offshore drilling operations are:

- Leaks and Spills;
- Blowouts;
- Fires and explosions; and
- Collisions with other vessels.

Of these potential incidents, blowouts releasing large volumes of crude oil are likely to create the most significant impacts. Such an event, while extremely unlikely to occur, could result in extensive negative impacts should the released hydrocarbons enter nearshore waters and coastline habitats. Other potential spills during a drilling operation include diesel fuel releases from the rig or support vessels. Large diesel spill events are also highly unlikely, and spills in most cases would involve much lower volumes than a blowout. The potential impacts of these incidents will be discussed below.

For the majority of the environmental components, the impacts of fires and explosions or vessel collisions are those associated with the spillage of hydrocarbons and impacts are therefore similar to leaks and spills or blowouts.

An introduction to the four non-routine events is provided below, following which the potential impacts on the environmental components are discussed.

Leaks and Spills

A large spill, such as one resulting from a catastrophic diesel tank rupture, would be an extremely rare event. The probability of such an event has not been determined and historical data for the U.S. Gulf of Mexico include no such incidents between 1981 and 1999 (Anderson and LaBelle, 2000). A more likely scenario would be a small diesel-fuel spill during bunkering to the drilling rig from a supply vessel. Anderson and LaBelle (2000), in their compilation and assessment of U.S. and worldwide spill statistics, identified 19 506 spills categorized as between 0 and 1.0 bbl on the U.S. Outer Continental Shelf (OCS) during the period from 1985 to 1999 for all exploration and development operations, with a spill rate of 3,357 and an average spill size of 0.07 bbl. Spill rate was based on the number of spills per billion barrels of oil (Bbbl) handled, applicable primarily to oil production but also relevant to exploratory activities. Similar analyses for slightly larger spills, ranging between 1.1 and 9.9 bbl, identified 434 spills during the same period, a spill rate of 74.7, an average spill size of 3.2 bbl, and a median spill size of 2.8 bbl. Historical spill data for these small-volume spills, which would include the diesel spill scenario considered in this analysis, indicate that a spill of 1 to 2 bbl is likely. Measures will be implemented to prevent spills during fuel transfer. However, for impact analysis and contingency planning, it is assumed that a 1- to 2-bbl diesel spill could occur.

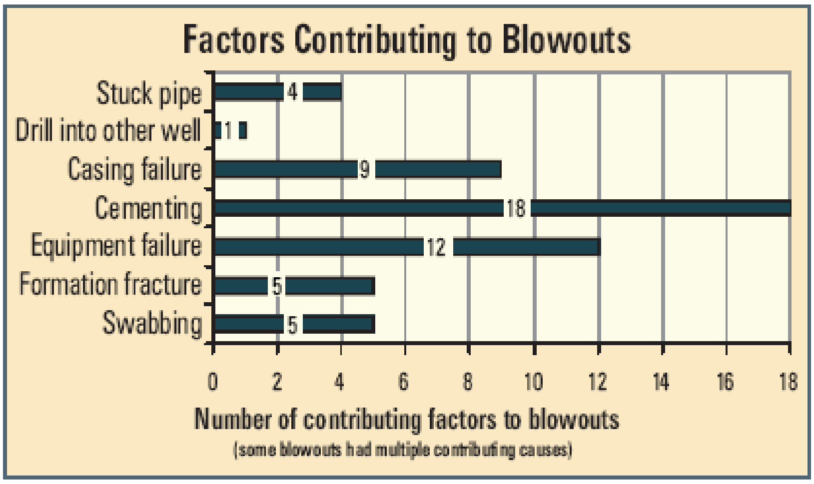
Blowouts

Offshore oil and gas exploration and development has the potential for minor to severe releases of oil, natural gas, condensate, and formation water (e.g., from a blowout). A blowout is an uncontrolled flow of reservoir fluids into the wellbore and, very occasionally, to the surface. A blowout may consist of saltwater, oil, gas, condensate, or a mixture of these, depending upon the reservoir being drilled. During drilling, all wells are equipped with a blowout preventer (BOP), a special assembly of high-pressure valves fitted to the top of a well to prevent high pressure oil or gas from escaping.

Blowouts are rare events and most do not result in spills. Statistics from offshore drilling in the U.S. Gulf of Mexico provide a reasonable basis for evaluating spill risk. According to Holand (1997), the average blowout frequency for exploration drilling in the U.S. Gulf of Mexico is 0.00593 blowouts per well drilled, or one blowout per 169 exploration wells drilled. Similarly, the US Minerals Management Service (MMS) Safety and Environmental Management Program (SEMP) blowout incident rate for 1996 to 1999 was approximately five blowouts per 1 000 well starts (1 in 200) (MMS, 2001).

Historically, most blowouts have not resulted in oil spills; of 151 well blowouts in the Gulf of Mexico from 1971 to 1995, only 18 (12%) resulted in oil spills. The total volume released from all of these spills was 1 000 bbl of crude oil and condensate (MMS, 2001). Between 1964 and 1999, almost all offshore spills (94%) from drilling- and production-related operations on the U.S. OCS were less than or equal to 1 bbl in size (Anderson and LaBelle, 2000). Taken together, the historical data indicate that a blowout occurring and resulting in an oil spill of any size is very unlikely (less than 0.1 %). The probability of a blowout resulting in a large oil spill is even lower.

According to the MMS (2007), the main factors contributing to blowouts are leaks behind casing flows after cementing; equipment failure; casing failure; formation fracture; swabbing; and stuck pipes (Figure 95 below).



Source: MMS (2007)

Figure 95 Factors contributing to blowouts

Despite the fact that blowouts resulting in spills are rare events, should they occur, they are likely to result in water pollution due to the spillage of muds, chemicals and hydrocarbons. Potential impacts can range from minor to major, depending on the magnitude of the blowout and the location of the rig. From 1992 – 2006 in the Gulf of Mexico, environmental impacts due to blowouts were negligible (MMS, 2007).

Fires/explosions

A well blowout, particularly where it involves gas, could ignite causing a large fire or explosion. The impacts on the environment of a fire or explosion are largely concerned with the associated oil or fuel spillage, but will also have an effect on localized air quality.

Vessel Collisions

Vessel collisions may occur between the rig and the support vessels, between the support vessels and other third party vessels and/or between the rig and other third party vessels.

The most common causes of such accidents are related to unsafe work practices, including vessels not being seaworthy; use of improper and/or poorly maintained equipment; inadequate crew training in maritime safety procedures and equipment operations; and violation of rules.

Collision with other vessels is a highly unlikely event but could result in spills of diesel fuel and/or other products, including hazardous substances that the vessels may be transporting.

Effects on Environmental Components

The effects of non-routine events are largely concerned with the spillage/release of hydrocarbons. This can be associated with a diesel spill during transfer or vessel collision or the release of crude oil during a blowout. Fires or explosions are also likely to result in the release of hydrocarbons and can also have an effect on localized air quality. The effects of these events on the environmental components (with the exception of air quality, which includes fires/explosions) are therefore focused on hydrocarbon releases.

In order to assess the potential impacts on the environmental components, it is important to understand the fate of oil spills in the marine environment, which involves a series of complex processes whose progression, duration, and impact depend upon several key parameters, including:

- oil composition;
- release characteristics (e.g., release rate, surface or subsurface location); and
- ambient oceanographic conditions.

In general, an oil spill is influenced by mechanisms of physical transport (i.e., spreading, drifting, dissolution, emulsification, photooxidation, adsorption, and subsequent sedimentation) and biological activity (i.e., microbial biodegradation) (Figure 96).

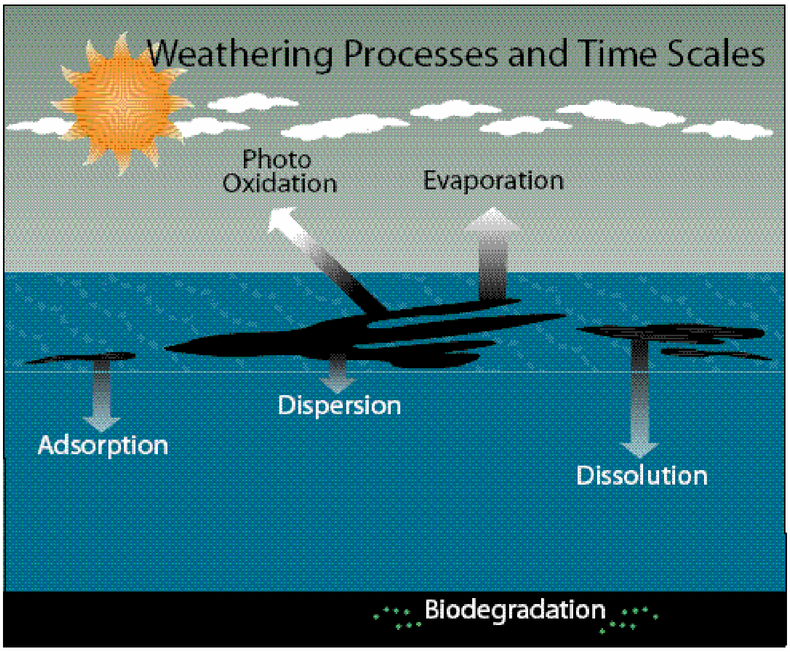


Figure 96 Weathering processes affecting oil spilled into the marine environment (From: National Oceanic and Atmospheric Administration, 2006).

Spreading characteristics are affected by uniform and non-uniform currents, winds, and waves. As oil is released over time, these mechanisms physically break up the slick; droplets are formed, then disperse, and resurface. Historically, the thickness of an oil spill "slick" has been estimated by dividing volume/area (Mackay and Chau, 1986; Lunel and Lewis, 1993a,b; Lewis et al., 1995a,b; Walker et al., 1995; Brandvik et al., 1996; Brown et al., 2000). Spill measurements indicate that oil does not spread uniformly, but is irregular in shape and thickness – generally elongated in the direction of the wind, often composed of thick "patches" (>1 mm) and thinner "sheens" (<0.01 mm). Ross (1997) gives a general rule of thumb: 90% of spill volume is contained in 10% of its area (National Research Council [NRC], 2005).

Under a blowout scenario, oil is released at depth, forming a plume that discharges into the marine environment near the seafloor. Once the plume surfaces from a subsea blowout, oil and entrained water will spread radially in a surface layer (Fannelop and Sjoen, 1980). The resulting oil slick will be significantly thinner than those produced by oil spilled directly on the surface. Natural gas may also be associated with oil. If gas is present in the formation, gas bubbles released during a blowout will affect plume buoyancy. In deeper water, ambient currents and water column density stratification will cause the gas bubbles and larger oil droplets to separate from the remainder of the plume and ascend as individual (or small groups of) droplets and bubbles (Socolofsky and Adams, 2002) Because droplet rise-velocity depends on diameter, the larger oil droplets will reach the surface sooner and closer to their source than smaller droplets (i.e., fractionation [NRC, 2005]), which would lead to a substantially longer and thinner plume than would be produced by a surface oil spill.

Under the diesel fuel spill scenario, fuel would be released at the sea surface. Unlike the blowout scenario where released crude oil forms a subsurface buoyant plume, diesel fuel released onto the ocean surface forms no subsurface plume. Diesel oil is much lighter than water (i.e., specific gravity ~0.85, compared to 1.03 for seawater) and therefore cannot sink. However, it is possible for diesel fuel to be physically mixed into the water column by wave action, forming small droplets that are carried and kept in suspension by currents. An accidental release of diesel fuel will rapidly spread and thin. Refined products such as diesel fuel contain higher proportions of lighter fractions (e.g., C2-C10 compounds) than crude oil and are more susceptible to spreading and mixing.

While spreading and drift are important physical processes, other mechanisms affect the fate of spilled oil or petroleum products, including evaporation, dissolution, photooxidation, biodegradation, water-in-oil emulsification (mousse formation), dispersion of whole oil droplets into the water column (entrainment), interaction of dissolved and dispersed components with suspended particulate material (SPM), uptake by organisms, and stranding on shorelines (NRC, 1985, 1989, 2003).

Evaporation is the single most important and rapid of all weathering processes (McAuliffe, 1989). The NRC (2005) notes that weathering losses can account for the loss of 20% to 50% of many crude oils, 75 % or more of refined petroleum products, and 10% or less of residual fuel oils (Butler, 1975; Butler et al., 1976; NRC, 1985, 2003). The NOAA (2006) indicates that more than 90 % of the diesel in a small spill incident into the marine environment is either evaporated or naturally dispersed into the water column within hours to several days. Photochemical generation of additional polar products (e.g., resins, carboxylic acids, ketones, aldehydes, alcohols, and phenols) with low hydrophilic-lipophilic balance (HLB) values that remain in the oil phase also can lead to the formation and stabilization of water-in-oil emulsions with greater water content.

The potential impacts of hydrocarbon spills on the various environmental components are discussed in the following sections. There are many different types of oil; therefore each oil spill is different depending on the type of oil accidentally released into the environment. Each oil spill will have a different impact on sensitive resources and the surrounding environment depending on the following:

- Type of oil spilled – physical and chemical characteristics of oil, susceptibility to evaporation, mousse formation, dispersion, etc., and degree of oil weathering that occurs prior to contact;
- Spill location – distance from sensitive resources;
- Species present – temporal (e.g., seasonal presence, migrants), spatial (i.e., distribution, tendency to occur in schools, herds, etc.), and behavioral characteristics (e.g., species-specific response to oil); and

- Timing of breeding cycles and seasonal migrations.

In general, direct oil effects typically include smothering, toxicity from ingestion and/or inhalation, increased levels of hydrocarbons in water and air, and areal exclusion. Indirect impacts include adverse effects on prey organisms and/or destruction of habitat.

6.3.2.1. PHYSICAL ENVIRONMENT

6.3.2.1.1 Air Quality

Potential Impact 1: Reduced air quality due to hydrocarbon release or fire/explosion

Air quality could be reduced due to the evaporation of spilled hydrocarbons or, more severely, from fires or explosions.

An oil spill would affect air quality in the vicinity of the oil slick by introducing volatile organic compounds (VOCs) through evaporation. Emissions would not last long due to rapid volatilization of hydrocarbons. Evaporation is also greatest within the first 24 hours. The more toxic, light aromatic, and aliphatic hydrocarbons are lost rapidly by evaporation and dissolution (NRC, 1985; Payne et al., 1987). Evaporated hydrocarbons are degraded rapidly by sunlight. Biodegradation of oil on the water surface and in the water column by marine bacteria and fungi initially removes the n-alkanes and subsequently the light aromatics. Other components are biodegraded more slowly. Photooxidation attacks mainly the medium and high molecular weight polycyclic aromatic hydrocarbons of a spill. The extent and persistence of impacts would depend on meteorological and oceanographic conditions at the time. Little or no impact on air quality in coastal areas would be expected.

A diesel spill would also affect air quality through the evaporation of volatile compounds, but only within the immediate vicinity of the spill. Dissolution, dispersion, biodegradation, and photooxidation would also act on select components of the diesel. Given the relatively small volume of diesel released under this accident scenario, coupled with rapid dissolution, dispersion, evaporation, and, to a lesser extent, photooxidation, only very localized air quality impacts would be realized. No impact to coastal areas would be expected.

A blowout resulting in the uncontrolled escape of gas during the drilling activity has the potential to cause more significant, short-term, localized air pollution. It is likely that gas blowouts will result in a fire\ explosion, releasing combustion products such as CO_2, volatile organic compounds (VOCs), polyaromatic hydrocarbons (PAHs) and particulate matter.

In the unlikely event of a fire\explosion or hydrocarbon release, it is probable that the air quality in the immediate vicinity of the incident will be reduced but this will be short term. **Due to the lack of receptors in the deep water drilling location that are likely to experience this reduction in quality, potential impacts from non-routine events are considered to be of minor significance.**

6.3.2.1.2 Water Quality

Potential Impact 2: Reduced water quality due to a hydrocarbon release

An oil spill of either crude oil or diesel fuel would affect marine water quality by increasing hydrocarbon concentrations due to dissolved components and small oil droplets. Natural weathering processes are expected to rapidly remove the diesel fuel from the water column and dilute the constituents to background levels. Similarly, the lighter fractions of crude oil will weather, while more complex compounds will persist. The highly evaporative and dispersive *components* of a medium crude oil are expected to result in its ready dispersal into the water column.

Although drilling will be conducted in deepwater, the potential for released hydrocarbons to drift into shallow waters means that water quality could be significantly reduced. Given the greater sensitivity of the shallow waters, it is considered that a reduction in water quality due to non-routine events will be of major significance.

6.3.2.2. BIOLOGICAL ENVIRONMENT

6.3.2.2.1 Flora

Potential Impact 3: Effects on coastal mangroves due to a hydrocarbon release

The mangroves of Rovuma Estuary are the largest and best developed along the northern sector of the coast and occur as a continuous stand across the border into Tanzania. Approximately 7600 ha of mangroves occur in the Rovuma estuary on the Mozambican side of the border.

Patches of mangrove occur on Tecomaji, Rongui and Vamizi Islands with the largest stand on Rongui Island. These islands are located 5.7 km, 5.0 km and 3.8 km, respectively, from the western limit of the drilling area.

Mangroves provide habitat for a variety of bird species, fishes, and invertebrates. Fourteen bird species use the mangroves as a feeding and breeding habitat, including the black egret (*Egretta ardesaica*), the little egret (*E. garzetta*), the western reef heron (*E. gularis*), the goliath (*Ardea goliath*), black-headed herons (*A. melanocephala*), the white (*Ciconia ciconia*) and black storks (*C. nigra*), the sacred ibis (*Threskiornis aethiopicus*), the mangrove (*Halcion senegaloides*) and brown hooded kingfishers (*H. albiventris*), the African fish eagle (*Haliaeetus vocifer*), the African hawk eagle (*Hiearaoetus faciatus*), and the lesser (*Phoenicopterus minor*) and greater (*P. ruber*) flamingos (IMPACTO and Mark Wood Consultants,[2006]).

Crustaceans found in mangroves include fiddler crabs (*Uca sp.*) and the mud crab (*Scylla serrata*). Mangroves are also recognized as prime nursery microhabitats for two major crustacean species of commercial importance in Mozambique – *Penaeus indicus* and *Metapenaeus monoceros* (Rönnbäck et al., 2002). Mollusc species found within mangrove forests include mud creepers (*Terebralia palustris*), pencil bait (*Solen capensis*), mud snails (*Cerithidea decollate*), burrowing crabs (*Cardisoma carnifex*), sand-bubbler crab (*Dotilla fenestrate*), and giant knobbed ceriths (*Cerithium nodolosum*). Barnacles (*Balanus amphitrite*) and rock oysters (*Saccostrea cucullata*) grow on the trunks of mangrove trees (Taylor et al., 2003; IMPACTO and Mark Wood Consultants, 2006).

Mangroves are particularly sensitive to oil and are primary areas for protection (International Petroleum Industry Environmental Conservation Association [IPIECA], 1993). Oil spills have been reported to kill mangroves in Nigeria, Indonesia, Panama, Kenya, Puerto Rico and other areas (Thorhaug, 1992). Experimental studies and field observations show that the impact of oil spills on mangroves can be divided into two phases:

1. Short-term mortality phase, attributed to coating with fresh oil and probably to the aromatic hydrocarbon content; and
2. Longer-term effects of weathered oil becoming incorporated into the sediment, inhibiting the growth of seedlings and larger plants (Volkman et al., 1994).

While experts agree that oil causes physical suffocation and toxicological/physiological impacts, researchers disagree as to the relative contributions of each mechanism, which may vary with type of oil and time since the spill (Proffitt, 1997; Hoff, 2002). Snedaker et al. (1997) have suggested that several mangrove species can tolerate or accommodate exposure to moderate amounts of oil on breathing roots.

Hoff (2002), in an analysis of mangrove oiling effects and remediation, addressed both acute and chronic impacts, and summarized a broad range of effects ranging from stress to mortality (Table 69). Oil-impacted mangroves may suffer yellowed leaves, defoliation, and tree death. More subtle responses include branching of pneumatophores, germination failure, decreased canopy cover, increased rate of mutation, and increased sensitivity to other stresses.

Table 69 Acute and chronic responses of mangrove forests to oil spills (From: Lewis, 1983 and Hoff, 2002).

Stage	Observed Impact
Acute	
0-15 days	Death of birds, fishes, invertebrates
15-30 days	Defoliation and death of small (<1 m) mangroves Loss of aerial root community
Chronic	
30 days – 1 year	Defoliation and death of medium (<3 m) mangroves Tissue damage to aerial roots
1 year – 5 years	Death of larger (>3 m) mangroves Loss of aerial roots Regrowth of roots; occasionally deformed Recolonization of oiled areas by new seedlings
1 year – 10 years?	Reduction in litterfall Reduced reproduction Reduced seedling survival Death or reduced growth of recolonizing trees Increased insect damage
10 – 50 years	Complete recovery

Oil slicks enter mangrove forests when the tide is high and the oil can be deposited on the aerial roots and sediment surface as the tide recedes. This commonly leads to a patchy distribution of the oil and its effects such as patches of dead trees, etc. It appears, however, that mangroves are not killed by oil spills which do not sink into the root systems, but only oil the bark of trees at high tide (Thorhaug, 1992).

Mangroves oiled following the Bahia las Minas (Panama) spill in 1986 created a band of dead and dying trees in those areas where oil washed ashore five months earlier. Dead mangroves were observed up to year and a half after the spill (Jackson et al., 1989). Four years after the 1992 Era spill in Australia, a lack of recovery was evident; adverse effects had peaked; however, there were no strong signs of recovery (Wardrop et al., 1996)

The organisms among and on the mangrove trees can affected in two ways. Firstly, there may be heavy mortalities as a direct result of the oil. For example, oil may penetrate burrows in the sediments killing crabs and worms, or coat molluscs on the sediment surface and aerial roots. Secondly, dead trees lead to loss of habitat (IPIECA, 1993). The physical effects of oiling (e.g., covering or blocking of specialized tissues for respiration or salt management) can be as damaging to mangroves as the inherent toxicity of the oil (Hoff, 2002). Research is inconclusive – some studies indicate that mangroves can tolerate some coating without apparent damage, while others identify physical effects of oiling as the most serious mechanism.

Volkman et al. (1994) in a scientific review of the impacts of oil spills, give recovery times of low energy intertidal communities, such as mangroves, as being about 10 to 15 years after the spill. Five years after the Bahia las Minas (Panama) spill, oil remaining in mangrove sediments continued to adversely affect root survival, canopy condition, and growth rates of mangrove seedlings in oil-deforested gaps. Six years after the spill, surviving forests fringing deforested areas showed continued deterioration of canopy leaf biomass (Burns et al., 1993). Persistence of oil residues from 5 to over 20 years is reported.

In the absence of exact locations of drill sites, three hypothetical points (Figure 97) have been used and modelled for different times of the year, as well as different weather conditions. The modelling used a volume of 100 barrels per day (bbls/day) for illustrative purposes. Based on the modelling, and depending on the time of year and weather conditions, an oil spill at any of the three modelled points could reach the shore, whether island or mainland, at times varying between six hours and one and a half days.

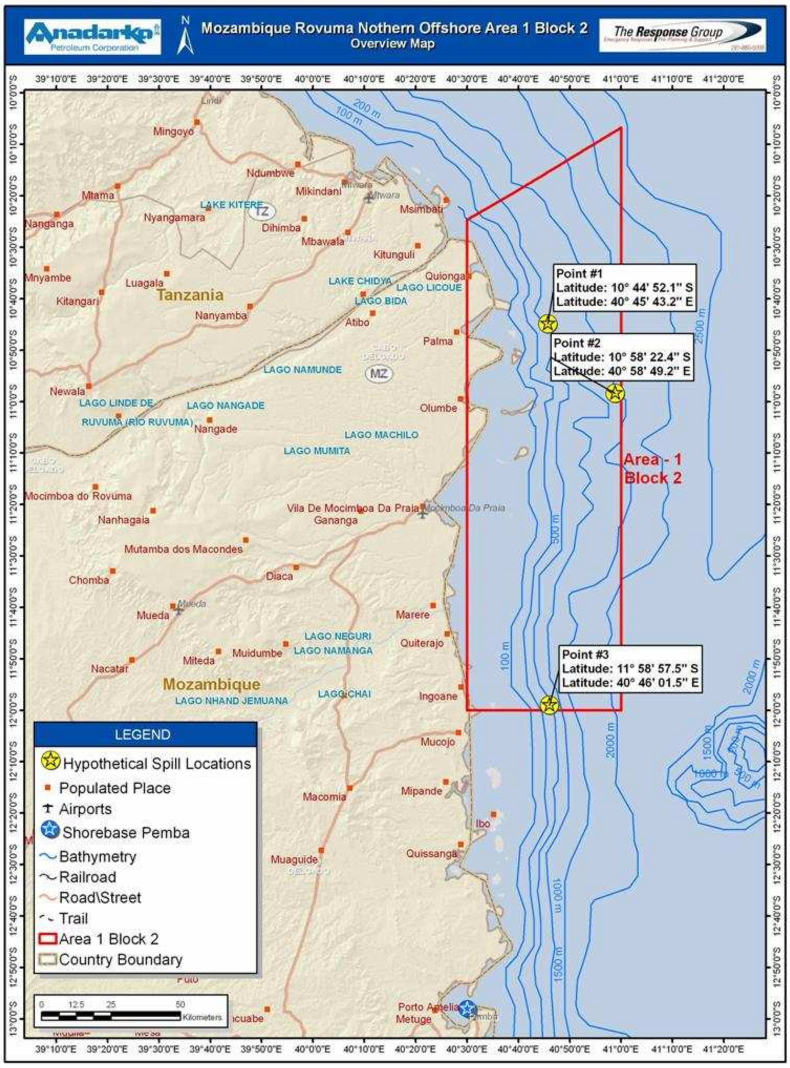


Figure 97 Points from where oils spill trajectory modeling was done

These trajectories indicate that the mangroves could be affected by spilt volumes of 100 bbls/day under the conditions presented in Table 70 (also refer to the oil trajectories in the OSCP in Part B of Volume II):

Table 70 Impact of oil spills on Mangrove forests according to the trajectory modeling

Island	Time for impact	Spill location	Wind	Current
Tecomaji	6h	Point # 1	10 knots from NE	0.70 knots towards W
Tecomagi	8h	Point # 1	11 knots from N	0.70 knots towards W
Rongui	16h	Point # 2	16 knots from SE	0.65 knots towards W
Vamizi	18h	Point # 2	10 knots from NE	0.65 knots towards W

The oiling of mudflats and mangroves could have severe negative impacts for species populations and community structure. Due to the dependence of some commercially fished resources in the region on estuaries, e.g., pink shrimp, the socioeconomic consequences could be equally severe. **Potential impacts on coastal mangroves due to non-routine events are therefore considered to be of major significance.**

6.3.2.2.2 Shallow Water Macrobenthic communities

Potential Impact 4: Effects on coral reefs and seagrass beds due to a hydrocarbon release

Corals

Coral reefs are some of the more sensitive habitats found in the Mozambique area. Coral reefs in this region include stony corals (Order Scleractinia), octocorals (Subclass Octocorallia), black corals (Order Antipatharia), as well as other taxa (e.g., sponges, diverse motile invertebrates, and reef-associated fishes). Spilled oil can come into contact with coral reefs in a number of ways. Because oil is less dense than water, it tends to float over reefs, although there is dispersion and dissolution of portions of crude oil into the water column. However, some reef areas are exposed to the air during low tides and, when coupled with an oil spill, could experience direct contact with oil, resulting in smothering.

Another mechanism involves waves breaking on the reefs and shoreline, creating droplets of oil that are distributed into the water column and come into contact with the corals. As corals secrete mucus, especially when stressed, the droplets can easily stick to them, but may subsequently be shed with the mucus. In some areas with high dust loadings and/or high particle content of the water column, oil can combine with mineral particles and sink, and these oily particles may affect the corals. The whole process of weathering (including evaporation and effect of sunlight) can also cause oil to sink and come into contact with deeper corals.

A series of field studies has documented both short-term mortality to corals and long-term, sub-lethal impacts to reproduction and growth lasting five years or longer. Guzmán *et al*. (1991, 1994) compared cover of common shallow water coral species at six reefs before 1985 and three months after the oil spill at Bahía Las Minas (Panama). At one heavily oiled reef, total coral cover decreased by 76 % in the 0.5 - to 3-m depth range and by 56 % in the >3- to 6-m range. Cover decreased less at moderately oiled reefs and either increased or did not change at the un-oiled reference reefs. The branching species *Acropora palmata* nearly disappeared at the heavily oiled site, but increased by 38 % at the un-oiled reefs. Coral colony size and diversity also significantly decreased with increased oiling.

Various physiological effects of oil exposure to coral reefs have been documented, as summarized by the National Oceanic and Atmospheric Administration (NOAA) (2001), including:

- Tissue death (Johannes et al., 1972; Reimer, 1975; Neff and Anderson, 1981; Wyers et al., 1986);
- Impaired feeding response (Reimer, 1975; Lewis, 1971; Wyers et al., 1986);
- Impaired polyp retraction (Elgershuizen and de Kruijf, 1976; Neff and Anderson, 1981; Knap et al., 1983; Wyers et al., 1986);
- Impaired sediment clearance ability (Bak and Elgershuizen, 1976);
- Increased mucus production (Peters et al., 1981; Wyers et al., 1986; Harrison et al., 1990);
- Change in calcification rate (Birkeland et al., 1976; Neff and Anderson, 1981; Dodge et al., 1984; Guzmán et al., 1991, 1994);
- Gonad damage (Rinkevich and Loya, 1979; Peters et al., 1981);
- Premature extrusion of planulae (Loya and Rinkevich, 1979; Cohen et al., 1977);
- Larval death (Rinkevich and Loya, 1977);
- Impaired larval settlement (Rinkevich and Loya, 1977; Te, 1991; Kushmaro et al., 1996; Epstein et al., 2000);
- Expulsion of zooxanthellae (Birkeland et al., 1976; Neff and Anderson, 1981; Peters et al., 1981);
- Change in zooxanthellae primary production (Neff and Anderson, 1981; Cook and Knap, 1983; Rinkevich and Loya, 1983); and
- Muscle atrophy (Peters et al., 1981).

Oil reaching coral reefs inshore of exploratory operations will be subject to weathering, dispersal, and dissolution. Due to the relatively large volumes associated with a blowout, crude oil is expected to be more persistent in the environment than a smaller diesel fuel spill. Diesel fuel will quickly undergo weathering, dispersal, and dissolution. Distance and transport time, and the degree of oil weathering that may occur are critical elements in assessing impact. With relatively short transport times (i.e., estimated at 3 to 17 hours), crude oil weathering will be highly dependent upon physical mechanisms of weathering (e.g., wind and wave action enhancing dissolution and transport of floating crude oil) and the relative percentage of VOCs (i.e., spill fractions susceptible to evaporation and/or dissolution). Tidal cycle may also influence degree of subsurface exposure for both crude oil and diesel fuel.

Seagrass

Ten species of seagrass belonging to seven genera have been recorded along the Cabo Delgado coastline and Quirimbas Archipelago (Whittington et al., 1998). Fish species assemblages associated with seagrass beds are incredibly diverse – 249 species of fishes belonging to 64 families have been recorded. Seagrass beds occur in close association with the fringing coral reefs that form part of the Quirimbas Archipelago. They constitute the dominant vegetation in the shallow water ecosystems. Sub-tidal *Enhalus acoroides* and *Thalassodendrun ciliatum* dominate the seagrass beds, with small areas of the fine cylindrical seagrass *Syringodium isoetifolium* also present.

Seagrass beds and macroalgal assemblages play a valuable role by providing food and shelter and serving as nursery grounds for diverse, commercially-exploited species, such as fishes, crustaceans, gastropods, and sea cucumbers. Seagrasses are important feeding habitats for the endangered dugong (*Dugong dugon*) and green turtle (*Chelonia mydas*).

Dean et al. (1998) documented possible injury to, and recovery of, populations of eelgrass (*Zostera marina L.*), in Prince William Sound following the Exxon Valdez oil spill by comparing populations at oiled versus reference sites between 1990 and 1995. Eelgrass beds in heavily oiled bays were exposed to moderate concentrations of hydrocarbons. In 1990, a year after the spill, concentrations of total polycyclic aromatic hydrocarbons averaged nearly 4000 $ng.g^{-1}$ dry weight of sediment at oiled sites compared to less than 700 $ng.g^{-1}$ at reference sites. Injuries to eelgrass, if any, appeared to be slight and did not persist for more than a year after the spill. There were possible effects on the average density of shoots and flowering shoots, as these were 24 % and 62 % lower, respectively at oiled as compared to reference sites in 1990 ($p < 0.10$ for both). However, there were no differences between oiled and reference sites with respect to eelgrass biomass, seed density, seed germination, or the incidence of normal mitosis in seedlings, and there were no signs of the elimination of eelgrass beds. Populations recovered from possible injuries by 1991, as there was a sharp decline in hydrocarbon concentrations and there were no differences in shoot or flowering shoot densities between oiled and reference sites in 1990 or subsequent years.

For spilled diesel fuel, minimal toxicity to seagrasses is expected due to hydrocarbons being readily dissolved, dispersed, and evaporated, depending upon proximity of seagrass beds to spill location. For the larger crude oil spill, seagrass beds could be coated and smothered, causing mortality. Lighter fractions of crude oil may also result in toxicity to seagrasses and associated fauna (e.g., juvenile fishes and invertebrates).

Given the relative ecological importance of coral reefs and seagrass beds and the functions they provide in terms of shelter and feeding and nurturing grounds, potential impacts on these shallow macrobenthic communities are considered to be of major significance.

6.3.2.2.3 Deep Water Macrobenthic Communities

Potential Impact 5: Effects on deep water macrobenthic communities due to a hydrocarbon release

Deep water benthic communities expected to occur in the vicinity of potential wellsites would include soft bottom communities within sand and mud sediments. There is a prominent lack of infaunal and epifaunal data for continental shelf waters off the Cabo Delgado coastline and Quirimbas Archipelago. Regional studies in Mozambique, South Africa, and Madagascar suggest that dominant benthic taxa should include polychaetes, molluscs, crustaceans, echinoderms, and minor phyla. Physical factors expected to influence infaunal community structure include water depth, sediment grain size, organic content, dissolved oxygen levels, and presence of anthropogenic pollutants, among others.

An oil spill resulting from a seafloor blowout could affect benthic communities within a few hundred meters of the wellsite. While some oil could initially adhere to surface sediments surrounding the wellsite, resulting in smothering and/or toxicity to benthic organisms, most of the oil is assumed to rise rapidly through the water column. The extent of benthic effects would depend on current speed, oil density and toxicity, and flow rate.

Physical impacts from a seafloor blowout are also a consideration. The U.S. MMS (2002) estimates that a seafloor blowout could re-suspend and disperse sediments within a 300-m radius. Surface sediments in the project area could be re-suspended for several hours to several days and dispersed over a wide area.

A study of the biological impacts at the wreck site of the JESSICA oil spill in the Galapagos (Gelin et al., 2002) indicated that effects on sub-tidal reef communities were generally localized within approximately 100 m of the wreck site. Increases in the density of several algal, sea urchin, hydroid, and fish taxa were detected adjacent to the wreck, and were probably caused by JESSICA-associated disturbance. A diesel fuel spill in surface waters would have no impact on benthic communities.

Given the fact that hydrocarbons from a blowout will rise to the surface, coral reefs and seagrass beds are not present in deep water and impacts are likely to be

localized in extent, potential impacts on deep water benthic macrofauna are considered to be of minor significance.

6.3.2.2.4 Fauna

Potential Impact 6: Effects on marine mammals, turtles, fish and seabirds due to a hydrocarbon release

Marine Mammals

Marine mammals may be exposed to oil in several ways, including inhalation of hydrocarbon vapors, direct contact between oil and the skin, ingestion of oil droplets or contaminated prey, and fouling of baleen plates (Geraci and St. Aubin, 1987; Geraci, 1990; Loughlin, 1996). Whales and dolphins can apparently detect oil slicks on the sea surface, but do not always avoid them; Scholz et al. (1992) have seen various whale and dolphin species surfacing in oil slicks. Whales (e.g., humpback, fin, right, and minke) and bottlenose dolphins have been observed to swim through oil slicks without apparent deleterious effects. Because cetaceans apparently do not avoid oil slicks, they may be vulnerable to inhalation of hydrocarbon vapors.

Effects of oil spills on marine mammals depend on the level of exposure and potential for ingestion or inhalation. Direct oiling of whales and dolphins is not considered to be a serious risk as their skin contains a resistant dermal shield that acts as a barrier to toxic petroleum compounds (Scholtz et al., 1992). Cetacean skin is highly impermeable to oil and is not seriously irritated by brief exposure to environmentally-realistic amounts of oil (Geraci, 1990). However, if a cetacean surfaces directly within a slick of fresh oil, it may inhale hydrocarbon vapors, possibly leading to irritation and congestion of the lungs and bronchi. Absorption of volatile hydrocarbons through the lungs can lead to liver damage and may be a greater hazard to cetaceans than ingestion of oil or oil-contaminated prey (Geraci, 1990). Vapor concentrations of volatile hydrocarbons may be high enough just above a fresh slick (particularly if the oil is a light crude, a condensate, or a light or middle distillate fuel) to cause systemic damage for a few hours after a spill.

There is no evidence that ingestion of oil as droplets or contaminated prey represents a significant risk to baleen and toothed cetaceans. Fouling of the baleen feeding apparatus of baleen whales has not been observed; if it does occur, it is probably transitory and not debilitating. Preferred prey items are not likely to be sufficiently contaminated to pose a significant health risk to cetaceans.

The dugong (Dugong dugon) is one of four living species of marine mammals within the Order Sirenia. Dugongs occur in tropical and tropical shallow waters of the Indo-Pacific. Over much of its present range, it is represented by relict populations separated by large areas where it is close to extinction or, in some areas, extinct (Nishiwaki and Marsh, 1985). Dugongs occur in small groups of up to six individuals, though they are reported to periodically aggregate into much larger groups, or herds (Jefferson et al., 1993).

Dugongs feed on various types of bottom vegetation, primarily seagrasses (Reeves et al., 2002).

Historically, dugongs were considered relatively abundant within eastern Africa and Madagascar (Nishiwaki and Marsh, 1985). Recent surveys suggest that dugongs are generally scarce within Mozambique, distributed primarily in southern Mozambique within the nearshore waters of Maputo Bay (near Inhaca Island) and Inhambane Bay, Pomene, the Bazaruto Archipelago, and between Inhassoro and the Save River (World Wildlife Fund [WWF] Eastern African Marine Ecoregion, 2004; A. Guissamulo, Universidade Eduardo Mondlane, Maputo, Mozambique, personal communication, 2007). The IUCN currently lists the dugong as Vulnerable, and its status in Mozambique is listed as declining (Marsh, 2006). Factors responsible for its decline include harvest subsistence, accidental netting, agriculture-related water pollution, natural disasters (e.g., storms), and human disturbance (e.g., recreation and tourism). During a recent survey for marine mammals and turtles conducted within near-shore continental shelf waters near the area of exploratory interest, no dugongs were sighted (CSA International, Inc., 2007a).

Direct and indirect impacts of either crude oil or diesel fuel upon these highly mobile animals are liable to be very short term and insignificant on the regional scale. Should a crude oil spill reach dugong coastal habitat in large volumes, the potential exists for longer term exposure if oil becomes trapped in embayments. Diesel fuel is not likely to reach dugong habitat.

Turtles

Five sea turtle species occur in the area, all of which are protected by international convention, including green (Chelonia mydas), hawksbill (Eretmochelys imbricata), leatherback (Dermochelys coriacea), loggerhead (Caretta caretta), and olive ridley (Lepidochelys olivacea). Turtle nesting occurs throughout Mozambique, although most nesting activity appears to be distributed in the south. Adult loggerhead, green, hawksbill, and olive ridley turtles utilize a variety of habitats for feeding, including seagrasses, coral reefs, mud flats, and mangroves. All four species, particularly hawksbills, nest on sandy beach habitats in Mozambique, although current information on turtle nesting sites (especially within northern Mozambique) is lacking. Adult leatherbacks generally feed in deeper waters (Zoological Society of London, 2007).

Sea turtles usually do not avoid contact with oil either on the sea surface or onshore, and may even seek out and ingest tar balls (Odell and MacMurray, 1986; Lohoefener et al., 1989). If a sea turtle does encounter a large oil slick on the sea surface, there is a high probability that the turtle will suffer injury or possible death (Lutcavage et al., 1995, 1997). A loggerhead turtle was observed to surface repeatedly within an oil slick for more than an hour in the western Gulf of Mexico (Lohoefener et al., 1989). Leatherback sea turtles, in particular, may ingest tar balls, mistaking them for their preferred prey of gelatinous zooplankton.

All species and life stages of sea turtles are vulnerable to injury from encounters with oil. Oil can adhere to the body surface and cling to the nares, eyes, and upper esophagus of sea turtles, causing contact dermatitis (Lutcavage et al., 1995). Mucus membranes around the eyes, nose, and mouth may become irritated and damaged by oil contact. Short-term contact with or ingestion of the oil may cause significant changes in respiration, blood chemistry, energy metabolism, and diving behavior. Salt gland function has also been shown to be inhibited immediately after oil exposure, returning to normal within several weeks following exposure. In the field, these responses to oil would cause a variety of sub-lethal physiological effects that may lessen the ability of the turtle to cope with normal environmental stresses. Inhalation of hydrocarbon vapors may cause respiratory pathology and systemic toxicity.

Adult and juvenile turtles can survive and, through their swimming ability, avoid oil slicks. The most vulnerable stage in the turtle life cycle is if an oil slick reaches beaches where hatchlings are about to emerge and migrate to the sea. It is probable, although not specifically proven, that the presence of an oil slick will disorientate the hatchlings. This may lengthen their exposure to predators on the beaches and/or interfere with their swimming abilities. Hatchling survival is not high in any case (Bjorndal, 1982) and any increased mortalities can be reflected in the overall population.

The potential impacts of a crude oil spill on turtle populations inhabiting the region may be significant, including both contact at sea and on nesting beaches. The potential for impact from a small diesel spill are significantly reduced (relative to crude oil impacts) because the smaller spill volume and weathering of the diesel fuel will limit the areal extent of the spill and overall effects on sea turtles that may be present; in addition, diesel fuel is not expected to reach shore; therefore, no impacts to turtle nesting beaches are expected.

Fish

Pelagic fish (adults, larvae) mortalities as a result of oil spills are limited in size and have not translated into measurable effects on fish stocks. However, local mortalities especially in fish larvae and fish eggs can occur but direct observation of this is apparently rare (Baker et al., 1990).

Demersal, near-shore, and estuarine stocks, especially those species feeding on the sediment surface (e.g., soles and some Mugil [mullet] species) may suffer mortalities through ingesting contaminated sediments. This has been observed on the Brittany coast where plaice (*Pleuronectes platessa*) were adversely affected for at least two years by the Amoco Cadiz oil spill.

Fish species of intertidal and shallow sub-tidal sites affected by oiling showed no clear effects from the JESSICA oil spill in the Galapagos (Gelin et al., 2002); increases in the density of several fish taxa (as well as increases in algal, sea urchin, and hydroid populations) were detected adjacent to the wreck, and were probably caused by Jessica-associated disturbance.

Fishes are mobile and can move out of an impacted area. However, the overall habitat range can be significantly decreased, leading to major implications for the fish populations as a whole. An oil spill, therefore, can have a major negative impact upon these near-shore and shallow water species. Crude oil exposure may be expected to result in toxicity effects on fishes, with localized mortality to fish eggs and larvae also possible. Similar effects may be expected following exposure to diesel fuel, although the smaller spill volume and weathering of the diesel fuel will limit the areal extent of the spill and overall effects on local fish populations.

Seabirds

Nine taxonomic families of seabirds (broadly defined as species that spend a large portion of their lives on or over seawater) are found in both offshore and coastal waters of northern Mozambique. Some species of this group primarily inhabit offshore (continental slope) habitats (e.g., albatrosses, petrels and their allies, boobies and gannets, and tropicbirds). Most Mozambique Channel seabird species, however, inhabit waters of the continental shelf and shelf edge and adjacent coastal and inshore habitats (Newman, 2002; Sinclair and Ryan, 2003). Two species (wandering albatross and cape gannet) are currently listed by the IUCN as Vulnerable, and two species (Jouanin's petrel and African skimmer) are listed as Near Threatened (IUCN, 2007).

Census surveys performed within the Bazaruto Archipelago showed large numbers of terns (Sternidae), particularly the common tern (*Sterna hirundo*), lesser-crested tern (*S. bengalensis*), and swift tern (*S. bergii*) (Dodman et al., 1997). Common and lesser crested terns were the most common seabird species sighted within waters of the continental shelf edge during a 2007 CSA benthic habitat characterization survey (CSA International, Inc., 2007b).

Seabirds are conspicuous victims of oil pollution in the sea. Birds are affected through fouling of plumage and resulting hypothermia, direct ingestion of oil, reduced reproductive success, and physical disturbance associated with spill cleanup operations. Even moderate oiling can lead to death, mainly due to reduced thermoregulation and/or insulation. Direct observations of bird mortalities through oil spills probably only reflect 10 % at most of the actual mortalities (Donnet, 1982 cited in Volkman et al., 1994). These effects are expected to be similar for both crude oil or diesel fuel, although the number of birds affected by a small diesel spill will be small because of the short time diesel remains on the water surface. Experience noted by NOAA (2006) following hundreds of small diesel spills in Alaska is that few birds are directly affected by diesel spills from fishing vessels.

Mozambique's seabird and shorebird populations are, therefore, vulnerable to oil spills (crude and diesel), which may have a high negative impact on individual birds. If crude oil was to reach the estuaries of Mozambique, this high negative impact may extend to the population level. A small diesel spill is not expected to reach coastal bird habitat.

Due to the rich biodiversity found along the Mozambican coast and the presence of threatened and endangered species, potential impacts associated with non-routine events are considered to be of major significance.

6.3.2.1.4 Protected Areas

Potential Impact 7: Effects on protected areas due to a hydrocarbon release

Hydrocarbon spills that occur in the drilling areas may be transported to sensitive habitats that are critically important for coastal marine mammals (dolphins and dugongs), sea turtles and sea birds. These habitats are sandy beaches, corals, sea grasses and mangroves and the extent of the damage would depend on the size, type and duration of the spill, currents and wind direction.

Although it is not within the AMA1 concession or the boundary of the currently proposed drilling project, the Quirimbas National Park (QNP) lies directly to the south (7.5km) of the study area with a very small portion of the proposed buffer zone falling within the AMA1 Concession Area. The QNP includes the southern-most 11 islands of the Quirimbas Archipelago, as well as a large portion of the mainland. The marine protected portion of the QNP covers 152,237km^2 and is one of the largest marine protected areas in Africa.

The Mnazi Bay-Ruvuma Estuary Marine Park (MBREMP) in Tanzania is located 3km to the north of the AMA1 Concession Area, while a very small portion of the Proposed Rovuma National Reserve occurs within the drilling area (Figure 62).These protected areas could be significantly affected by a major spill event such as an oil well blowout.

Sandy beaches, mangroves, seagrass beds and coral reefs are located approximately 3.6 - 3.8 km from the western limit of the drilling area. Should spilled oil reach these more sensitive areas, the impacts are likely to be significant due to their vulnerability and high ecological value as well as their importance to the local tourism sector and their protection status.

The impacts of a hydrocarbon release on coastal features such as mangroves, corals and seagrass beds have been discussed. Ecological protected areas are usually designated due to their biodiversity value or vulnerability and as such are likely to be significantly affected by a hydrocarbon release that reached the shore.

The oil spill trajectory modelling conducted by The Response Group, using three hypothetical points (Figure 97 above) modelled for different times of the year, as well as different weather conditions and using a volume of 100 bbls/day shows that an oil spill at any of the three modelled points could reach the shore, whether island or mainland, at times varying between six hours and one and a half days (Table 71 below and oil trajectories included in OSCP in Part B of Volume II).

Table 71 Results of the impact of hypothetical oil trajectories on the shallow water sensitive ecosystems

Initial Impacted habitat	Time for impact	Spill location	Wind	Current	Period
Mangrove/sandy beaches	6h	Point # 1	10 knots from NE	0.70 knots towards W	October - March
Mangrove/sandy beaches	8h	Point # 1	11 knots from N	0.70 knots towards W	October - March
Mangrove/sandy beaches	16h	Point # 2	16 knots from SE	0.65 knots towards W	April - September
Mangrove/sandy beaches	18h	Point # 2	10 knots from NE	0.65 knots towards W	October – March
Coral Point/sandy beaches	1 day and 4h	Point # 2	12 knots from E	0.65 knots towards W	April - September
Coral points/ sandy beaches	1 day and 2h	Point # 2	11 knots from N	0.65 knots towards W	October - March
Coral Reefs/Point	1 day and 3h	Point # 3	11 knots from N	0.60 knots towards W	October - March
Various Coral points/sandy beach	16h	Point # 3	16 knots from SE	0.60 knots toward W	April - September
Mangrove/sandy beaches	10h	Point # 3	12 knots from E	0.60 knots towards W	April - September

Due to the high intrinsic value of the sensitive and protected areas, and the proximity of these areas to the western limit of the drilling area, the impacts due to non-routine events are considered to be of major significance.

6.3.2.3 SOCIO-ECONOMIC ENVIRONMENT

6.3.2.3.1 Population

Potential Impact 8: Effects on population due to a hydrocarbon spills or fire/explosion

Effects on human populations are realized through potential health hazards as well as economic losses, such as those associated with the temporary loss of fishing grounds.

The local population may be affected because they depend upon coastal and marine resources for subsistence. If water quality is affected, coastal and marine resources may be affected and that will reduce the source of food and income for the local population. Some health problems could also arise within the communities living in the vicinity of the spill as a result of contaminated foods and through odour and atmospheric pollutants evaporating from the spill. It is important to highlight that petroleum hydrocarbons are potentially carcinogenic and can cause severe dermatitis.

An indirect impact would be a loss in trade and market confidence as the local people and restaurants may be unwilling to purchase marine products from the local fisherman.

Prohibitions may be imposed on fishing and harvesting marine products after a spill in order to regain market confidence as well as to protect fishing and collection equipment from damage. This would seriously impact the livelihoods of the local population, who depend upon the marine resources.

The intensity and duration of the impact of hydrocarbon spills on the local population is dependent on the intensity and volume of hydrocarbons spilled into the environment. Impacts could be short term; however, there is a potential for recovery time to take longer (e.g. 5 years or more), if the impact's magnitude is large. Also, it should be noted that if local communities depend upon the coastal and marine resources for living, even a short-term impact could be significant due to the vulnerable socio-economic status of these communities and their inability to fish in different areas. **Impacts on the local population as a result of non-routine events are therefore considered to be of moderate significance.**

6.3.2.3.2 Artisanal Fisheries

Potential Impact 9: Effects on artisanal fisheries due to a hydrocarbon release

Artisanal fishing in the Quirimbas Archipelago is mainly in and around the island reefs, extending occasionally into the deepwater up to 13 km east. Artisanal fishers catch reef fishes and, in cases where boats venture into deeper waters east of the reefs, pelagic fishes, squid, and demersal fishes.

An oil spill can lead to mortality, tainting of fish rendering products unmarketable, altering of habitats (affecting availability and/or recruitment), and oiling of gear leading to increased maintenance or replacement costs. The larger the spill, the more extensive its impacts – more area is potentially affected, and there is a longer presence in the environment. Under the crude oil spill scenario, a much larger volume of oil will be released. Furthermore, crude oil is not expected to weather as quickly as a smaller diesel spill. Thus, crude oil impacts may be expected to extend further and last longer than those from diesel spills.

According to Born *et al*. (2002), no clear impact of the *Jessica* oil spill could be detected on fishing effort, total fishing catches or catch-per-unit effort (CPUE) for the Galápagos artisanal fishing sector based on analyses of fisheries monitoring data. No significant changes were noted in CPUE before and after the 2001 spill. Large boats tended to move away from sites near the path of the spill following the grounding in 2001, with no fishing recorded from oil-affected regions. During 2001, prices paid to fishers remained stable at levels higher than in 2000, with the notable anomaly that prices fell precipitously to 30% of previous levels during a 1- to 2-week period in early February 2001. Little export of fish occurred from Galápagos until March and April, with most fish product obtained in January and February dried and stored for up to 2 months prior to transport to the continent. Results are consistent with studies elsewhere that have also failed to reveal substantive effects on fish stocks of oil in open sea (Shelton, 1976; Marshall et al., 2002).

The intensity and duration of a reduction in fish yields as a result of hydrocarbon spills is dependent upon the intensity and volume of hydrocarbons spilled into the environment. A decrease in catch volume and limited access to fishing grounds farther afield could result in significant impacts. **Potential impacts on artisanal fisheries as a result of non-routine events are therefore conservatively considered to be of major significance.**

6.3.2.3.3 Commercial Fisheries

Potential Impact 10: Effects on commercial fisheries due to a hydrocarbon release

An accidental release of liquid hydrocarbons associated with either drilling or discharge from the well could have impacts on the purse seine fishery in Area 1.

Direct impacts could include damage to catch and gear if the spill occurred when a vessel was fishing in the immediate vicinity. In practice, and considering the safety zone in operation, it may be possible to attenuate such impacts through direct communication with these vessels immediately following such an event so that gear could be lifted before it became damaged.

Indirect impacts may include the displacement of migratory tuna from Area 1. This is thought to be a potentially significant impact in that both tuna themselves and their prey will probably remain clear of heavily polluted areas and this will reduce localised catches. However in the wider context of the fishery, the stock would not be reduced and would still be available to be fished elsewhere.

Due to the ability of commercial fishers to move to alternative fishing grounds (an ability not necessarily shared by artisanal fishers), the potential impacts of non-routine events on commercial fisheries is considered to be of moderate significance.

6.3.2.3.4 Tourism

Potential Impact 11: Effects on tourism due to a hydrocarbon release

Based on the hypothetical oil spill trajectory modelling, and depending on the time of year and weather conditions, an oil spill at any of the three modelled points could reach the shore, whether island or mainland, at times varying between six hours and one and a half days (Refer to the oil trajectories in the OSCP in Part B of Volume II). The impacts of a major spill on the tourism industry could be very significant. Lodges would have to close during the clean-up period, and depending on the volumes that reached the shore, the effects could be long term. Also, near-shore coral reefs and other sea life upon which tourism operators depend for recreation for their guests could be seriously impacted. Oil spills preclude leisure activities such as swimming, sailing, fishing, angling and snorkelling and diving until the area recovers from the impacts. This can take from days to years depending upon the specific parameters of the spill event.

Loss of revenue due to closure or disrupted activities could have a significant effect on the local economy. The attraction of the Quirimbas Archipelago for tourists is due, at least partially, to its image as un-spoilt, and this could be negatively affected for a long period, if not permanently, by an oil spill. **The potential impacts on tourism as a result of non-routine events are therefore considered to be of major significance.**

6.3.2.3.5 Navigation

Potential Impact 12: Effects on navigation due to hydrocarbon release

Navigation is not likely to be directly affected by hydrocarbon spills. However, vessels may be requested to change their routes in order to avoid the spill and not disturb response activities. It should be remembered that traffic within the AMA1 concession area is not intense and that most international traffic (mainly oil tankers) pass outside this area.

Potential impacts on navigation as a result of non-routine events are therefore considered to be insignificant.

6.3.2.3.6 Coastal Industries

Potential Impact 13: Effects on coastal industries due to a hydrocarbon release

The most important activities developed by the micro-industries in the coastal region of the study area are maize flour mills, cashew processing, carpentries, cold-storage timber-exploration unities, salt pans and furniture manufacture. Forty-one percent of these industries are located in Mocimboa da Praia, while 34 % were found in Macomia. Aquaculture is still developing.

The industries that are likely to be affected are the salt pans and potential aquaculture projects due to their location and usage of sea water.

The salt pans are all located along the coast (less than 2 km from the shore line) and they may employ a maximum of 10 workers, but are not currently marketing the product. However, should a spill occur, a ban could be imposed during clean-up, affecting the local population that consumes the salt.

If such a spill occurred once the salt is being marketed, the salt could potentially become contaminated. That would render the salt unsaleable. An indirect impact would be a loss in trade and market confidence as the local people and restaurants may be unwilling to purchase salt from the local salt industries.

Regarding potential aquaculture projects, Section 5.6.9 above indicated that some suitable and priority areas for aquaculture development exist in Cabo Delgado province, Pemba, Macomia and Mecufi (Government of Mozambique, 2007). It should be stated there that should these be developed, they are very likely to be affected by hydrocarbon spills and the consequences could be severe.

Seaweed farming has been developed under the AGA KHAN Project in the district of Macomia (*Pangane, Messano, Lumwamwa, Naunde and Kirimize).* The seaweed farms are located between 0 to 3 miles from the coast, depending on the coastal configuration, but not farther than the 6 m isobath. During 2007, approximately 1,400 households were involved in Macomia (≈ 800), Quissanga and Pemba.

As the method used for seaweed production is artisanal, hydrocarbon spills would damage the sticks, strings and nylon line used to produce seaweed as well as the seaweed itself because it would be using contaminated sea water for the culture, which would then affect its trade and export, rendering an economic loss to the company and the country (through export).

It should be noted that the aquaculture of seaweed has currently been suspended by AGA KHAN. It is not known when production is likely to resume.

The impact of hydrocarbon spills on the coastal industries is not likely to be significant as it is expected to only affect the salt pans and potential aquaculture projects. Additionally, the local population has more important sources of income and clearly do not depend on the salt pans for living, although it might affect many households involved in seaweed production (should this industry be reactivated) and may contribute to a loss of revenues for the country.

The potential impacts of non-routine events on coastal industries are therefore considered to be insignificant at this stage.

6.4. SUMMARY OF IMPACT EVALUATION FROM ROUTINE EVENTS

Table 72 Summary of impact evaluation from routine events

No.	EC	EC Category	Impact	Magnitude	Spatial Extent	Duration	Type	Cumulative	Reversibility	SIGNIFICANCE	Probability
BIOPHYSICAL ENVIRONMENT											
1	AIR	MEDIUM	Reduction in air quality due to project emissions	Very small	Very small	Very short	Direct	Medium	Reversible	**MINOR**	Certain
2	WATER	VERY HIGH	Reduction in water quality due to the discharge of drilling muds and cuttings	Small	Small	Very short	Direct	No effect	Reversible	**MODERATE**	Certain
3			Reduction in water quality due to deck drainage, bilge water and sewage discharge	Very Small	Very small	Very short	Direct	No effect	Reversible	**MINOR TO INSIGNIFICANT**	Certain
4			Reduction in water quality due to solid waste discharge	Very small	Very small	Very short	Direct	No effect	Reversible	**INSIGNIFICANT**	Very unlikely
5			Reduction in water quality due to the disposal of produced water	Very small	Very small	Very short	Direct	No effect	Reversible	**MINOR**	Certain
6	FLORA	HIGH	Effects of waste disposal (including muds and cuttings) on coastal mangroves	Very small	Very small	Very short	Direct	No effect	Reversible	**INSIGNIFICANT**	Very unlikely

7	SHALLOW WATER MACROBENTHOS	VERY HIGH	Effects of waste disposal (including drilling muds and cuttings) on coral reefs and seagrass beds	Very small	Very small	Very short	Direct	No effect	Reversible	**INSIGNIFICANT**	Very unlikely
8	DEEP WATER MACROBENTHOS	LOW	Effects of pre-drilling assessment on deep water benthic macrofauna	Very small	Very small	Very short	Direct	No effect	Reversible	**INSIGNIFICANT**	Certain
9			Effects of drilling on deep water benthic macrofauna including mooring anchors and chains (if applicable)	Very small	Very small	Very short	Direct	No effect	Reversible	**INSIGNIFICANT**	Certain (Moored rig) Very unlikely (Dynamically positioned rig)
10			Effects on deep water benthic macrofauna due to the discharge of drilling muds and cuttings	Small	Small	Moderate	Direct	No effect	Reversible	**MODERATE**	Certain
11	FAUNA	HIGH	Impacts due to the disposal of muds and cuttings on fauna through increased turbidity and contaminant load	Very small	Very small	Very short	Indirect	No effect	Reversible	**MINOR**	Probable
12			Impacts due to deck drainage, bilge water and sewage discharge	Small	Very small	Very short	Indirect	No effect	Reversible	**MINOR**	Probable
13			Impacts due to solid food waste discharge	Very small	Very small	Very short	Direct	No effect	Reversible	**INSIGNIFICANT**	Very unlikely
14			Impacts due to the introduction of invasive species in ballast water	Moderate	Very small	Very short	Indirect	No effect	Reversible	**INSIGNIFICANT TO MAJOR**	Highly probable
15			Impacts of noise on marine mammals, turtles and fish	Very small	Very small	Very short	Direct	Low	Reversible	**MINOR**	Highly probable

16			Increased vulnerability of fauna attracted to the rig's lighting/ flare	Very small	Very small	Very Short	Direct	No effect	Reversible	**INSIGNIFICANT**	Highly probable
17	PROTECTED AREAS	VERY HIGH	Impacts of waste management (discharges) on protected areas	Very small	Very small	Very short	Direct	Low	Reversible	**INSIGNIFICANT**	Very unlikely
SOCIO-ECONOMIC ENVIRONMENT											
18	POPULATION AND LOCAL ECONOMY	MEDIUM	Social conflicts due to the presence of foreign workers	Small	Very small	Very Short	Indirect	Low	Reversible	**MODERATE**	Probable
19			Increased revenue due to the presence of the crew in Pemba and possibly in the islands	Very small	Very small	Very Short	Indirect	Low	Reversible	**POSITIVE**	Certain
20	ARTISANAL FISHERIES	HIGH	Loss of access to fishing grounds due to exclusion zones	Very small	Very small	Very short	Direct	No effect	Reversible	**MINOR**	Probable
21			Temporary catch decrease due to fish displacement	Very small	Very small	Very short	Indirect	No effect	Reversible	**MINOR**	Probable
22			Effects of noise on artisanal fishery divers	Very small	Very small	Very short	Indirect	No effect	Reversible	**INSIGNIFICANT**	Very unlikely
23	COMMERCIAL FISHERIES	MEDIUM	Loss of access to fishing grounds due to exclusion zones	Very small	Very small	Very short	Indirect	No effect	Reversible	**MINOR**	Probable
24			Temporary catch decrease due to fish displacement	Very small	Very small	Very short	Indirect	No effect	Reversible	**INSIGNIFICANT**	Probable
25			Damage to trawl nets caused by surface structure remaining after well suspension/abandonment	Very small	Very small	Long	Direct	No effect	Reversible	**MINOR**	Very unlikely

26	TOURISM	HIGH	Reduction in revenue due to a perceived decline in tourist potential	Very small	Very small	Very short	Indirect	No effect	Reversible	**MINOR**	Unlikely
27			Effects of noise on recreational divers	Very small	Very small	Very short	Indirect	No effect	Reversible	**INSIGNIFICANT**	Unlikely
28			Impacts of waste disposal	Very small	Very small	Very short	Direct	No effect	Reversible	**INSIGNIFICANT**	Very unlikely
29	NAVIGATION	VERY LOW	Interference with maritime traffic	Very small	Very small	Very short	Direct	No effect	Reversible	**INSIGNIFICANT**	Very unlikely

6.5. SUMMARY OF IMPACT EVALUATION FROM NON-ROUTINE EVENTS

Table 73 Summary of impact evaluation from non-routine events

No.	EC	EC Category	Impact	Magnitude	Spatial Extent	Duration	Type	Cumulative	Reversibility	SIGNIFICANCE	Probability
BIOPHYSICAL ENVIRONMENT											
1	AIR	MEDIUM	Reduction in air quality due hydrocarbon spills or fire/explosion	Small	Very small	Very short	Direct	Low	Reversible	**MINOR**	Very unlikely
2	WATER	VERY HIGH	Reduction in water quality due to hydrocarbon release	Large	Moderate	Short	Direct	Moderate	Reversible	**MAJOR**	Very unlikely
3	FLORA	HIGH	Effects on coastal mangroves due to hydrocarbon release	Large	Moderate	Very short	Direct	Moderate	Reversible	**MAJOR**	Very unlikely
4	SHALLOW WATER MACROBENTHOS	VERY HIGH	Effects on coral reefs and seagrass beds due to hydrocarbon release	Large	Moderate	Moderate	Direct	Low	Reversible	**MAJOR**	Very unlikely

5	DEEP WATER MACROBENTHOS	LOW	Effects on deep water benthic macrofauna due to hydrocarbon release	Very small	Very small	Moderate	Direct	Low	Reversible	**MINOR**	Very unlikely
6	FAUNA	HIGH	Impacts on marine mammals, turtles, fish and sea birds due to hydrocarbon release	Large	Moderate	Short	Direct	Moderate	Irreversible	MAJOR	Very unlikely
7	PROTECTED AREAS	VERY HIGH	Effects on protected areas due to hydrocarbon release	Large	Small	Moderate	Direct	Moderate	Reversible	MAJOR	Very unlikely
SOCIO-ECONOMIC ENVIRONMENT											
8	POPULATION AND LOCAL ECONOMY	LOW	Effects on population and local economy due to hydrocarbon spills or fire/ explosion	Large	Moderate	Short	Indirect	Low	Reversible	MODERATE	Very unlikely
9	ARTISANAL FISHERIES	HIGH	Effects on artisanal fisheries due to hydrocarbon release	Large	Moderate	Short	Direct	Low	Reversible	MAJOR	Very unlikely

10	COMMERCIAL FISHERIES	MEDIUM	Effects on commercial fisheries due to hydrocarbon release	Small	Moderate	Very short	Indirect	Low	Reversible	MODERATE	Very unlikely
11	TOURISM	HIGH	Effects on tourism due to hydrocarbon release	Large	Moderate	Short	Direct	Low	Reversible	MAJOR	Very unlikely
12	NAVIGATION	VERY LOW	Effects on navigation due to hydrocarbon release	Very small	Very small	Very short	Direct	Low	Reversible	INSIGNIFICANT	Very unlikely
13	COASTAL INDUSTRIES	VERY LOW	Effects on coastal industries due to hydrocarbon release	Very small	Very small	Very short	Direct	Low	Reversible	INSIGNIFICANT	Very unlikely

7.0. MITIGATION MEASURES AND RESIDUAL IMPACTS

The majority of impacts associated with the drilling programme are considered to be minor to insignificant provided that mitigation measures are implemented. Adherence to environmental operating procedures described in this report, in conjunction with adherence to the Environmental Management Plan (Part B of Volume II) will result in the reduction of adverse environmental impact to a minimum. Nevertheless, close attention should be paid to the prevention of non-routine events and prevention of impacts on water quality. Avoidance of these impacts will result in the reduction or elimination of impacts to other Environmental Components.

Each significant residual impact anticipated for the AMA1 drilling programme proposed in Area 1 has been listed in Tables 74 (routine events) and 75 (non-routine events). Also listed are the Environmental Component, the EC Sensitivity, the Environmental Aspect, the impact, the impact significance prior to mitigation, the required mitigation, and the impact significance after mitigation.

Table 74 Residual Impacts from routine events after Mitigation

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
BIOPHYSICAL ENVIRONMENT							
1	AIR	MEDIUM	Mobilization/ demobilization and drilling operations	Reduction in air quality due to project emissions	**MINOR**	Regularly maintain drilling rig motors and engines. Operate and maintain exhaust systems and engines in accordance with the manufacturer's specifications. Use preventative maintenance, leak detection and repair programs. Maintain and effectively control well test burners for high efficiency. Consider the use of an alternative "green burner" test flare to improve the quality of flare emissions and to minimize incomplete combustion and black smoke and to prevent hydrocarbon fallout to the sea. Limit periods of hydrocarbon burning to the operationally required minimum. Compliance to Annex VI MARPOL emission standards: • Diesel engine NO_x emissions should be limited to between 9.8 and 17 g/kWh, depending on maximum operating speed. • Substances harmful to the ozone layer (including halon and CFCs), cannot be deliberately released. New facilities can contain HCFCs until 1Jan 2020, but cannot contain other substances that harm the ozone layer.	**INSIGNIFICANT**
2	WATER	VERY HIGH	Drilling operations (waste management)	Reduction in water quality due to the discharge of drilling muds and cuttings	**MODERATE**	Mud recovery systems must be used, whenever possible, and the rig should have an efficient solid control and mud recirculation system with the following main components: • Shale shakers to remove large-sized cuttings • De-gasser to remove entrained gas • De-sanders to remove sand-sized cuttings; • De-silters to remove silt-sized cuttings • Centrifuge to recover fine solids and weighting materials such as barite.	**INSIGNIFICANT**

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
						WBM and low toxicity additives should be used whenever possible. For SBM, use the Group III NADFs – Non Aqueous Drilling Fluids (most environmentally acceptable with low to negligible aromatic content). Synthetic fluids that are low in toxicity, biodegradable and non-accumulative should be used. All chemicals used should conform to internationally accepted standards and submitted to MICOA and INP for approval when necessary before the drilling activities begin. The use of all drilling fluid components and other chemicals should be monitored and recorded. WBM mud and cuttings and SBM cuttings will be discharged to sea in compliance with international practices as described below. However a final decision will be made based on the results of the site-specific drilling and mud cuttings dispersion modeling so as to ensure that the environmental components described in the EIA are not affected. This is especially important if the well sites are located close to the western limit. As with most oil and gas companies in their worldwide offshore operations, AMA1 will comply with the following requirements for discharge of drilling cuttings and muds (EPA, 2007): • Metal concentrations in the barite added to mud must not exceed: 1mg/kg for mercury and 3mg/kg for cadmium. • No discharge of drilling wastes allowed within 3 miles of shore. • Discharge rate not to exceed 1,000 bbls/hour. • Cuttings coated up with 6.9%SBMs may be discharged • Ester SBMs can have up to 9.4% SBM on cuttings.	
3			Mobilization/ demobilization and drilling operations	Reduction in water quality due to deck drainage, bilge water and sewage discharge	**MINOR TO INSIGNIFICANT**	All vessels must be certified for seaworthiness through an appropriate internationally recognized marine certification body. The rig must have adequate safety systems (alarms and automated shut-down devices), that meet regulatory and industry standards. Adequate maintenance and testing programs must be in place.	**INSIGNIFICANT**

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION

						Establish separate drainage systems for hydrocarbon-contaminated water (closed drains) and water from non-process areas (open drains). Bund all process areas to prevent contamination by storm waters, contain spills and leaks, and channel drainage water into the closed drains.
						Ensure that oil separators are in place and that spills are cleaned up immediately. Equip oil and water separators with sensors and an alarm to avoid exceeding the discharge limit.
						Use drip trays to collect run-off and spills from equipment not contained within a bunded area and channel runoff to the closed drainage system.
						Train crew members regarding the risks of contamination from deck water discharge and the importance of cleaning up spills as soon as they occur.
						
						Disposal of liquid waste in accordance with MARPOL 73/78 (Annexes 1-4):
						• Liquid effluents must be treated before discharged to the sea (Refer to Section 2.3.2).
						• Sewage must be treated and disinfected (on-board treatment plant) prior to discharge.
						    • Collect and adequately treat grey and black waters with a small on-board sewage treatment station before release into the sea.
						    • Treated effluents shall achieve a BOD < 40 ppm, suspended solids < 50 ppm and a coliform count < 200 cells per 100 ml of effluent.
						    • The discharge depth is variable, depending on the draught of the rig at the time, but it should not be less than 5m below the surface.
						
						• Discharge of ballast water and bilge water (water coming from machinery spaces) according to established international maritime guidance and legal requirements.	

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
						• The discharge of residues into the ocean is forbidden, except when the ship has an operation approved device for treatment of residue or when it is discharging disinfected residues and in small amounts, using an approved system at more than 3 nautical miles from the nearest coast; or discharging non-disinfected and un-fragmented residues, at more than 12 nautical miles from the nearest coast. • The concentration of oil in the water after treatment in an IMO approved oil/water separator shall not exceed 15 ppm. • Do not discharge deck water near sensitive habitats, such as seagrass beds and coral reefs. • Route water from machinery spaces to the closed drainage system, or contain and treat the bilge water before discharge. • Untreatable waters should be contained and shipped to shore for disposal. • Contain oil and chemical use areas and equipment (deck, mud tanks and pumps) • Use efficient oil and water separators in bilges.	
4			Drilling operations (waste management)	Reduction in water quality due to solid waste discharge	**INSIGNIFICANT**	Disposal of solid waste in accordance with MARPOL 73/78: • Domestic waste must be disposed in compliance with Annex V. • Solid waste (kitchen waste) can be macerated to 25mm and then discharged to the sea. • All other solid waste must be segregated and contained for appropriate treatment and disposal according to the Waste Management Plan. • Hazardous wastes will not, under any circumstances, be discharged to the sea. No garbage[81] can be discharged closer than 12 nautical miles (21,6km) from the nearest land.	**INSIGNIFICANT**

[81] Under Annex V of the Convention, garbage includes all kinds of food, domestic and operational waste, excluding fresh fish, generated during the normal operation of the vessel and liable to be disposed of continuously or periodically.

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
5			Drilling operations (waste management)	Reduction in water quality due to the disposal of produced water	**MINOR**	Comply with the MARPOL 73/78 requirements. Ensure that oil separators are in place and establish separate drainage system for hydrocarbon-contaminated water (closed drain). The concentration of oil in the water after treatment in an IMO approved oil/water separator shall not exceed 15 ppm.	**INSIGNIFICANT**
6	FLORA	HIGH	Drilling operations (waste management)	Impacts of waste disposal (including muds and cuttings) on the coastal mangroves	**INSIGNIFICANT**	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to the discharge of drilling muds and cuttings (Action # 2) and waste (Action # 4) ensures the mitigation of the impact on coastal mangroves.	**INSIGNIFICANT**
7	SHALLOW WATER MACROBENTHOS	VETY HIGH	Drilling operations (waste management)	Effects of waste disposal (including drilling muds and cuttings) on coral reefs and seagrass beds	**INSIGNIFICANT**	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to the discharge of drilling muds and cuttings (Action # 2) and waste (Action # 4) ensures the mitigation of the impact on shallow water macrobenthos.	**INSIGNIFICANT**
8	DEEP WATER MACROBENTHOS	LOW	Drilling operations (pre-drilling assessment of shallow hazards)	Effects of pre-drilling assessment on deep water benthic macrofauna	**INSIGNIFICANT**	Ensure that the drilling vessel is certified for seaworthiness through an appropriate internationally recognised marine certification body. Adhere to specific safety precautions and procedures to minimise the risk of offshore accidents and/or incidents. In case a moored rig is used, the integrity of its mooring system must be ensured. The drilling contractor must be registered with the International Association for Drilling Contractors (IADC), and all responsible personnel must be qualified. Use the ROV to assist the positioning of the rig and ensure that anchoring avoids significant seafloor features.	**INSIGNIFICANT**
9			Drilling operations	Effects of drilling on deep water benthic macrofauna including mooring anchors and chains (if applicable)	**INSIGNIFICANT**		**INSIGNIFICANT**

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
10			Drilling operations (waste management)	Effects on deep water benthic macrofauna due to the discharge of drilling muds and cuttings	**MODERATE**	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to the discharge of drilling muds and cuttings (Action # 2) ensures the mitigation of the impact on deep water macrobenthos.	**MINOR**
11	FAUNA	HIGH	Drilling operations (waste management)	Impacts due to the disposal of muds and cuttings on fauna through increased turbidity and contaminant load	**MINOR**	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to the discharge of drilling muds and cuttings (Action # 2) ensures the mitigation of the impact on marine fauna.	**INSIGNIFICANT**
12			Mobilization/ demobilization and drilling operations	Impacts due to deck drainage, bilge water and sewage discharge	**MINOR**	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to deck drainage, bilge water and sewage discharge (Action # 3) ensures the mitigation of the impact on marine fauna.	**INSIGNIFICANT**
13			Drilling operations (waste management)	Impacts due to solid food waste discharge	**INSIGNIFICANT**	The implementation of the proposed mitigation measures for the avoidance of water quality reduction and impacts on coastal mangroves , due to the discharge of waste (Action # 4) ensures the mitigation of the impact on marine fauna.	**INSIGNIFICANT**
14			Mobilization/ demobilization and drilling operations	Impacts due to the introduction of invasive species in ballast water	**INSIGNIFICANT TO MAJOR**	• Discharge of ballast water according to established international maritime guidance and legal requirements. • Discharged no closer than 12 nautical miles (21,6km) from the nearest land.	**MINOR**
15			Drilling operations	Impacts of noise on marine mammals, turtles and fish	**MINOR**	Periodically maintain equipment to minimize noise. Use a top drive motor on the drill string to limit drill noise.	**INSIGNIFICANT**
16			Drilling operations	Increased vulnerability of fauna attracted to the rig's lighting/flare	**INSIGNIFICANT**	Not applicable	**INSIGNIFICANT**

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
17	PROTECTED AREAS	VERY HIGH	Drilling operations (waste management)	Impact of waste management (discharges) on protected areas	**INSIGNIFICANT**	The implementation of the proposed mitigation measures for the avoidance of water quality reduction and impacts on coastal mangroves, due to the discharge of waste (Action # 4) ensures the mitigation of the impact on protected areas.	**INSIGNIFICANT**
SOCIO-ECONOMIC ENVIRONMENT							
18	POPULATION AND LOCAL ECONOMY	MEDIUM	Drilling operations and support operations	Social conflicts due to the presence of foreign workers	**MODERATE**	Personnel should be informed of social conduct codes based on cultural characteristics of the resident population, of local culture and costumes and of the importance of respectful social relationships with the local community. Personnel should be provided with information about avoidance of sexually transmitted diseases through hygienic practices and low risk behaviour.	**INSIGNIFICANT**
19			Drilling operations and support operations	Increased revenue due to the presence of the crew in Pemba and possibly in the islands	**POSITIVE**	Local goods and service providers in Pemba should be used whenever possible.	**POSITIVE**
20	ARTISANAL FISHERIES	HIGH	Drilling operations	Loss of access to fishing grounds due to exclusion zones	**MINOR**	Inform artisanal fishers, at least two months prior to the start of the drilling, of well locations, safety exclusion zones, and vessel locations, and of planned events through established means of communication. • Political forums, such as the *Foruns de Localidade* (Localidade Forums), *Conselhos Consultivos Distritais* (District Consultative Councils), and *Conselhos Comunitários de Pesca* (Community Fisheries Councils) • Traditional and other local leaders • Radio stations • Provide a grievance procedure regarding the project.	**INSIGNIFICANT**

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
						Consider a Compensation Plan that outlines strategies for, and means of, compensation in the event of loss of catch by artisanal fishers based on annual catches declared during previous years (a Compensation Plan will be submitted to MICOA together with Grievance Procedures).	
21			Drilling operations	Temporary catch decrease due to fish displacement	**MINOR**	Implementation of mitigation measures to minimize the impact on marine mammals, turtles and fish (Action # 17), will reduce the impact on catches. Coordination and communication with fishers, the establishment of a grievance procedure and the consideration of a compensation plan are also recommended (a Compensation Plan will be submitted to MICOA together with Grievance Procedures).	**INSIGNIFICANT**
22			Drilling operations	Effects of noise on artisanal fishery divers	**INSIGNIFICANT**	Implementation of mitigation measures to reduce impacts on artisanal fisheries will reduce the impact on divers (Actions # 23 & 24).	**INSIGNIFICANT**
23	COMMERCIAL FISHERIES	MEDIUM	Drilling operations	Loss of access to fishing grounds due to exclusion zones	**MINOR**	Inform maritime authorities prior to rig mobilization regarding detailed routes, rig locations, exclusion zones and scheduling plans through established means of communication. • National Maritime Authority (INAMAR), with details about vessel entry, duration of stay and exact area(s) and duration of exclusion. INAMAR should make a formal Notice to Mariners for international dissemination • Notice to Mariners through maritime communications networks and GMDSS / Inmarsat Provide advance notice writing to the Delegation of the European Commission, Maputo, and the Ministry of Fisheries, Mozambique	**INSIGNIFICANT**
24			Drilling operations	Temporary catch decrease due to fish displacement	**INSIGNIFICANT**	Not Applicable	**INSIGNIFICANT**

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
25			Drilling operations (abandonment)	Damage to trawl nets caused by surface structures remaining after well suspension/abandonment	**MINOR**	Implement a detailed program of abandonment and decommissioning adhering to applicable Mozambique Petroleum Regulations and Environmental Guidelines. Submit the abandonment and decommissioning plan to MICOA and INP. Inform trawling vessels operating in the area with the geographical locations of any obstructions left on the seabed. Publish a notice to mariners via INAMAR and the Ministry of Fisheries with a clear definition of the area where bottom gears (bottom trawl, bottom set gill nets) are prohibited.	**INSIGNIFICANT**
26	TOURISM	HIGH	Drilling operations	Reduction in revenue due to a perceived decline in tourist potential	**MINOR**	Provide a media fact sheet for use by L&A Operators to brief staff and inform clients regarding the temporary nature of the drilling program and the measures taken to mitigate environmental impacts. Helicopter flight paths should avoid tourist areas, when possible, or fly at sufficient altitude to minimize noise disturbances when rerouting is not possible. The EIS should be appended with the exact drill sites for later identification of site-specific effects to be addressed. Consider a Compensation Plan that outlines strategies for, and means of, compensation (a Compensation Plan will be submitted to MICOA together with Grievance Procedures).	**MINOR**
27			Drilling operations	Effects of noise on recreational divers	**INSIGNIFICANT**	Compile a Communications Plan to inform tourism interests of the drilling locations and scheduling. AMA1 could coordinate with dive operators. Provide a grievance procedure regarding the project. Refer to the Communication Plan included as part of the EMP. A Compensation Plan will be submitted to MICOA together with Grievance Procedures.	**INSIGNIFICANT**

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
28			Drilling operations (waste management)	Impacts of waste disposal	**INSIGNIFICANT**	The implementation of the proposed mitigation measures for the avoidance of water quality reduction due to the discharge of waste ensures the mitigation of the impact on tourism (Actions # 4 & 5).	**INSIGNIFICANT**
29	NAVIGATION	VERY LOW	Mobilization/ demobilization and drilling operations	Interference with maritime traffic	**INSIGNIFICANT**	Apply for authorization to conduct oil exploration drilling activities at sea from the Maritime Authority (INAMAR). Inform maritime authorities prior to rig mobilization regarding detailed routes, rig locations, exclusion zones and scheduling plans through established means of communication: • National Maritime Authority (INAMAR), with details about vessel entry, duration of stay and exact area(s) and duration of exclusion. INAMAR should make a formal Notice to Mariners for international dissemination • Notice to Mariners through maritime communications networks and GMDSS / Inmarsat • Provide advance notice writing to the Delegation of the European Commission, Maputo, and the Ministry of Fisheries, Mozambique Whenever necessary, maintain the exclusion zone using the rig and support vessel resources. Prohibit purse seine fishing in the area at least 10km up current of the drilling vessel to avoid drift into the exclusion zone. Provide a grievance procedure regarding the project (a Compensation Plan will be submitted to MICOA together with Grievance Procedures).	**INSIGNIFICANT**

Table 75 Residual Impacts from non-routine events after Mitigation

No.	EC	EC Sensitivity	Environmental Aspect	Impact	SIGNIFICANCE	MITIGATION MEASURES	SIGNIFICANCE AFTER MITIGATION
BIOPHYSICAL ENVIRONMENT							
1	AIR	MEDIUM	Mobilization/ demobilization and drilling operations	Reduced air quality due to hydrocarbon release or fire/explosion	**MINOR**	The aim should be in preventing the occurrence of hydrocarbon release and of fires and explosions. Compliance to the Emergency Response Plan and Oil Spill Contingency Plan is mandatory.	**INSIGNIFICANT**
2	WATER	VERY HIGH	Drilling operations and support operations	Reduced water quality due to a hydrocarbon release	**MAJOR**	<u>Planning</u> • General Oil trajectories and an Oil Spill Contingency Plan (OSCP/ERP)/Emergency Response Plan (ERP) prepared for this project are presented in Part B of Volume II. • Prepare & submit site-specific Oil Trajectory Models and OSCP/ERP to the MICOA & the INP before drilling activities o Incorporate results of the site-specific Oil Trajectory Models in the OSCP/ERP o The Mozambique draft National Oil Spill Contingency Plan (NOSCP) should be considered • Drilling operations will <u>not</u> commence until the OSCP/ERP has been updated and addresses local environments. • Compliance to the OSCP/ERP is mandatory • Consider acquiring or contracting services (Southern Africa region) for rapid response to accidental oil spills as local resources are limited. <u>Prevention</u> • Ensure that the rig and the supply vessel comply with the following: • International certification and approval by the Mozambican Authorities • Good operational conditions and serviced according to a service maintenance plan • Have OSCP/ERP and for (i) oil and chemical spills; (ii) fire and explosions, (iii) diesel or bunker fuel spills • Crews trained for emergency response relative to the cargo they transport and operations they perform	**MINOR**

						• Maintain contact with the Port Authorities • Have updated information regarding the weather conditions in the area • Safety measures such as BOPs are in place • Fuel tanks or drums capped, not overfilled, marked with contents, and valves closed between connected fuel tanks • Store petroleum products & hazardous substances in adequately labeled approved containers • Store petroleum products & hazardous substances in bunded areas where spills can be contained & collected • Use oil collector trays or drip pans under equipment • Ensure that pipes and hoses are properly connected, closed and in good condition • Monitor tank levels throughout the program • Make available absorbent pads near the area where spills may occur • Conduct transfer operations during calm weather conditions • Ensure that transfer hoses are of sufficient length and strength to maneuver vessels as sea conditions require • Only conduct transfer operations during the day, if possible, and hoist the “bravo” flag. • Transfer under reduced visibility conditions (night or overcast), hoist a red light flag • Conduct transfer under favorable wind and tide conditions that would carry any spill away from sensitive habitats • Post warning signals before transfer operations begin • During transfers, maintain effective communication between the supply vessel and the drilling rig and monitor the transfer • Implement drilling rig fuel transfer procedure Response • Response procedures shall be outlined in the site-specific OSCP/ERP. • Limit the spill at the source to the extent possible and contain or recover the material before it reaches the coastal or marine resources.	

						• Clean-up actions are required if hydrocarbons reach shore. • Inform the port authorities immediately in the event of any spill or accident that could result in a spill. • Report all leaks and spills in accordance with the OSCP/ERP. Refer to the Communication Plan included as part of the EMP.	
3	FLORA	HIGH	Drilling operations and support operations	Effects on coastal mangroves due to a hydrocarbon release	**MAJOR**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on the mangroves (Action # 2).	**INSIGNIFICANT**
4	SHALLOW WATER MACROBENTHOS	VERY HIGH	Drilling operations and support operations	Effects on coral reefs and seagrass beds due to a hydrocarbon release	**MAJOR**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on the shallow water macrobenthic communities (Action # 2).	**INSIGNIFICANT**
5	DEEP WATER MACROBENTHOS	LOW	Drilling operations and support operations	Effects on deep water macrobenthic communities due to a hydrocarbon release	**MINOR**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on the deep water macrobenthic communities (Action # 2).	**INSIGNIFICANT**

6	FAUNA	HIGH	Drilling operations and support operations	Effects on marine mammals, turtles, fish and seabirds due to a hydrocarbon release	**MAJOR**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on marine fauna (Action # 2). <u>Response measures include:</u> • Use marine mammal deterrents with the buoys signaling the spill to prevent the animals from entering affected areas. • Do not apply hydrocarbon dispersion agents directly onto the affected animals (cetaceans & sea turtles).	**MINOR**
7	PROTECTED AREAS	VERY HIGH	Drilling operations and support operations	Effects on protected areas due to a hydrocarbon release	**MAJOR**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on the protected areas (Action # 2).	**MINOR**
SOCIO-ECONOMIC ENVIRONMENT							
8	POPULATION AND LOCAL ECONOMY	MEDIUM	Drilling operations and support operations	Effects on population due to a hydrocarbon spills or fire/explosion	**MODERATE**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on population (Action # 2).	**MINOR**
9	ARTISANAL FISHERIES	HIGH	Drilling operations and support operations	Effects on artisanal fisheries due to a hydrocarbon release	**MAJOR**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on artisanal fisheries (Action # 2). Whenever necessary, maintain the exclusion zone using the rig and support vessel resources.	**MINOR**

10	COMMERCIAL FISHERIES	MEDIUM	Drilling operations and support operations	Effects on commercial fisheries due to a hydrocarbon release	**MODERATE**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on commercial fisheries (Action # 2). Additional measures include: <u>Prevention</u> • Whenever necessary, maintain the exclusion zone using the rig and support vessel resources. • Establish and maintain radio communications with vessels fishing within 15km of drilling rig • Prohibit purse seine fishing to 10km up current from the drilling vessel to avoid drift into the exclusion zone <u>Response</u> • Radio is the first means of communication, and vessels within 15km should be advised to leave the area immediately. • Prohibit fishing in the area immediately down current or downwind of the drilling rig (temporary high risk.	**INSIGNIFICANT**
11	TOURISM	HIGH	Drilling operations and support operations	Effects on tourism due to a hydrocarbon release	**MAJOR**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on tourism (Action # 2).	**MINOR**
12	NAVIGATION	VERY LOW	Mobilization/ demobilization and drilling operations	Effects on navigation due to hydrocarbon release	**INSIGNIFICANT**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on navigation (Action # 2).	**INSIGNIFICANT**

13	COASTAL INDUSTRIES	VERY LOW	Drilling operations and support operations	Effects on coastal industries due to a hydrocarbon release	**INSIGNIFICANT**	The implementation of the proposed mitigation measures for reduced water quality due to hydrocarbon release will ensure the minimization of such impacts on coastal industries (Action # 2).	**INSIGNIFICANT**

8.0 CONCLUSIONS AND RECOMMENDATIONS

The proposed deepwater exploration drilling operations will take place within the AMA1 Concession area, in water depths greater than 200m. Therefore, no sensitive habitats, such as coral reefs, mangroves and seagrass beds, will be encountered. Additionally, inhabited islands are not located in the project area.

In the specific case of this project the following factors should be taken into consideration:

- The project is an exploratory and not a production activity
- Well locations are still not known;
- The period of time is limited: up to 2 months per well;
- It is located beyond the 200m bathymetric line, where there are no mangroves, seagrass beds, coral reefs or population.

For the purpose of evaluation of environmental impacts, the receiving environment was divided into several important Environmental Components (EC): air, water, flora, shallow water and deep water macrobenthic communities, fauna, protected areas, population and local economy, artisanal fisheries, commercial fisheries, tourism, navigation and coastal industries. Each of these ECs are considered important on the basis of cultural values and/or scientific and public concern, and have been used to support the impact assessment.

A number of potential environmental and socio-economic impacts associated with the drilling activities have been identified, and the value of each EC value (most of them had a medium-high value) was considered. Most of the impacts from routine events were determined to be insignificant or of only minor significance, while most of the impacts from non-routine events were determined to be of major significance, but these are very unlikely to occur. Furthermore, the majority of impacts associated with the drilling programme can be reduced to insignificant if mitigation measures are implemented. No moderate or major impacts would remain if mitigation measures are adequately implemented.

Of major importance is that protected areas are not impacted by the AMA 1 drilling activities. The Quirimbas National Park (QNP) is located directly to the south (7.8km) of the study area, and the Mnazi Bay-Ruvuma Estuary Marine Park (MBREMP) in Tanzania is located 3km to the north of the concession area.

Marine mammals, turtles and fish are abundant in the project area. At least three species of whales (pilot, sperm and humpback) and several species of dolphins have been observed in the project area. Humpback and sperm whales are listed as Vulnerable species on the Red List of Threatened Species (The World Conservation Union (IUCN, 2007).

The turtles nesting beaches are located on the Vamizi (3.8km from the western boundary of the AMA1 deepwater area), on Rongui and on Macaloe (5km and 5.6km, respectively, from the western boundary of the AMA1 deepwater area). The islands are protected by the Cabo Delgado Biodiversity and Tourism Project (CDBTP) and by the Forestry and Wildlife Regulation (Decree No. 12/2002). In 2004, 250 nest sites belonging to the green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) species were identified and protected within the CDBTP study area. Both turtle species are listed as endangered or critically endangered on the Red List of Threatened Species (IUCN, 2006). Although within the AMA1 concession, these islands are located outside the AMA1 deepwater drilling project area and should not be affected by routine events.

The scoping phase (EPDA) report indicates that the precise locations of the drilling sites can only be determined after processing and interpretation of the seismic survey data. The EPDA also refers to the fact that the project area would be divided into two distinct impact zones (Sensitivity Zone 1 and Sensitivity Zone 2) to better identify the potential impacts with the help of specialist studies. However, during the course of the EIA it was decided not to differentiate between the two zones and only one study area was considered as drilling will take place where the water depths are greater than 200m and at these depths the biophysical variations are minimal. Only some socio-economic impacts, such as the visual impacts on tourism are of the highest sensitivity. The EPDA also stated that additional specialist studies may be required once the drilling sites were known. During the EIA it was concluded that the only additional specialist studies that should be carried out are (i) drilling and mud cuttings dispersion modelling and (ii) oil spill modelling. However, once the well locations are known, the relevant addendums shall be produced for each site. The types and quantities of the studies will be determined on a case-by-case basis.

Artisanal fisheries are an important source of protein and income generation in the study area for the coastal communities living in Macomia, Mocímboa da Praia and Palma coastal areas, and fishing is the main source of income.

The majority of artisanal fishing activities take place close to the islands or between the islands and the mainland. Most of the fishermen do not go as far as the 200 bathymetric line, but hand liners may go as far as 13km east of the islands and fish in depths of up to 400m.

There are no national commercial fisheries activities in the Area 1 concession. There may be some sporadic international fishing effort north of 16˚S, but this will normally be limited to water depths of 25m-200m (Almeida 2005) and not within the potential drilling area. The impacts of exploratory drilling on commercial fisheries in Area 1 will be confined to the purse seine fishery. Fishing for large pelagic species (tunas, swordfish and sharks) is only periodically focussed on fishing grounds within the entire Area 1. The vessels are not present in any one area all year round. Their location depends on the position of the principle concentrations of target species, which changes throughout the year. Otherwise, they will only cross through AMA1 area.

Although the tourism industry in the Quirimbas Archipelago is in its infancy, it is growing rapidly, and is already a sought-after international destination in the high-end tourism market. Tourists visiting the resorts in the study area are predominantly from the UK and Europe. Lodges in the Quirimbas capitalise on the theme of unspoilt wilderness, and luxury holidays in a tropical island paradise. Diving, recreational fishing, and whale watching are integral parts of their marketing, important factors when targeting high-end consumers who want a unique experience. If the perception of a “unique experience” is not sustained, there could be a decline in tourism. The potential effect of the proposed drilling operation on the image of the Quirimbas is strongly dependant on how activities associated with the drilling are managed. The magnitude of the impact is likely to be low, if the following is assumed:

- There will be no significant effect on recreational fishing, diving, or Cetacean sightseeing excursions
- The visibility of the drilling rig and associated activities would be limited (it should be taken into account that a drilling rig can be seen within 10 km).

The Mozambique Channel is a preferential international navigation route, but there are no formally established routes and the international traffic passes outside the project area. Area 1 in the Rovuma Basin is mainly used by national and regional cabotage shipping, with traffic (low intensity) to and from Madagascar, Comoros, Tanzania and Kenya, connecting the Ports of Pemba and Mocímboa da Praia.

Early consultation with all relevant authorities, prior to rig mobilization, must be established to avoid interference with maritime traffic and other activities by providing detailed drilling locations, transportation routing and scheduling information.

Key to these measures is the establishment and maintenance of proper, transparent lines of communication between the proponent and the tourism industry, the artisanal fishing representative, the commercial shipping stakeholders and the other relevant stakeholders (a Communication Plan has been included as part of the Environmental Management Plan). Through proper liaison, due notification of activities and careful monitoring of grievances, many of the potential impacts can be either avoided or minimized. Where impacts cannot be avoided, the affected parties should be compensated (a Compensation Plan will be submitted to MICOA together with a Grievance Procedure at a later stage, following agreements with the relevant Government Authorities (INP, MICOA; Fisheries and Tourism sectors).

It is recommended that while the drilling vessel is operational, a 500m radius safety zone be maintained around the drilling site, regardless of the type of rig. In this regard, a communication strategy must be developed to inform the key stakeholders of the location and timing of the drilling operations and the exclusion zone, ensuring that they are well covered by the *"Navigation Warnings"* dissemination systems.

Management of these impacts will require special attention prior to and during the exploration period. Therefore, mitigation measures have been designed to minimise or eliminate the negative impacts. This EIA includes an Environmental Management Plan (EMP), Part B of Volume II of this EIA, that clearly defines responsibilities and obligations when implementing the mitigation measures and when monitoring their implementation.

Adherence to environmental operating procedures described in this report, in conjunction with adherence to the EMP will reduce adverse environmental impacts to a minimum. In addition, close attention should be paid to the prevention of non-routine events and impacts on water quality. The prevention of both is inherent to preventing impacts to other Environmental Components.

The drilling rigs must have adequate safety devices and procedures, such as BOPs, adequate lighting and signally (for day and night); visual radar and support vessels to prevent collisions.

The crew must be adequately trained in safety, waste management and environmental protection prior to the beginning of operations. The topics should include:

- Regulatory requirements for drilling operations
- Environmental considerations and special procedures to be used for environmental protection
- Safety procedures with particular regard for appropriate conduct on vessels and safe use of equipment
- Emergency preparedness and response procedures

At the end of drilling operations, no equipment is to be left in the area, except for the wellhead, and the Remotely Operated Vehicle (ROV) should be used to make a final assessment. The location of any equipment that may be hazardous to future marine operations should be reported to relevant authorities for inclusion in the appropriate hydrographic charts.

AMA1 will permanently abandon the well if commercial volumes of hydrocarbons are not found. The well will be temporarily abandoned if the potential of commercially viable hydrocarbons exists. This means the well can be re-entered and used during future production operations. In either case, the well head and casing will be left on the seafloor, rising no more than 4 meters above the mud line.

All stakeholders must be informed of the completion of the operation through the same means of communication used before and during operations.

Although a low-probability non-routine event, an oil spill could reach shore, island or mainland, between six hours and one and a half days based on hypothetical oil trajectory modelling. The required oil spill response time would be very short. Training is crucial in such an event, but more effective is training to prevent situations that could result in an oil spill (e.g. spills during transferring or refuelling, blowouts, explosions and collisions).

The Framework Oil Spill Contingency Plan - OSCP/Emergency Response Plan – (ERP) contained in this EIA (Part B of Volume II) should be updated when well locations are defined, and should be submitted to MICOA and INP. The OSCP/ERP should follow the Mozambican National Oil Spill Contingency Plan (2006), and it should consider local resources and the need to acquire or contract services within the Southern Africa region for a rapid response to reduce the impacts from an accidental oil spill.

A Waste Management Plan has been included in this EIA (Part B of Volume II). The drilling vessel should comply with regulations detailed in the Annex V of MARPOL 73/78, which clearly defines the procedures to be applied for each category of domestic waste.

All activities conducted during the scope of the project should comply with the legislation in force (Section 2 of Volume II of this EIA).

With proper implementation of the mitigation measures outlined in this EIA, the project is feasible from environmental and socio-economic viewpoints. If hydrocarbons are discovered in the offshore Rovuma Basin, revenues will add to the Gross National Product and generate foreign exchange and job opportunities.

At this point, the well locations have not been defined. Once established, this report and the EMP may require adjustments

9.0 LITERATURE CITED

Alicia Delgado de Molina1, Juan José Areso2 and Javier Ariz. (2007) Statistics Of The Purse Seine Spanish Fleet In The Indian Ocean(1984-2006) IOTC

Almeida J. T. 2005: Descrição das Pescarias Marinhas e Custos Operacionais de Monitorização, Controle e Vigilância em Moçambique . EC/ SADC MCS Programme

Anderson, C.M. and R.P. LaBelle. 2000. Update of comparative occurrence rates for offshore oil spills. Spill Sci. Tech. Bull. 6(5/6):303-321.

Anzon Australia Limited. 2008. Basker-6 Drilling Summary Environmental Plan. AGR Asia Pacific Controlled Document No. 3626-HS-02-PI-004. 13p.

Asplin, L; Morten D. Skogen; W. Paul Budgell; Veronica Dove; Emidio Andre; Tor Gammelsrød and Antonio Mubango Hoguane. 2006. Numerical modelling of currents and hydrography f the Mozambique Channel. Rev. Inv. Pesq, 25.

Bak, R.P.M. and J.H.B.W. Elgershuizen. 1976. Patterns of oil-sediment rejection in corals. Marine Biology 37:105-113.

Baker, J.M., R.B. Clark, P.F. Kingston, and R.H. Jenkins. 1990. Natural recovery of cold-water marine environments after an oil spill. Presented at the Thirteenth Annual Arctic and Marine Oilspill Program Technical Seminar, June 1990.

Barton, P., J. Diebold, and S. Gulick. 2006. Balancing mitigation against impact: A case study from the 2005 Chicxulub seismic survey. Eos Trans. Am. Geophys. Union 87(36), Joint Assembly Supplement, Abstract OS41A-04.

Berta, A., & Sumich, J.L. 1999. Marine mammals: Evolutionary Biology. 494 p. Academic Press. San Diego.

Best, PB, Findlay, KP., Sekiguchi, K., Peddemors, V.M., Rakotonirina, B., Rossouw, A., Gove, D. 1998. Winter distribution and possible migration routes of humpback whales Megaptera novaeangliae in the southwest Indian Ocean. Mar Ecol Prog Ser 162: 287- 299.

Birkeland, C., A.A. Reimer, and J.R. Young. 1976. Survey of marine communities in Panama and experiments with oil. EPA Report EPA-60013-76-028. U.S. Environmental Protection Agency, Narragansett, RI. 177 pp.

Bjorndal, K. 1982. The consequences of herbivory for the life history pattern of the Caribbean green turtle, Chelonia mydas, pp. 19-26. In: K. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Born, A.F., E. Espinoza, J.C. Murillo, F. Nicolaides, and G. Edgar. 2002. Effects of the Jessica oil spill on artisanal fisheries in the Galápagos, pp. 107-118. In: L.W. Lougheed, G.J. Edgar, and H.L. Snell (eds.), Biological impacts of the Jessica oil spill on the Galápagos Environment. Final Report v.1.10. Charles Darwin Foundation, Puerto Ayora, Galápagos, Ecuador.

Boyle, K S and Tricas, T. 2006. EOS Transactions. AGU 87(36), Ocean Sciences Meeting supplement. Abstract OS440-82

Brandvik, P.J., T. Strom-Kristiansen, A. Lewis, P.S. Daling, M. Reed, H. Rye and H. Jensen. 1996. The Norwegian Sea trial 1995 offshore testing of two dispersant systems in simulation of an underwater pipeline leakage, a summary paper, pp. 1,395-1,416. In: Proceedings of the Nineteen Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Edmonton, Alberta, Canada. Environment Canada, Ottawa, Ontario, Canada.

Brown, C.E., M.F. Fingas, R.H. Goodman, J.V. Mullin, M. Choquet, and J.-P. Monchalin. 2000. Progress in achieving airborne oil slick thickness measurement, pp. 493 498. In: Proceedings of the Twenty-Third Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Vancouver, British Columbia, Canada. Environment Canada, Ottawa, Ontario, Canada.

Burns, K.A., S.D. Garrity, and S.C. Levings. 1993. How many years until mangrove ecosystems recover from catastrophic oil spills? Marine Pollution Bulletin 26(5):239-248.

Butler, J.N. 1975. Evaporative weathering of petroleum residues: the age of pelagic tar. Marine Chemistry 3:9-21.

Butler, J.N., B.F. Morris, and T.D. Sleeter. 1976. The fate of petroleum in the open ocean, pp. 287-297. In: Sources, effects, and sinks of hydrocarbons in the aquatic environment. The American Institute of Biological Sciences, Washington, D.C.

Cabo Delgado Biodiversity And Tourism Lda. 2003. Cabo Delgado Biodiversity And Tourism Project Management Plan (2003-2006).

Centre for Dolphin Studies and UEM- Museu de História Natural. 7 pp.

Chapman, C.J. and A.D. Hawkins. 1969. The importance of sound in fish behaviour in relation to capture by trawls. FAO Fish. Rept. 62:717-729.

Cockcroft, V.G. & Guissamulo, A.T. 2007. Strandings of whales and dolphins – a brief history of current stranding theories and a discussion of what needs to be assessed in relation to the cause of the mass stranding of offshore bottlenose dolphins on the Bazaruto Archipelago, 28th October, 2006. Preliminary report.

Cockcroft, V.G., Guissamulo, A. and Findlay,K. (2008) Dugongs (Dugong Dugon) Of the Bazaruto Archipelago, Mozambique. Final Report submitted to SASOL , January 2008. 84 p.

Cohen, Y., A. Nissenbaum, and R. Eisler. 1977. Effects of Iranian crude oil on the Red Sea octocoral Heteroxenia fuscescens. Environ. Pollut. 12:173-185.

Continental Shelf Associates, Inc. (M.J. Thompson, co-author). 1997. Environmental Review, Adoption of a Range Management Plan for the Atlantic Undersea Test and Evaluation Center (AUTEC), Andros Island, Bahamas. Naval Undersea Warfare Center, Detachment AUTEC, West Palm Beach, FL.

Cook Inlet NPDES General permit ODCE. 2006. Treatened and Environmental Species. Draft Report No. 1. 137 p.

Cook, C.B. and A.H. Knap. 1983. The effects of crude oil and chemical dispersant on photosynthesis in the brain coral, Diploria strigosa. Marine Biology 78:21-27.

CSA International (2007). Aerial Census Survey of Marine Mammals and Marine Turtles within the Rovuma Consession Block and Parque Nacional das Quirimbas, Mozambique. 33 pp. Report prepared for Anadarko Mozambique Area 1, Lda.

CSA International, Inc. 2007a. Representative marine habitat survey in Quirimbas Archipelago, Moçambique. Prepared for Anadarko Moçambique Área 1, Lda. 20 pp.

CSA International, Inc. 2007b. Aerial census survey of marine mammals and sea turtles within the Rovuma Concession Block and Parque Nacional Quirimbas, Mozambique. Prepared for Anadarko Moçambique Área 1, Lda. 33 pp.

Csanady, G.T. 1973. Turbulent Diffusion in the Environment. Reidel Publishing Company, Boston, MA.

Cumming, J. & Brandon, N. 2004. Sonic Impact: a precautionary assessment of noise pollution from Ocean Seismic Surveys. Greenpeace. 45 pp.

Cutler A, J Swallow 1984: Surface currents of the Indian Ocean. IOS report No 187
De Boer, M.N, R. Baldwin, CLK Burton, E.L. Eyre, KCS Jenner, M_NM, Jenner, S>G> Keith, K.A. McCabe, E.C.M. Parsons, V.M. Peddemors, H.C. Rosebaum, P.

Dean, T.A., M.S. Stekoll, S.C. Jewett, R.O. Smith, and J.E. Hose. 1998. Eelgrass (Zostera marina L.) in Prince William Sound, Alaska: Effects of the Exxon Valdez oil spill. Mar. Poll. Bull. 36(3):201-210.

Decree Nº 27/2004 of 20th August 2004, Council of Ministers – Mandate and Competencies of INAHINA- National Institute of Hydrography and Navigation;

Decree Nº 43/2003 of 10th December 2003, Council of Ministers – Creation of INAMAR-National Maritime Institute and approval of its Organic Statutes;

Decree Nº 44/2006 of 29th August 2006, Council of Ministers – Approves the Recreational Diving Regulations;

Department of the Navy: Chief Naval Operations. 2005. Draft Supplementary Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar.

Diving Medical Advisory Committee. 1979. A note regarding safe diving distance from seismic surveying operations. DMAC 012, November 1979. London.

DNAP, (2008): Relatório anual de 2007: Conselho coordenador do Ministério das pescas. Gondola (relatório interno).

DNEP, (2008): Relatório do Balanço do PES 2007: Conselho coordenador do Ministério das Pescas. Gondola. (relatório interno)

Dodge, R.E., S.C. Wyers, H.R. Frith, A.H. Knap, S.R. Smith, and T.D. Sleeter. 1984. The effects of oil and oil dispersants on the skeletal growth of the hermatypic coral Diploria strigosa. Coral Reefs 3:191-198.

Dodman, T., C. de Vaan, E. Hubert, and C. Nivet. 1997. African waterfowl census 1997. Les dénombrements internationaux d'oiseaux d'eau en Afrique, 1997. Wetlands International, Wageningen, The Netherlands. 260 pp.

Drilling Operations. Environmental Plan. Document no. 34332-HS-05-0011. Prepared for Nexus energy.Ldt. 10p.

Edwards, R & I. White The sea Empress oil Spill: Environmental Impact and Recovery. Report of the Sea Empress Environmental Evaluation Committee. 10 p.

Elgershuizen, J.H.B.W. and H.A.M. de Kruijf. 1976. Toxicity of crude oils and a dispersant to the stony coral Madracis mirabilis. Marine Pollution Bulletin 7:22 25.

Epstein, N., R.P.M. Bak, and B. Rinkevich. 2000. Toxicity of third generation dispersants and dispersed Egyptian crude oil on Red Sea coral larvae. Marine Pollution Bulletin 40:497-503.

ERM (2006). EIA for Sasol´s Offshore Exploration Project in Blocks 16 & 19. Final Environmental Impact Report.

European Commission 2007a: Council Regulation (EC) No. 1446/2007 on the conclusion of the Fisheries Partnership Agreement between the European Community and the Republic of Mozambique. - 22 November 2007. LEX-FAOC076005

European Commission 2007b: Fisheries Partnership Agreement between the European Community and the Republic of Mozambique. Official Journal of the European Union L331/35-54 17 December 2007

Fannelop, T.K. and K. Sjoen. 1980. Hydrodynamics of underwater blowouts. Norwegian Maritime Research 4:17–33.

Ferraz, B. and B. Munslow (eds.). 2000. Sustainable Development in Mozambique. Africa World Press, Inc., Trenton, NJ and Asmara, Eritrea. 242 pp.

Findlay, K., M. Meyer, S. Elwen, D. Kotze, R. Johnson, P. Truter, C. Uamusse, S. Sitoe, C. Wilke, S. Kerwath, S. Swanson, L. Staverees, and J. van der Westhuizen.

2004. Distribution and abundance of humpback whales, Megaptera novaeangliae, off the coast of Mozambique, 2003. Document SC/56/SH12 submitted to the IWC Scientific Committee, Sorrento, Italy. 22 pp.

Findlay, K., Meÿer, M., Elwen, S., Kotze,D., Johnson, R., Truter, P., Uamusse, C., Sitoe, S., Wilke, C., Kerwath, S., Swanson, S., Staverees, S., and van der Westhuizen, J. 2005. Distribution and abundance of humpback whales, Megaptera novaeangliae, off the coast of Mozambique, 2003. *J. Cetacean Res. Manage.*

Findlay, K.P., Best P.B., Peddemors V.M., Gove D. 1994. The distribution and abundance of humpack whales on their southern and central Mozambique winter grounds. Rep Int. Whal Commn 44: 311-320

Fischer, H.B., E.J. List, R.C.Y. Koh, J. Imberger, and N.H. Brooks. 1979. Mixing in Inland and Coastal Waters. Academic Press, New York, NY.

Folkens, P. A, Revees, R.R., Stewart, B.S., Clapham, P.J. Powell, J.A. 2002. guide to marine mammals of the world. 527 pp. Alfred A. Knopf. New York.

Gelin, A., V. Gravez, and G. Edgar. 2002. Impacts of the Jessica oil spill on intertidal invertebrate communities, pp. 42-57. In: L.W. Lougheed, G.J. Edgar, and H.L. Snell (eds.), Biological impacts of the Jessica oil spill on the Galápagos Environment. Final Report v.1.10. Charles Darwin Foundation, Puerto Ayora, Galápagos, Ecuador.

Geraci, J.R. 1990. Physiologic and toxic effects on cetaceans, pp. 167-197. In: J.R. Geraci and D.J. St. Aubin (eds.), Sea Mammals and Oil: Confronting the Risks. Academic Press, San Diego. 259 pp.

Geraci, J.R. and D.J. St. Aubin. 1987. Effects of offshore oil and gas development on marine mammals and turtles, pp. 587-618. In: D.F. Boesch and N.N. Rabalais (eds.), Long-term Environmental Effects of Oil and Gas Development.

Girard, C., Benhamou, S., and Dagorn, L. 2004. FAD: Fish Aggregating Device or Fish Attracting Device? A new analysis of yellowfin tuna movements around floating objects. Anim. Behav. **67**(2): 319-326.

Gubbay.S & R. Earll. 1999. Proposed Guidelines for Dealing with Cetaceans in the Event of an Oil Spill in the Moray Firth, Scotland. 15p.

Guissamulo, A., H. Balidy & N. Hill (2003) Socio-economic survey of communities and survey of fisheries. Cabo Delgado Biodiversity and Tourism Project: Report for the Marine Programme. 71-86 pp.

Guissamulo, A.T. 2003. Status report of status of dugongs population in Mozambique. Report submitted to WWF-Tanzania

Guissamulo, A.T. & Cockckroft, V.G. 2004. Ecology and population estimates of the Indo-Pacific humpback dolphins (Sousa chinensis) in Maputo Bay, Mozambique. Aquatic Mammals, 30 (1): 94-102.

Guzmán, H.M., J.B.C. Jackson, and E. Weil. 1991. Short-term ecological consequences of a major oil spill in Panamanian subtidal coral reefs. Coral Reefs 10:1-12.

Guzmán, H.M., K.A. Burns, and J.B.C. Jackson. 1994. Injury, regeneration and growth of Caribbean reef corals after a major oil spill in Panama. Marine Ecology Progress Series 105:231-241.

Harrison, P.L., J.C. Collins, C.G. Alexander, and B.A. Harrison. 1990. The effects of fuel oil and dispersant on the tissues of a staghorn coral Acropora formosa: A pilot study, pp. 51-61. In: Scientific Input to Oil Spill Response, Proceedings of Second National Workshop on Role of Scientific Support Coordinator, HMAS Cerberus (Hastings, Victoria), March 26-30, 1990.

Hill, N. & Garnier, J . 2003. Monitoring of Populations of Endagered Species. In: Garnier, J (editor) Report on Marine Programme- November 2003. Cabo Delgado Biodiversity and Tourism Project. P.54-69.

Hoff, R. (ed.). 2002. Oil spills in mangroves: planning and response considerations. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration, Washington, DC. January 2002. 72 pp.

Hoguane, A.M. 2007. Perfil Diagnóstico da Zona Costeira de Moçambique **(***Diagnosis of Mozambique Costal Zone***).** *Revista de Gestão Costeira Integrada* 7(1):69-82. *www.aprh.pt/rgci* e *www.gci.inf.br*

Holand, P. 1997. Offshore Blowouts: Causes and Control. Gulf Professional Publishing (Elsevier), Oxford, UK and Boston, MA.

Hoskins H, W Wood 1996: Seismic Acquisition System Grounding and Noise. Proc Ocean Drilling Platform Initial Reports Vol 164

Hughes, G. 1971. Preliminary report on the sea turtles and dugongs of Mozambique. Veterinaria Moçambicana 4 (2): 45-62.

IDPPE. (2004). Relatório de actividades 2003: Versão preliminar. Maputo, Mozambique.

IDPPE. (2004). Relatório de actividades 2003: Versão preliminar. Maputo, Mozambique.

Impacto & CSA (2007). EIA for the Proposed Deepwater Seismic Survey in Rovuma Offshore Area 1 (On behalf of Anadarko).

Impacto & Mark Wood Consultants (2006) EIA for the Proposed Deepwater Seismic Survey in Rovuma Offshore Areas 2 & 5 (On behalf of Hydro).

IMPACTO and Mark Wood Consultants. 2006. Environmental Impact Report for the Proposed Offshore Seismic Surveys of Areas 2 and 5, Rovuma Basin, Mozambique.

Oil and Gas Exploration Project, Volume 2. Prepared for Hydro Oil and Gas Mozambique and Empresa Nacional de Hidrocarbonetos.

Information Notes from CFM – Pemba Branch.

Instituto Nacional de Estatistica (2002).

Instituto Nacional de Estatística (2008).

International Petroleum Industry Environmental Conservation Association (IPIECA). 1993. Biological impacts of oil pollution: mangroves. IPIECA Report Series, Volume 4. London, UK. 24 pp.

International Union for the Conservation of Nature and Natural Resources (IUCN). 2007. Red List of Threatened Species. IUCN website, http://www.iucnredlist.org/.

IOTC (2007) status of IOTC databases for tropical tunas, IOTC

IOTC 2007: Report of the Tenth Session of the Scientific Committee Victoria, Seychelles, 5-9 IOTC-2007-SC-R[E]

Jackson, J.B., J.D. Cubit, B.D. Keller, V. Batista, K. Burns, M. Caffey, R.L. Caldwell, S.D. Garrity, D.C. Getter, C. Gonzalez, H.M Guzmman, K.W. Kaufmann, A.H. Knap, S.C. Levings, M.J. Marshall, R. Steger, R.C. Thompson, and E. Weil. 1989. Ecological effects of a major oil spill on Panamanian coastal marine communities. Science 243:37-44.

Jefferson, T.A., S. Leatherwood, and M.A. Webber. 1993. FAO Species Identification Guide. Marine Mammals of the World. FAO, Rome. 320 pp.

Johannes, R.E., J. Maragos, and S.L. Coles. 1972. Oil damages corals exposed to air. Marine Pollution Bulletin 3:29-30.

Karczmarski, L. (2000). Conservation and management of humpback dolphins: the South African perspective. Oryx, 34, 207-216.

Knap, A.H., T.D. Sleeter, R.E. Dodge, S.C. Wyers, H.R. Frith, and S.R. Smith. 1983. The effects of oil spills and dispersants use on corals: A review and multidisciplinary experimental approach. Oil and Petrochemical Pollution 1:157 169.

Kushmaro, A., G. Henning, D.K. Hofmann, and Y. Benayahu. 1996. Metamorphosis of Heteroxenia fuscescens planulae (Cnidaria: Octocorallia) is inhibited by crude oil: A novel short term toxicity bioassay. Marine Environmental Research 43:295 302.

L. A. Bojórquez-Tapia, E. Ezcurra and O. García. Instituto de Ecologia, UNAM, Apartado Postal 70-275, D.F. 04510, México.Received 30 October 1996; accepted 26 April 1998. ; Available online 8 April 2002.

Law Nº 3/90 of 26th September, 1990 – Fisheries Law of Mozambique;

Lee, R.F. and D.S. Page. 1997. Petroleum hydrocarbons and their effects in subtidal regions after major oil spills. Mar. Poll. Bull. 34(11):928-940.

Lei Nº 4/96 of 4th January 1996 – Maritime Law of Mozambique;

Leis , Jeffrey M. and Matthew M. Lockett, 2005. Localization of Reef Sounds by Settlement-stage Larvae of Coral-reef Fishes (Pomacentridae). Bulletin of Marine Science, 76(3): 715–724.

Leis , Jeffrey M. and Matthew M. Lockett, 2005. Localization of Reef Sounds by Settlement-stage Larvae of Coral-reef Fishes (Pomacentridae). Bulletin of Marine Science, 76(3): 715–724.

Lewis, A., P.S. Daling, T. Strom-Kristiansen, A.B. Nordvik, and R. Fiocco. 1995a. Weathering and chemical dispersion of oil at sea, pp. 157-164. In: Proceedings of the 1995 International Oil Spill Conference, Long Beach, California. American Petroleum Institute, Washington, D.C.

Lewis, A., P.S. Daling, T. Strom-Kristiansen, and P.J. Brandvik. 1995b. The behavior of Sture blend crude oil spilled at sea and treated with dispersant, pp. 453-469. In: Proceedings of the Eighteenth Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Edmonton, Alberta, Canada. Environment Canada, Ottawa, Ontario, Canada.

Lewis, J.B. 1971. Effects of crude oil and oil spill dispersant on reef corals. Marine Pollution Bulletin 2:59-62.

Lewis, R.R., III. 1983. Impact of oil spills on mangrove forests, pp. 171-183. In: H.J. Teas (ed.), Tasks for Vegetation Science, Vol. 8 (Biology and Ecology of Mangroves), Dr. W. Junk Publishers, The Hague.

Lohoefener, R.R., W. Hoggard, C.L. Roden, K.D. Mullin, and C.M. Rogers. 1989. Petroleum structures and the distribution of sea turtles, pp. 31-35. In: Proceedings: Spring Ternary Gulf of Mexico Studies Meeting. U.S. Department of the Interior, Minerals Management Service, New Orleans, LA.

Løkkeborg, S and Soldal, AV. 1993. The influence of seismic exploration with airguns on cod (Gadus morhua) behaviour and catch rates.

Løkkeborg, S. 1991. Effects of a geographic survey on catching success in longline fishing.

LosseG, N. Merrett 1971: The occurrence of Oratosquilla investigatoris (Crustacea: Stomatopoda) in the pelagic zone of the Gulf of Aden and the equatorial western Indian Ocean. Marine Biology 10 244-253,

Loughlin, T.R. 1996. Marine Mammals and the Exxon Valdez. Academic Press, San Diego. 395 pp.

Loya, Y. and B. Rinkevich. 1979. Abortion effect in corals induced by oil pollution. Mar. Ecol. Prog. Ser. 1:77-80.

Lunel, T. and A. Lewis. 1993a. Effectiveness of demulsifiers in sea trials: the use of fluorometry, surface sampling, and remote sensing to determine effectiveness, pp. 179-202. In: A.H. Walker, D.L. Ducey, Jr, J.R. Gould and A.B. Nordvik (eds.), Formation and Breaking of Water-in-Oil Emulsions: Workshop Proceedings. Marine Spill Response Corporation, Washington, D.C.

Lunel, T. and A. Lewis. 1993b. Oil concentrations below a demulsifier-treated slick, pp. 955-972. In: Proceedings of the Sixteenth Arctic and Marine Oil Spill Program (AMOP) Technical Seminar, Calgary, Alberta, Canada. Environment Canada. Ottawa, Ontario, Canada.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts of sea turtle survival, pp. 387-409. In: P.L. Lutz and J.A. Musick (eds.), The Biology of Sea Turtles. CRC Press, Boca Raton, FL.

Lutcavage, M.E., P.L. Lutz, G.D. Bossart, and D.M. Hudson. 1995. Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Archives of Environmental Contamination and Toxicology 28(4):417-422.

Mackay, D. and A. Chau. 1986. The effectiveness of chemical dispersants: A discussion of laboratory and field tests results. Oil and Chemical Pollution 3:405–415.

Marine Highway Project Report, 2007;

Marques da Silva, I., Guissamulo, A., Garnier,J.1 and Shawn,A . 2007. The Maluane whale and dolphin watching programme in the North Quirimbas, Mozambique. Presented at the Workshop on Marine Mammal Research in Africa 27th November 2007, South Africa Museum, 17th Biennial Conference on the Biology of Marine Mammals. Cape Town South Africa.

Marsh, H. 2006. Dugong dugon. In: 2006 IUCN Red List of Threatened Species. IUCN website, www.iucnredlist.org.

Marsh, H., Penrose, H., Eros, C. and Hugues, J. 2005. Dugong Status and action plans for countries and territories. EARLY WARNING REPORT SERIES, UNEP/DEWA/RS.02-

Marshall, P., P. Mooney, and G. Edgar. 2002. The effect of the Jessica oil spill on reef communities: initial wreck site assessment and monitoring baseline for benthic invertebrates, plants and fishes, pp. 69-94. In: L.W. Lougheed, G.J. Edgar, and H.L. Snell (eds.), Biological impacts of the Jessica oil spill on the Galápagos Environment. Final Report v.1.10. Charles Darwin Foundation, Puerto Ayora, Galápagos, Ecuador.

McAuliffe, C.D. 1989. The weathering of volatile hydrocarbons from crude oil slicks on water, pp. 357-364. In: Proceedings of the 1989 International Oil Spill Conference, San Antonio, Texas. American Petroleum Institute, Washington, D.C.

McCauley, R.D. 1994. Environmental implications of offshore oil and gas development in Australia - seismic surveys, pp. 19-121. In: Report by the Australian Inst. of Marine Sci.

Minerals Management Service (MMS). 2001. Outer continental shelf oil and gas leasing program: 2002-2007, Draft Environmental Impact Statement. U.S. Department of the Interior, Minerals Management Service, Washington, D.C. OCS EIS/EA, MMS 2001-079. 2 volumes.

Minerals Management Service (MMS). 2002. OCS oil spill facts. September 2002. U.S. Department of the Interior, Minerals Management Service, Washington, D.C. 7 pp. Accessed at: http://www.mms.gov/stats/PDFs/2002OilSpillFacts.pdf.

Ministério do Turismo. 2003. Tourism Policy and Implementation Strategy, Resolution No. 14 of the 4th of April, 2003.

Ministério do Turismo. 2004a. Strategic Plan for the Development of Tourism in Mozambique (2004 – 2013).

Ministério do Turismo. 2004b. General Management Plan, 2004-2008: Quirimbas National Park.

Mocímboa da Praia Maritime Delegation Reports – 2006 and 2007;

National Oceanic and Atmospheric Administration. 2001. Oil spills and coral reefs: planning and response considerations. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration, Washington, DC. 78 pp.

National Oceanic and Atmospheric Administration. 2006. Small diesel spills (500 5000 gallons). Accessed at: www.noaa.gov (July 2008).

National Research Council (NRC). 1985. Oil in the Sea: Inputs, Fates, and Effects. National Academies Press, Washington, D.C.

National Research Council (NRC). 1989. Using Oil Spill Dispersants on the Sea. National Academies Press, Washington, D.C.

National Research Council (NRC). 2003. Oil in the Sea III: Inputs, Fates and Effects. National Academies Press, Washington, D.C.

National Research Council (NRC). 2005. Oil Spill Dispersants: Efficacy and Effects. Ocean Studies Board (OSB). National Academies Press, Washington, D.C.

Neff J 2005: Composition, environmental fates, and biological effects of water based drilling muds and cuttings discharged to the marine environment. PERF/API

Neff j, S McKelvie, R Ayres 2000: Environmental Impacts of Synthetic Based Drilling Fluids. US Dept of the Interior, Mineral Management Service. MMS 2000-064

Neff, J.M. and J.W. Anderson. 1981. Response of Marine Animals to Petroleum and Specific Petroleum Hydrocarbons. John Wiley & Sons, New York. 177 pp.

Nelson P. 2003: Marine Fish Assemblages Associated with FADS. NMFS
Newman, K. 2002. Newman's Birds of Southern Africa. Struik Publishers, Cape Town. 527 pp.

Nishiwaki, N. and H. Marsh. 1985. Dugong Dugong dugon (Muller, 1776), pp. 1-31. In: S.H. Ridgway and R. Harrison (eds.), Handbook of Marine Mammals, Volume 3, The Sirenians and Baleen Whales. Academic Press, Inc., Orlando, FL.

NOAA 2002: Trajectory Analysis Handbook. Office of Response and Restoration, Hazardous Materials Response Division. NOAA Ocean Service

Noormahommed, AR. 2006. Overview of Mozambique's Natural Oil and Gas Potential. Deputy Minister of Mineral Resources.

NORAD. 2009, A Study of the Fisheries Sector in Mozambique.

Odell, D.K. and C. MacMurray. 1986. Behavioral response to oil. In: S. Vargo, P.L. Lutz, D.K. Odell, T. Van Vleet, and G. Bossart (eds.), Study of the effects of oil on marine turtles, final report. 3 volumes. U.S. Department of the Interior, Minerals Management Service, Atlantic OCS Region. OCS Study MMS 86 0070.

Payne, J.R., C.R. Phillips, and W. Hom. 1987. Chapter 5 - Transport and Transformations: Water Column Processes, pp. 175-231. In: D.F. Boesch and N.N. Rabalais (eds.), Long Term Environmental Effect of Offshore Oil and Gas Development.

Pearson, W., J. Skalski, and C. Malme. 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish. Can. J. Fish. Aquatic Sci. 49:1,343-1,356.

Peddemors, V.M. and V.G. Cockcroft. 1993. Prey Distribution and its Importance for Dolphins off the South-West Indian Ocean. *In* Okemwa, E. (Editor). Proceedings of the Symposium on large marine Ecosystems, Mombassa, Kenya. 28 March-2 April.

Peddemors, V.M., P.B. Best, K.P. Findlay, D. Gove, B. Rakotonirina, A. Rossouw, and K. Sekiguchi. 1997. Small cetaceans of the south-west Indian Ocean. Paper SC/49/SM33 presented to the International Whaling Commission Scientific Committee, October 1997.

Pemba Maritime Administration Reports – 2006 and 2007;
Perry, J. 2005. Environmental Impact Assessment for Offshore Drilling The Falkland Islands to Desire Petroleum PLC. RPS Energy. Report No. EOE0534. 7p.

Peters, E.C., P.A. Meyers, P.P. Yevich, and N.J. Blake. 1981. Bioaccumulation and histopathological effects of oil on a stony coral. Marine Pollution Bulletin 12:333 339.

Potier M , Marsac F, Lucas V, Sabatié R nd: Trophic Ecology of Four Apex Trophic Ecology of Four Apex Predators of the Pelagic Ecosystem Predators of the Pelagic Ecosystem in the Indian Ocean in the Indian Ocean. IRD/THETIS

Potier M, F. Marsac, V. Lucas, R. Sabatié, J-P Hallier and F. Ménard 2004: Feeding Partitioning among Tuna Taken in Surface and Mid-water Layers: The Case of Yellowfin (Thunnus albacares) and Bigeye (T. obesus) in the Western Tropical Indian Ocean. Western Indian Ocen Journal opf Marine Science Vol 3 No 1

Proffitt, C.E. (ed.). 1997. Managing oil spills in mangrove ecosystems: Effects, remediation, restoration, and modeling. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 97-0003. 76 pp.

Reeves, R., B. Stewart, P. Clapham, and J. Powell. 2002. National Audubon Society Guide to Marine Mammals of the World. Alfred A. Knopf, New York, NY. 527 pp.

Reimer, A.A. 1975. Effects of crude oil on corals. Marine Pollution Bulletin 6:39-44.

Richardson, W.J; Greene, C.R; Malme C.I; Thompson, H.H (1995) Marine Mammals and Noise. Academic Press, San Diego

Rinkevich, B. and Y. Loya. 1977. Harmful effects of chronic oil pollution on a Red Sea scleractinian coral population, pp. 585-591. In: D.L. Taylor (ed.), Third International Coral Reef Symposium, Miami, Vol. 2, University of Miami, Florida.

Rinkevich, B. and Y. Loya. 1979. Laboratory experiments on the effects of crude oil on the Red Sea coral Stylophora pistillata. Marine Pollution Bulletin 10:328-330.

Rinkevich, B. and Y. Loya. 1983. Response of zooxanthellae photosynthesis to low concentrations of petroleum hydrocarbons. Bulletin of the Institute of Oceanography and Fisheries 9:109-115.

Rodrigue, J-P. 2004. Straits, passages and chokepoints: a maritime geostrategy of petroleum distribution. Cahiers de Géographie du Québec 48(135):357-374.

Romanov E. 2007: Swimming crab Charybdis smithii of he Indian Oceean - key link in the pelagic tropic web. IRD/CRH

Rönnbäck, P., A. Macia, G. Almqvista, L. Schultza and M. Troell. 2002. Do penaeid shrimps have a preference for mangrove habitats? Distribution pattern analysis on Inhaca Island, Mozambique. Estuarine, Coastal and Shelf Science 55(3):427 436.

Rousselot, J.E.2005. Caracterizaco socio-economica da comunidade piscatoria de Quirimba, Norte de Mocambique.

Routeing along The Coast of Mozambique, 1st Edition (1986);

Rudolph and M.P. Simmonds (2003) Cetaceans in the Indian Ocean Sanctuary: A review. A WDCS Science report. 52pp.

S.L. Ross. 1997. A review of dispersant use on spills of North Slope crude oil in Prince William Sound and the Gulf of Alaska. Report No. C\634.96.1. Report by S.L. Ross Environmental Research Ltd. for Prince William Sound Regional Citizens' Advisory Council, Anchorage, AK.

Saetre R and R. de Paula e Silva 1979. The marine fish resources of Mozambique. Report on surveys with the R/V Dr. Fridtjot Nansen. Serviços de Investigações Pesqueiras, Maputo. and Institute of Marine Research, Bergen. 173 pp.

Sætre, R. and da Silva A.J., 1982. Water masses and circulation of the Mozambique Channel, *Report of the Instituto de Desenvolvimento Pesqueiro*, no **3**.

Saetre, R. and R.P. Silva. 1979. The marine fish resources of Mozambique. Reports on surveys with R/V Dr. Fridtjof Nansen. Fisheries Research Services, Maputo and Institute of Marine Research, Bergen. 179 pp.

Sara G, J. Dean, D D'Amato, G Buscaino 2007: Effect of boat noise on the behaviour of bluefin tuna Thunnus thynnusin the Mediterranean Sea. Mar Ecol Prog Ser Vol 331 243-253

Scholz, D.K., J. Michel, G. Shigenaka, and R. Hoff. 1992. Chapter 4: Biological Resources. In: Impacts of Oil. Spills on Coastal Ecosystems: Course Manual. Prepared by Research Planning, Inc., Columbia, SC. Prepared for the Marine Spill Response Corporation: Washington, D.C. January 13-17, 1992, Monterey, CA. 70 pp.

Seinfeld, J.H. & S. Pandis (1998). Atmospheric Chemistry and Physics: From Air Pollution to Climate Change. John Wiley & Sons, INC, USA.

Shelton, R.G.T. 1976. Environmental effects of oil and the chemicals used to control it on fisheries, pp. 51-56. In: J. Wardley-Smith (ed.), The Control of Oil Pollution on the Sea and Inland Waters. Graham and Trotman Ltd., London, U.K.

Silva, R.; Vallejos , A; Cunat, O. (1990) Relatório de Cruzeiro nº 23: 1ª campanha do M. Christine na Costa Norte de Moçambique, Abril-Maio de 1990.

Simmonds M, S Dolman and L Weilgart 2004: Oceans of Noise. WDCS

Sinclair, I. and P. Ryan. 2003. Birds of Africa South of the Sahara. Princeton University Press, Princeton, NJ. 759 pp.

Skalski, J., W. Pearson, and C. Malme. 1992. Effects of sounds from a geophysical survey device on catch per unit effort on a hook-and-line fishery for rockfish (Sebastes spp.). Can. J. Fish. Aquatic Sci. 49:1,357-1,365.

Snedaker, S.C., P.D. Biber, and R.J. Aravjo. 1997. Oil spills and mangroves: An overview, pp. 1-18. In: C.E. Proffitt (ed.), Managing oil spills in mangrove ecosystems: Effects, remediation, restoration, and modeling. U.S. Department of the

Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 97-0003.

Socolofsky, S.A. and E.E. Adams. 2002. Multi-phase plumes in uniform and stratified crossflow. J. Hydraulic Res. 40(6):661–672.

Steen, J.-E e A.M.Hoguane 1992. Circulação e distribuição de massas de água na zona económica e exclusiva de Moçambique. Rev. Inv. Pesq. **20**, Maputo.

Taylor, M., C. Ravilious, and E.P. Green. 2003. Mangroves of east Africa. UNEP World Conservation Monitoring Centre, Cambridge, UK. 26 pp.

Te, F.T. 1991. Effects of two petroleum products on Pocillopora damicornis planulae. Pacific Science 45:290-298.

Text of the recently approved Regulations on Maritime Commercial Transport (not yet published in the Official Bulletin)

Thorhaug, A. 1992. Oil spills in the tropics and subtropics, pp. 99-127. In: D.W. Connell and D. Hawker (eds.), Pollution in Tropical Aquatic Systems. CRC Press Inc, London.

U.S. Environmental Protection Agency (EPA) 2004. General permit for Offshore Oil and Gas Exploration Facilities on outer Continental Shelf and Contiguous State Waters. Permit AKG280000. Fact Sheet. 47p.

UK Offshore Operators Association Limited. 1997. Guidelines for the Conduct of Mobilie Drilling Rig Site Surveys. Volume 1. Issue 1.2. 17p.

UNEP (2002). EIA Training Resources Manual

Upstream Petroleum Pty Ltd. 2005. Executive SummaryLongtom-3 (Vic/P54)

US Environmental Protection Agency. 1999. Wildlife and Oil Spills. In: EPA Office and Emergency and Remedial Response. p.21-26

Vella G, I Rushforth 2001: Assessment of the effects of niose and vibration from offshore windfarms on marine life. University of Liverpool Centre for Marine and Coastal Studies.

Volkman, J.K., G.J. Miller, A.T. Revill, and D.W. Connell. 1994. Oil spills, Part 6, pp. 509-695. In: Environmental Implications of Offshore Oil and Gas Development in Australia—The Findings of an Independent Scientific Review, J.M. Swan, J.M. Neff and P.C. Young, (eds.), Australian Petroleum Exploration Association (APEA) and Energy Research and Development Corporation (ERDC), Sydney, Australia.

Walker, A.H., T. Lunel, P.J. Brandvik, and A. Lewis. 1995. Emulsification processes at sea—Forties crude oil, pp. 471-491. In: Proceedings of the Eighteenth Arctic and Marine Oilspill Program (AMOP) Technical Seminar, Edmonton, Alberta, Canada. Environment Canada. Ottawa, Ontario, Canada.

Wardrop, J.A., B. Wagstaff, P. Pfennig, J. Leeder, and R. Connolly. 1996. The distribution, persistence and effects of petroleum hydrocarbons in mangroves impacted by the "Era" oil spill (September, 1992): Final Phase One report. South Australian Department of Environment and Natural Resources, Office of the Environment Protection Authority, Adelaide.

Whittington, M.W., C.M. António, M.S. Heaseman, M. Myers, and D. Stanwell-Smith. 1998. Marine biological and resource use surveys of the Quirimba Arquipelago, Mozambique. Technical Report 6: Results Summary and Management Recommendations. 49 pp. Maputo, SEE/MICOA.

Wilson J. 2008: Economic and Social Impacts of the Mozambique / EU Fisheries Agreements. EJC Mozambique

World Bank,. 2005. Mozambique Country economic memorandum: sustaining growth ad reducing poverty. Africa region. Report nr 32615-MZ

Wray, P. and K.R. Martin. 1983.Historical Whaling Records from the western Indian Ocean. Rep. Int. Whal. Commn (Special Issue 5).: 213-241.

WWF Eastern Africa Marine Ecoregion, 2004. Towards a Western Indian Ocean Dugong Conservation Strategy: the status of dugongs in the Western Indian Ocean Region and Priority Conservation Actions. Dar es Salaam, Tanzania: WWF. 68 pp.

Wyers, S.C., H.R. Frith, R.E. Dodge, S.R. Smith, A.H. Knap, and T.D. Sleeter. 1986. Behavioural effects of chemically dispersed oil and subsequent recovery in Diploria strigosa (Dana). Marine Ecology 7:23-42.

Internet sources

http://www.boatsafe.com/kids/distance.htm

http://www.inprovuma.com/images/2nd%20Rnd%20Awarded%20Blocks%20March%202006.pdf

http://boatsafe.com/tools/horizon.htm

http://www.shellchemicals.com/neoflo/1,1098,1846,00.html

http://en.wikipedia.org/wiki/Drilling_mud

http://www.cisoilgas.com/pastissue/article.asp?art=26165&issue=155 (Article: High quality fluids, minimal waste)

http://www.ogp.org.uk/pubs/342.pdf Environmental Aspects of the use and disposal of the use and disposal non aqueous drilling fluids associated with offshore oil & gas operations – May 2003

http://pbrla.blogspot.com/2006/07/drilling-rigs-part-3.html

http://see-the-sea.org/topics/pollution/toxic/ToxPol.htm

(http://www.eia.doe.gov/pub/international/iealf/tableh2co2.xls),

Personal communications (cited and not cited)

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