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EXECUTIVE SUMMARY

Mozambique is located in the South-Eastern part of the African Continent, between latitudes 10°27'S and 26°52'S and longitudes 30º 12'E and 40º 51'E. The country has a total surface area of 784,032 km^2 subdivided into 10 provinces. The country possesses the third longest coastline in the Indian Ocean covering a total distance of 2700 km. Total continental shelf area is about 104,300 km^2. The current population is slightly more than 20 million people with a growth rate of 2.5% per annum. Most of the population is concentrated in the southern provinces of Maputo, Gaza and Inhambane and in central and Northern provinces of Zambézia and Nampula. About 43% of the population resides within the coastal region of the country.

The Mozambique Channel is an important source region for the Agulhas Current which is one of the major western boundary currents flowing along the southeastern coast of South Africa. The Mozambique Channel is also one of the two routes through which the South Equatorial Current feeds the Agulhas Current. Mozambique also has an extensive drainage network that includes about 100 principal river basins and a number of international rivers. The international rivers include the Rovuma, Zambezi, Save, Limpopo and Incomati Rivers. The runoff entering Mozambique through international rivers has decreased over the years due to damming, water abstraction and irrigation in neighbouring countries. There has also been modification of stream flow leading to either freshwater shortage/reduction or excessive runoff in certain periods of the year. The rivers are main sources of sediments and dissolved inorganic nutrients in coastal zones of Mozambique. The Sofala Bank – one of the most productive shelf regions in Mozambique, is influenced by the discharges from Zambezi, Pungué, Buzí and Save rivers. The highest nutrient concentrations occur in the Angoche shelf area in the north, Sofala Bank in central and Delagoa Bight in the southern shelf.

The coral reefs of Mozambique are the southern continuation of the well-developed fringing reefs that occur along major sections of the fairly narrow continental shelf of the East African coast. The coral reefs are responsible for 70% of fish catches and provide a hugely important nursery ground for many species of other commercially important marine species. The reefs in protected areas such as those found in Lighthouse Reef – Bazaruto, Barreira Vermelha and Ponta Torres – Inhaca Island, and those found in areas with low accessibility such as Ponta Maunhane – Pemba, are in much better condition than reefs that are freely exploited. Mozambique corals reefs have been impacted by global warming. In 1997-1998, El Niño southern oscillation (ENSO) caused extensive coral bleaching. Full regeneration of corals after the El Niño is yet to be realised. In addition to global warming, the other major threats to coral reefs include sedimentation, flooding, beach seining and trampling.

Mangroves cover a total area of 396,080 ha stretching almost the entire coast of the country, mostly in sheltered shores and estuaries. Mangroves are being depleted at a rate varying from 15.2 % in Maputo province to 4.9 % in Sofala. The increased population pressure in coastal regions is a major factor in accelerating mangrove depletion. Seagrass beds are a found in the South and North of the country. The thirteen species of seagrasses are found in Mozambique. The seagrasses are being degraded due to beach seining, trampling during the collection of invertebrates and sedimentation associated with river discharges.

A total of 18 marine mammals, including dugong, dolphins and whales, are also found in the country. These include 3 species of migratory whales that breed in Mozambique waters, 2 species of dolphins that occur all year round and dugong that feed on seagrass beds. Mozambique hosts five species of marine turtle including the green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*) and leatherback turtles (*Dermochelys coriacea*). These endangered species are threatened due to use destructive and non-selective fishing gears, destruction of habitat, accidental and intentional catches and pollution

The fisheries and aquaculture sector in Mozambique contributed 1.6% of the GDP in 2009. The fisheries potential in Mozambique is however large as the yield is estimated to lie between 220,000 and 330,000 tonnes. In 2008, 15% of the domestic fish production came from commercial fisheries whilst 84.3% was from the artisanal fisheries. The semi-industrial fishery employed over 351,700 people and accounted for 93% of the country's total marine fish catch. The gross output of the commercial fishery is estimated to be some US$63.5 million. It is estimated that the artisanal fishery has a gross value of US$292.5 million. The major issues

threatening fisheries are over-fishing, use of destructive fishing practices and degradation of the ecosystems.

The agricultural sector in Mozambique is an important sector contributing 25% to GDP. Agricultural commodities contribute 10-15% of total exports. The sector has however, receded in the recent years due to the development of other lucrative sectors particularly aluminium smelting and exports, along with the increase in other large export projects. Tourism is also becoming important sector in the country but it contributes only about 3.2% to GDP and employs more than 350,000 people. Approximately 76.8% of total tourist expenditure comes from Africa-based residents with South Africa and other SADC region members representing the largest tourist source market, making up 51% of total arrivals. Most of the key sectors of the economy are however constrained by weak capacity, limited implementation of legislation and limited infrastructure development.

Mozambique is party to a number of international multi-lateral environmental agreements. The country has also domesticated some of the international conventions. The governance of coastal and marine environment is however characterised by weak implementation and/or enforcement of legislation, limited capacity, overlapping mandates and jurisdiction of institutions charged with the implementation of legislations or environmental conventions, among others.

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ACRONYMS

ASCLME:	UNDP-GEF Agulhas and Somali Current Large Marine Ecosystems Project
BOD:	Bio-Chemical Oxygen Demand
CENACARTA:	Centro Nacional de Cartografia e Teledetecção
CENOE:	National Operations Centre for Emergency
CBO:	Community Based Organisation
CLA:	Coastal Livelihood Assessment
CORDIO:	Coastal Oceans Research and Development in the Indian Ocean
COD:	Chemical Oxygen Demand
COTS:	Crown of Thorns Starfish
CTD:	Conductivity, Temperature and Density
EEZ:	Economic Exclusive Zone
EIA:	Environmental Impact Assessment
ENSO:	Nino–Southern Oscillation phenomenon
EU:	European Union
FAO:	Food and Agriculture Organization
GDP:	Gross Domestic Product
GIS:	Geographic Information System
GOOS:	Global Ocean Observing System
HABs:	Harmful Algal Blooms
HEP:	Hydro-Electric Power
ICZM:	Integrated Coastal Zone Management
IIP:	Institute of Fisheries Investigations
IMAF:	Sea and Frontier Institute
INAHINA:	National Institute of Hydrography and Navigation
INAQUA:	Instituto Nacional de Desenvolvimento da Aquacultura
INAM:	Instituto Nacional de Meteorologia
INGC:	National Institute of Calamities Management
INCM:	Instituto Nacional de Telecomunicações de Moçambique
IOC-UNESCO:	Inter-Governmental Oceanographic Commission of UNESCO
IOD:	Indian Ocean Dipole
ITCZ:	Inter-Tropical Convergence Zone
IUCN:	The World Conservation Union
MICOA:	Ministry for Coordination of Environmental Affairs
MIND:	Integrated Information Network for Decision-making
MISAU:	Ministry of Health, Mozambique
MPAs:	Marine Protected Areas
MCS:	Monitoring, Control and Surveillance
NDOC:	National Disaster Operation Centre
NWC:	National Warning Centre
NGO:	Non-Governmental Organisation
NORAD:	Norwegian Agency for Development Cooperation
POPs:	Persistent Organic Pollutants
CENADO:	Oceanographic Ocean Data Center
ORI:	Oceanographic Reseach Institute, South Africa
ROFI:	Regions of Freshwater Influence
SADC:	Southern Africa Development Community
SIOFA:	Southern Indian Ocean Fishing Agreement
SST:	Sea Surface Temperature
SWIOFP:	World Bank-GEF South-West Indian Ocean Fisheries Project
SWOT:	Analysis of Strengths, Weaknesses, Opportunities and Threats
TEDS:	Turtle Excluder Devices
UEM:	Universidade Eduardo Mondlane
USAID:	United States Agency for International Development

UNDP:	United Nations Development Programme
UNEP:	United Nations Environment Programme
UNESCO:	United Nations Educational, Scientific and Cultural Organisation
VMS:	Vessel Monitoring System
WIO-LaB:	UNEP-GEF WIO Project Addressing Land-Based Sources and Activities
WIO:	Western Indian Ocean
WTTC:	World Travel and Tourism Council
WWF-EAME:	World Wildlife Fund – Eastern Africa Marine Ecoregion

1. COUNTRY OVERVIEW

Mozambique is located in the South-Eastern part of the African Continent between latitudes 10°27'S and 26°52'S and longitudes 30º 12'E and 40º 51'E (Figure 1). The country has a total surface area close to 784,032 km^2 subdivided into 10 provinces. The population is slightly more than 20 million people, most of which is concentrated in the southern provinces of Maputo, Gaza and Inhambane and in central and Northern provinces of Zambézia and Nampula. About 43% of the population resides within the coastal region of the country.

Despite relatively good economic growth rate of 7.5% according to 2007 estimates, Mozambique is still dependant on foreign assistance. Also, about 50% of the population still lives below absolute poverty level. The UN Human Development Report published in 2010 ranked Mozambique as 165th out of the 169 countries covered. This low rating has been ascribed to the impact of HIV/AIDS, which has infected some 15% of the population and cut life expectancy significantly. Frequent droughts and crop failure have contributed to high poverty levels. The country also faces high levels of unemployment and illiteracy.

Due to its geographical location, the country is prone to several natural and man-induced disasters. The disasters that affect the country are droughts, floods, cyclones, epidemics, pestilence, bush fires and landslides. Some of these disasters, particularly floods and droughts are seasonal and cyclical in nature. Droughts and floods normally occur in the Southern and Central regions of the country. The cyclones are more frequent along the coast. The impacts of these natural disasters on livelihoods and infrastructures are enormous.

Mozambique has the third longest coastline in Africa, stretching 2700 km from Rovuma River in the North to Ponta do Ouro in the South. Coastal resources contribute significantly to the economy including the provision of social and economic benefits for about half of the population. This is particularly so in the key sectors such as fisheries, tourism, agriculture, mining and construction. Much of the wealth of the country is found along the coast which unfortunately is also the most vulnerable region (Sete *et al.* 2008). Since most of the population is concentrated along the coast, the pressure on coastal and marine resources is increasing. The problems of coastal erosion, sedimentation, water pollution, over-exploitation of resources, deforestation, reduction and modification of biological diversity, etc are becoming common along the coast.

Figure 1: Map of Mozambique

2. BIOPHYSICAL ENVIRONMENT

Description of the Coast and distinctive features

Mozambique is bordered by the United Republic of Tanzania in the north and, in the South and Southwest by the Kingdom of Swaziland and the Republic of South Africa. In the West, the country is bordered by the Republics of Malawi, Zambia and Zimbabwe. The coast is characterized by a high diversity of habitats including sandy beaches, coastal dunes, coastal forests, swamp, mangroves, and estuaries. According to Chemane *et al.* (1994), the coast can be characterized into four major coastal types:

1) The Coral Coast with an area of approximately 770 km^2 extending from Rovuma River in the north to the Ilhas Primeiras and Segundas (Latitude 17°20' S).

2) The Mangrove Coast extending 987 km from Angoche (Latitude 16° 14'S) to the Bazaruto Archipelago (Latitude 21° 10' S).

3) The Delta Coasts which occur in the mouths of Zambezi and Save Rivers.

4) The Parabolic Sand Dune Coast covering a distance of 850 km in the region between Bazaruto Archipelago and Ponta de Ouro (Longitude 26° 52' S).

i) Issues

- A study carried out by the ENVISION (2006) under the ODINAFRICA project, identified coastal pollution, overfishing and coastal erosion as the main environmental issues associated with the coastal and marine environment.

ii) Gaps

- There is a need for generating baseline data on the coastal and marine systems in Mozambique. Although there are some data on fisheries, there is a lack of data on pollution and coastal erosion processes.

General description of the climate

Mozambique generally has a tropical humid to sub-humid tropical climate with a relatively dry winter season (Kunder 1975). The region north of the Zambezi River is under the influence of the equatorial low pressure zone, with NE and SW monsoon influence during the southern summer (October-March) and winter (May-August). The central and southern Mozambique, south of Zambezi River, is influenced by the Indian Ocean subtropical anti-cyclonic system with SE trade winds (Saetre and Silva 1979).

Most of the precipitation, about 90%, falls during summer in the period between November and April (Kunder 1975). Rainfall is influenced by the East African Monsoon System in the north and the Indian Ocean Sub-tropical Anticyclone System in the south. The annual average rainfall is about 1100 mm, with about 20 to 40% year-to-year variability. The highest rainfall (1200-1600 mm) occurs in central Mozambique in the transition zone between monsoon and the sub-tropical Anticyclone systems. The driest part of the coast is south of Pemba where rainfall is less than 800 mm (Kunder 1975). Southern Mozambique, under the influence of an anti-cyclonic system receives rainfall ranging from 800 to 1,000 mm per year. The tropical cyclones occur regularly during the late NE monsoon period.

The average annual temperature is 23° C along the southern coast and 26°C along the northern coast. The average relative humidity is 69% (Kunder 1975). The north of the country has the highest temperature, with a yearly average ranging 25°-26°C in the coastal lowlands. The period of highest temperatures coincide with the period of highest rainfall. Also, the humidity is relatively higher during the NE monsoon as compared to the SW monsoon.

i) Issues and Gaps

- The livelihood of the majority of the people in Mozambique depends on agriculture and therefore rainfall is

important. Rainfall patterns are, however, changing. There has been an increase in the frequency of extreme events such as floods and droughts in Mozambique. Heavy rainfall in the central part of the country which is low-lying causes flooding. The socio economic impacts of floods include human displacement, loss of human life and property, damage to infrastructure e.g. roads and bridges. Drought causes shortage of water, reduces agricultural production and generally causes food shortage. Both floods and droughts also cause habitat degradation and modification.

- There is lack of long term climatic data for most parts of Mozambique. There is also lack of recent meteorological data. Most of the station records are short meaning their use in predicting extreme events is limited. The accurate prediction of flooding and droughts requires long time series of data (rainfall, temperature, pressure, etc). In addition, only a few meteorological stations are currently operational in Mozambique. Hence, there is a need to upgrade the existing stations and to establish new ones to improve the spatial coverage.

Marine and coastal geology and geomorphology

The genesis of the geological units of Mozambique is related to the movement of tectonic plates. Most of the terrain consists of phanerozoics having being formed between the Pre-Cambrian and the Quaternary periods (Afonso *et al*. 1998). The Protozoic geologic era encompassed the pre-Gondwana, Gondwana and Post-Gondwana formations. The most important episode in the Gondwana formation was the formation of a trench between Africa and Madagascar. The expansion of the seabed which occurred during this phase was followed by marine transgression over the eastern margin of Mozambique. This transgressive episode is responsible for the sedimentary deposits which form the coast of Pemba and Maputo. In the same period due to the faulting, the tectonic activities formed the regions of Sena, Mágue and Maconde (Afonso *et al*. 1998)

A much more stable phase occurred from the Cretaceous to the upper Eocene. The Neorifting phase occurred from the Oligocene up to the present, during which areas such as Inharime, Morrumbene, Inhaminga, Querimbas and Lacerda were formed. The main basins such as Rovuma, Save, Zambezi and Limpopo were created during the Post-Gondwana phase (Afonso *et al*. 1998).

The coastal region of Mozambique is characterized by lowlands that rise landward to above 200m, fifteen to 40km from the shoreline. The coastline is characterized by beaches, recent dunes and inland lagoons in the south, by mangrove forests, swampy depressions and series of low beach ridges in the central region. Small dunes alternating with cliffs are found further in the north. The alluvial valleys have fertile clay soils and are covered by steppe-like vegetation. There are also extensive plains and inland dunes with poor sandy soils and savanna vegetation (Afonso *et al*. 1998).

i) Issues

- Major issue is the loss and modification of ecosystems and habitats, linked to coastal erosion and deposition processes due to human activities and by flooding due to storm surge and river discharge.

ii) Gaps

- There is a need to monitor the changes of the coastline and to determine factors controlling the sediment dynamics (i.e. erosion and deposition processes). In particular, there is a need to determine the effect of the vegetation in the stabilization of coastal sand dunes and mangrove fringed coasts. Since most of the Mozambique coast is characterised by lowlands, there is a need to map the vulnerability of these areas to flooding. There is also a need to set up a network of seismic stations along the coast and inland in order to monitor seismic activities.

Freshwater resources and drainage

Mozambique has an extensive drainage network that includes about 100 principal river basins and a number of international rivers. The international rivers originate in the Central African plateaus discharging their waters into the Indian Ocean through Mozambique (Afonso *et al*. 1998). These rivers include the Rovuma, Zambezi, Save, Limpopo and Imcomati Rivers. The most important national rivers systems are the Lúrio, Licungo, and Messalo Rivers.

The surface runoff generated within the country per year is estimated to be 80 x$10^9 m^3$, which corresponds to approximately 10% of the mean annual rainfall. About 70% of the river runoff occurs in the rainy season (Kunder, 1975). However, the runoff entering the country through the international rivers is higher being 95 x $10^9 m^3$. The Zambezi River contributes most of this volume, with approximately 81 x $10^9 m^3$. Runoff of these rivers has decreased progressively over the years, as water is used for development in neighbouring countries such as South Africa, Swaziland, Angola, Zambia, Malawi, Zimbabwe, among others. A number of lakes are found in Mozambique. The most important are the Niassa, Chirua, Chiúta and Amaramba.

The region between Mozambique Island and Bazaruto Island is influenced by several large rivers that drain into the sea through estuarine and delta systems. Some examples of these systems are the Pungué and Bons Sinais and the Zambezi. The impacts to the coast by these rivers are due deposition of materials as well as coastal erosion due to the strong currents at the river mouths. Coastal erosion and sediment deposition are impacting negatively on the tourism, environment and transport sectors (Afonso *et al*. 1998).

i) Issues

- The major issue is the modification of streamflow leading to freshwater shortage, reduction or excessive runoff. Human activities in Mozambique and neighbouring countries have modified river flow through retention of water for irrigation, domestic and industrial use and construction of dams for electricity generation. The HEP production requires the maintenance of artificial runoff throughout the year, which is often high during the dry season and low during the rainy season, compared with natural flows. The rivers influence productivity of downstream ecosystems. For instance, the Zambezi river discharge is associated with an increase in the catches of shallow water shrimp in the Sofala Bank (Gammelsrød 1992). The artificial flow or freshwater shortage has negative impacts on the health and integrity of the downstream and coastal ecosystems. Further, shoreline stability in the estuaries and adjacent coast is mostly dependent on the input of sediments from rivers. Given that sediment dynamics is governed by the river runoff, freshwater shortage leads to sediment deficit, and consequently coastal erosion prevails.

ii) Gaps

- In order to safeguard the health and integrity of the downstream coastal ecosystems, there is a need to maintain environmental flows. The major challenge in maintaining environmental flows include lack of understanding of the ecosystem structure and functioning. The interactions within and between ecosystems are complex and require multidisciplinary research approaches. There is also a gap in the understanding of the coupled river basin and coastal systems including the main drivers of ecological, hydrodynamics and morphodynamic changes in the estuaries and coastal waters. There is a need to set up and maintain an operational network of the river gauging stations to provide data to support modelling and predicting of floods in Mozambique, including facilitating water resources management and planning.

Physical Oceanography

Offshore Currents

The Mozambique Channel is an important source region for the Agulhas Current which is one of the major western boundary currents flowing along the Southeast coast of South Africa (Ridderinkhof and de Ruijter 2003). The channel is also one of the two routes through which South Equatorial Current feeds the Agulhas Current (Lutjeharms 1976, Stramma and Lutjeharms 1997, Scott and McCreary 2001). Studies carried out by Ridderinkhof and de Ruijter (2003), Harris (1972), Saetre and da Silva (1984), and Nehring *et al*. (1987) have all identified both anti-cyclonic and cyclonic eddies in the Mozambique channel.

Recent satellite altimetry observations (Grundlingh 1995, Stammer 1997, Schouten *et al*. 2002a), drifter observations, and outputs from numerical models (Biastoch and Krauss 1999), have revealed that large-scale eddies are often present and moving southward through the Mozambique Channel. After leaving the Mozambique Channel, these eddies interact with the Agulhas Current creating a disturbance that deflects the Agulhas Current from the continental slope (Schouten *et al*., 2002a) to trigger the so-called Natal pulse (Lutjeharms and Ballegooyen 1988). In turn, this disturbance triggers shedding of Agulhas Rings (Van Leeuwen and de Ruijter 2000) which is an important contribution to the leakage of Indian Ocean waters into the South Atlantic (Gordon 1986, De Ruijter *et al*. 1999). On a large scale, the regular appearance of eddies in the central

Mozambique Channel seems to be connected to the variation in the intensity of wind in the Equatorial Indian Ocean (Schouten *et al*. 2002b).

i) Issues

- Global oceanic circulation drives the productivity, distribution and abundance of phytoplankton and fisheries, through convergence/divergence and upwelling. Thus, it controls the health and productivity of the marine ecosystems. Hence, the major issues related to global circulation of the Mozambique Channel are the productivity of the marine ecosystems, biodiversity conservation, atmospheric carbon dioxide regulation and climate change.

ii) Gaps

- Recent studies revealed that the circulation of the Mozambique channel consists of a series of eddies moving southward. The ecological impacts of the eddies are not well understood. There is a need to conduct studies aimed at understanding the ecological implication of eddies, particularly with regard to their influence on fish and fisheries distribution. In addition, there is a need to build capacity in modelling, including studies of physical and biological processes.

Tidal regime and waves

Tides in Mozambique coast are predominantly semi-diurnal. The tidal range varies between 5.20 m in Pemba, 5.9 m in Beira, decreasing to 3.49 m in Maputo (Canhanga *et al*. 2007). There is a lag phase and an increase in the amplitude as the tide approaches the coast (Canhanga and Dias 2005). The inclination of the bottom topography coupled with strong surface tides makes the Mozambique Channel very important in the generation of internal waves (Le Provist 2001, Manders *et al*. 2004).

Studies carried out by Cossa (2001) on the occurrence of internal waves along the Mozambique Channel, revealed that the internal waves exhibited wavelengths varying from 6.5 to 250 km. However, surface waves have wavelengths varying from 0.5 to 2 km. Analysis of seasonality of the internal waves showed that contrary to the south of Mozambique channel where internal waves occur only in summer, in the northern part of Mozambique channel, internal waves occur also in winter. This seems to be related to the variability of the stratification due to the variation in the heating of the water column.

i) Issues

- The vulnerability of the coast to coastal erosion and flooding depends partially on the tidal dynamics and surface waves. There is a need for establishment of additional sea level monitoring stations in addition to building the capacity for the analysis of sea level data. This would enable prediction of the future patterns of sea level rise in Mozambique.

ii) Gaps

- Mapping of the vulnerability of the coast to flooding and erosion requires knowledge of the tides and waves. A number of tide gauge stations have been installed in main harbours such as Beira and Maputo. However, no tide gauges have been installed within the continental shelf. There is also no wave gauge in the Mozambican waters. Therefore, there is a need to establish a network of oceanographic buoys along the coastal waters to monitor tides and waves. Further, there is a need to build capacity in wave modelling and studies of oceanographic processes.

Sea Level Change

The National Institute of Hydrography and Navigation (INAHINA) is responsible for the monitoring of sea level in Mozambique. There are 13 tide gauge stations that are contribute to the Permanent Service for Mean Sea Level (PSMSL) which is part of the Global Sea Level Observing System (GLOSS) program of the Intergovernmental Oceanographic Commission (IOC) (Mundlovo *et al*. 2007). However, monitoring of the sea level in Mozambique is constrained by budgetary limitations. Currently, only five stations are operational. These stations are located in Inhambane, Pemba, Nacala, Beira and Maputo.

The current information on sea level changes in the coastal area of Mozambique is based on the results of global

models such as those constructed by Church and White (2006). A recent study of sea level change was done by Ruby *et al*. (2008). This was based on tide data at Maputo harbour and the neighbouring stations in the Republic of South Africa (Richards Bay).

i) Issues

- The impacts of sea level rise on the physical structures, resources and on living organisms might be severe in Mozambique due to the lowlying nature of the coast. In Mozambique, the consequences of sea level rise could be severe because main cities are also located in highly vulnerable zones. The specific impacts of sea level rise in Mozambique are yet to be fully established.

ii) Gaps

- There is limited capacity for prediction of future changes in climate and sea level in Mozambique. There is also a lack of continuous monitoring of the sea level and its impacts on marine and coastal ecosystems. There is also no capacity for monitoring waves and storms. Satellite remote-sensing is not widely used.

Ocean Temperature

A number of oceanographic cruises have been undertaken in Mozambique in the period between 1975 and 1980 (Lutjeharms and Da Silva 1988). The summary is presented in Table 1.

Table 1: Cruises carried out in Mozambique waters in the period 1975 and 1988

Cruise	Years
Dr Fridtjof Nansen	1977, 1978, 1980, 1990, 2009
Myslitel	1978
Nikolay Reshetnyak	1978, 1979, 1986
Ernst Haeckel	1979, 1980
Alexander Von Humboldt	1980

Conductivity, Temperature and Density (CTD) data for some stations has been collected by the National Fisheries Research Institute (INAHINA) and the School of Marine Sciences of the Eduardo Mondlane University. Some studies such as Sete *et al*. (2008) and Langa (2006) resulted from these data. The most important papers published in the field of water masses are the work of Lutjaharms and Da Silva (1988), Sætre and Silva (1979, 1982), Hoguane (2007) and Gammelsrød and Hoguane (1987). Many other international oceanographers have contributed in this topic, such as Quartly and Srokosz (2004) who analyzed sea surface temperature anomalies using the imagery of the SeaWiFS satellite.

Work aiming at assessing the impact of the increase in sea temperatures associated with the 1997-1998 El Nino Southern Oscillation (ENSO) has been carried out in Mozambique in collaboration with the Ministry for Coordination of Environmental Affairs (MICOA), Institute of Fisheries Investigations (IIP), Universidade Eduardo Mondlane (UEM), Coastal Oceans Research and Development in the Indian Ocean (CORDIO) and Oceanographic Research Institute (ORI) (Schleyer *et al*. 1999).

i) Issues

- One of the major issues is increase in sea temperature brought by the global climate change. Increased temperatures cause coral bleaching and subsequent modification of marine ecosystems. Thermal expansion of the ocean will lead to sea level rise and consequent flooding of the lowlying coastal areas. The death of corals will impact biodiversity and tourism, and the associated reduction in ocean productivity will result in reduction in fisheries production, which will have substantial socio-economic impacts.

ii) Gaps

- There is a need for repatriation of data collected by past cruises. The data which is currently found in foreign institutions needs to be archived in the Mozambique Oceanographic Data Center (CENADO) in order to enable easy access by local scientists and institutions. The major drawback however, is that only few

of the cruises carried out in Mozambique Channel are officially known. However, the foreign institutions that are known to have Mozambique data should be approached and requested to repatriate the same to the National Oceanographic Data Center. In addition, there is a need to set up a system of monitoring oceanographic cruises and data collection in fixed buoys established within the EEZ of Mozambique.

Salinity patterns and Water Masses

The Regions of Freshwater Influence (ROFI) in Mozambique include Maputo Bay and Sofala Bank (Silva *et al.* 2010). Within the Mozambique Channel, a salinity maximum exists at a depth of between 150 and 300m. The Central Water lies in the depths ranging from 300 to 600 m. This water originates from the sinking of mixed waters north of the subtropical convergence. The Intermediate Waters are of two types in Mozambique Channel, namely, the low salinity water of Antarctic origin (Sub-Antarctic Intermediate Water) and the high salinity water originating from the Northern Indian Ocean. The high salinity water is formed in the Arabian Sea with contribution of water from the Red sea and the Gulf of Oman, while the other is formed at between latitudes 50 and 55º S. The Deep and Bottom Waters are encountered at depths between 2700 and 3200 m in the southern part of the Channel. This is caused by an intrusion of the North Atlantic deep water which is probably forced back to the south by the shallow topography of the channel (Saetre and Da Sliva 1982).

i) Issues

- Salinity and temperature determine water masses, circulation patterns and ecosystem structure and functioning. Key ecosystems most influenced by salinity are those located in the vicinity of mouths of major rivers which are also the nursery grounds that support large population of fish and crustaceans. In the open sea, the subtropical gyres are regions of formation of subsurface water masses. Salinity influences both the open sea ecosystem structure and productivity and dissolution of carbon dioxide into the water column which brings the global climate change dimension.

ii) Gaps

- There is limited understanding of ocean water mass structure and dynamics in Mozambique. The influence of global climate change in the Mozambique Channel is also not known. Understanding the structure, productivity and overall dynamics of the coastal ecosystem under the influence of freshwater input requires a relatively high time and space resolution of salinity data. Most of the data collected in cruises carried out in the Mozambique Channel are intermittent, not allowing for a sufficient time series to resolve for global climate change trends. Most of the data cannot be found in the National Data Centres. The few data collected in coastal waters do not have sufficient resolution to resolve for some highly dynamic features. Therefore, it is suggested that a set of network stations for systematic observation of oceanographic parameters be established along the coast and hydrodynamic models be developed to cater for resolution limitations of the data and for prediction of future scenarios.

Ocean Atmosphere Interactions

Studies on ocean-atmospheric interaction are rare in Mozambique. However, some relevant information related to the Indian Ocean "Dipole" (IOD) was obtained. IOD impacts climate in northern Mozambique, and a positive phase is characterized by intensified easterlies and large changes in equatorial circulation, low SST anomalies in the eastern tropical Indian Ocean, caused by intensified equatorial and Sumatra Upwelling. The IOD positive anomaly on the northern coast of Mozambique, produces heavy rainfall. The northern part of the channel is characterized by a strong anticyclonic curl associated with strong convergence. It is also a sensitive area for air-sea interactions on inter-annual time scales. More than 35 cyclones have affected extensive areas of Mozambique since 1946.

i) Issues

- The environmental issues related to ocean and atmosphere interaction are those related to global oceanic circulation and water, heat and gases budgets, with particular emphasis on carbon dioxide uptake into the ocean. These issues are poorly studied in Mozambique.

ii) Gaps

- The major gap in knowledge related to ocean atmosphere interaction is with regard to the determination of the extent to which atmosphere drives the ocean circulation. Information on the role of cyclones in the dynamics of the upper layer in Mozambique Channel are not well known. There is a need for studies to determine whether cyclone generation will increase as climate changes. There is a need for studies on the fluxes of particles and gases between the ocean and the atmosphere, with emphasis on carbon dioxide and particles emitted from industries. There is however limited capacity for studying ocean-atmosphere interactions in Mozambique.

Chemical and Biological Oceanography

This section provides a summary of what is known about the chemical and biological oceanography of the Mozambique coastal and marine waters. The available information on these subjects was collected during the Portuguese and French research conducted in the 1960s. Further research were undertaken on-board the research vessel, *Dr. Fridtjof Nansen* in 1970s, 2007 and 2008.

Nutrients

The general circulation in the Mozambique Channel is apparently highly influenced by the ocean bathymetry. Dynamic processes associated with eddies such as eddy induced upwelling or eddy interaction, drive transport and distribution of nutrients which support the whole marine food chain. It has been documented that eddies can shape the distribution of both phytoplankton, zooplankton and fish larvae (Lutjhearms 2006). Eddies flowing along the coast may cause the advection of coastal rich waters at their edges and move nutrients into the channel.

The main sources of dissolved inorganic nutrients in coastal zones of Mozambique are the rivers (Hoguane 2007, Gammelsrød and Hoguane 1987, 1996 and Sætre and Silva 1979). The Sofala Bank located between the latitudes 16º S - 21ºS, is influenced by the discharges from Zambezi, Pungué, Buzí and Save rivers. It is one of the most productive shelf regions of Mozambique (Lutjeharms 2006, Barlow 2007, 2008). The results from the R/V Dr. Fridjof Nansen cruise in 2007, showed a clear variability of nutrient concentration, with the highest concentrations occurring in the Angoche shelf area in the north, Sofala Bank in the central region and Delagoa Bight in the southern shelf region.

i) Issues

- The issues related to biogeochemical cycles are related to the primary production, and since the primary producers sustain all the organisms in the food web, issues consequently relate to biodiversity maintenance, health and productivity of the ecosystems and habitats.

ii) Gaps

- The biological and oceanographic characteristics of the Mozambique Channel and adjacent shelf regions are poorly known due to the lack of research in these regions. Further work should be conducted to determine the role of eddies in the biophysical functioning of the Mozambique Channel.
- There is a gap in knowledge of the influence of nutrient inputs through rivers and rainfall. The contribution of mangroves in the primary production of the coastal waters is poorly understood. There is an overall lack of data on nutrient variability in Mozambique. *In-situ* nutrient measurements in the open sea are expensive.

Persistent organic pollutants

The Mozambique Channel is an important route for large oil tankers. Since there is no control on tank cleaning in the deep sea, the risk for contamination of waters by POPs is high. In 1992 more than 16,000 tonnes of heavy fuel-oil were spilled by the *Katina P* tanker off the Mozambique coast threatening the coastal and marine ecosystems. Eddies travelling from the north to the south may concentrate pollution in localized areas within the Mozambique Channel in the case of oil spills. However, it is known that main sources of pollution are land-based, particularly those associated with domestic waste from coastal cities and from activities such as agriculture, industries, mining and commercial operations in ports and harbours. Most Mozambican coastal cities have obsolete

systems for sewage treatment. Thus many pollutants enter marine waters untreated.

Sewage and Domestic Solid Wastes

Faecal coliform content in the water within the Mozambique channel adjacent to the Infulene River in Maputo is high ($4.6x10^5$ bacteria counts/100 ml). In the river mouth it exceeds 2400 bacteria counts/100 ml. Faecal coliform, faecal streptococci and *E. coli* have also been detected in both marine waters and in shellfish tissues in Maputo Bay. The concentrations found in shellfish is extremely high. Some places in Maputo Bay, particularly where the discharge of sewage takes place, such as Miramar at the entrance of the Maputo Estuary, are not safe for swimming. High levels of microbial pollution have also been found at Beira and Nacala Bays, although the concentrations are low compared to those observed in Maputo Bay (Motta *et al*. 1998). There is only one wastewater treatment plant in the country, located in Maputo at the mouth of Infulene River.

Eutrophication

High levels of BOD and COD and low dissolved oxygen (DO) content have been detected in the Infulene River. The presence of water hyacinth and *Pistia* is a clear evidence of nutrient enrichment (Motta *et al*. 1998). Although no data are available, it is believed that the situation in Beira is similar to that of Maputo.

Untreated industrial waste

Most of the industries in Mozambique are located in coastal cities such as Maputo, Matola and Beira. Most of the industries do not have adequate industrial effluent treatment facilities. Thus industrial effluents are discharged directly into tidal channels or in coastal waters causing pollution. Analysis by the National Laboratory for Food and Water and Maputo Water Authority have revealed the presence of heavy metals particularly lead in different locations within the Port of Maputo, in the mouths of Matola and Maputo rivers and in Nacala Bay.

Agricultural run-off

Agricultural activities within the coastal region and in the hinterland areas also contribute to the pollution of coastal, marine and freshwater environment, through sediments, pesticides and fertilizer residues. Since most of the agricultural activities takes place along or close to main river channels, rivers are the main pathways through which agrochemicals enter the coastal and marine environment. The major rivers with intensive agricultural activity are Monapo (in Nampula Province), Zambezi, Pungoé, Limpopo and Incomati. The hinterlands of these rivers are important agricultural areas extending to neighbouring countries (Massinga and Hatton 1997). The contribution of Mozambican farming to the pollution of waters of these rivers is however negligible.

Oil spills

The main international ports in Mozambique are Maputo, Beira and Nacala. The port of Beira handles mostly petroleum products and has the largest petroleum refinery with a capacity of nearly 110 000 m^3. The pipeline transporting petroleum to Zimbabwe is connected through the port of Beira. About 1 to 1.5 million tonnes of petroleum are pumped to Zimbabwe through this pipeline every year. There are other ports in the country where oil is pumped with associated oil spill risks during the course of operation.

Pollution from ships along the Mozambican coast is often related to: (i) oily bilge water and oil sludge from engine rooms discharged at sea, (ii) accidental oil spills from damaged tankers, and (iii) blasting and cleaning operations. It is estimated that approximately 450 million tonnes of hydrocarbon products transit annually through the Mozambique Channel. These are transported by large crude oil carriers. The risk for oil spill is therefore high. The prevailing winds (South-easterly trade winds) make the Mozambican coast vulnerable, as evidenced during the Katina-P oil spill in 1992 near Maputo Bay (Massinga and Hatton 1997).

Suspended solids

Poor land-use practices which include poor farming and deforestation in the hinterland are the main reasons for the excessive inflow of sediments into the coast of Mozambique (Hatton 1996). In Maputo and Beira bays, the siltation is further aggravated by dredging of the navigational channels. A recent survey by the dredging company EMODRAGA indicated that about 1,200,000 m^3 and 2,500,000 m^3 of sediments are dredged annually in the ports of Maputo and Beira, respectively.

i) Issues

- The main issue is pollution of the water courses, coastal and marine environment. The major types of pollution are: microbiological due to sewage and domestic solid waste; chemical pollution due to industrial and agricultural activities. The sources of pollution are localized - mainly located in major cities. The environmental consequences of pollution include decline in water quality, degradation of ecosystems, loss of biodiversity, etc. Socio-economic and health impacts are high. Mozambique ha limited capacity for addressing all forms of pollution.

ii) Gaps

- Although land based sources of pollution are localized, there are limited resources to monitor and control pollution. Also, few comprehensive studies have been undertaken on the extent of pollution within coastal waters of Mozambique. Hence, there is a need for establishment of a network of stations to monitor pollution in the main point sources along the coast. There is also a need to model the hydrodynamic processes that may influence transport and dispersion of contaminants in coastal waters. Also, there is a need to construct vulnerability map of the coast to oil spills. Capacity in these areas is however limited in Mozambique.

Primary production

The Mozambique Channel is divided into three sub areas. In the north and south channel, the seasonality of chlorophyll concentration (CC) is mostly controlled by physical processes while in the central channel, the controlling mechanism is mesoscale eddies (Tew-Kai and Marsac 2008). The interactions between eddies generate strong dynamic barriers at meso and sub- mesoscale favourable to phytoplankton. Inter-annual variability of mesoscale eddies is negatively correlated to the inter-annual cycle of CC, confirming the importance of cyclonic activity in the central part of the channel.

A study to assess variations in phytoplankton biomass and primary production was conducted in the Delagoa Bight region (Kyewalyanga *et al*. 2007) and the results showed that the variations were mainly influenced by hydrographic conditions of the region. Out of the measured nutrients, nitrate concentrations showed some good correlation with both chlorophyll-*a* concentration (phytoplankton biomass) and primary production.

The result of analysis from the RV Dr. Fridjof Nansen survey 2007 (Johnsen *et al*. 2008), showed the abundance and composition of major taxonomic groups. The results obtained for the first part of the cruise (September to October 2007) in the south region (Delagoa Bight) showed existence of high concentration of Chlorophyll-*a* as well as cyanobacteria, diatoms and coccolithophores. Two stations, located near the coast in the south region in the Delagoa Bight, registered the highest biomass dominated by diatoms. The presence of cyanobacteria from picoplankton (cells < 2 μm) and coccolitophores in the open sea stations is another typical feature in this area.

i) Issues

- The issues related to primary production are the biodiversity maintenance, health and productivity of the ecosystems and habitats, following nutrient input to the euphotic zone by the rivers or upwelling systems.

ii) Gaps

- There is a gap in knowledge in determining the role of the hydrodynamics, particularly eddies, in the upwelling of nutrients, and hence in the primary production in the open sea. The role of river discharge in nutrient dynamics is also poorly known. Also, there is little knowledge on influence of mangroves in nutrient outwelling into the coastal waters. There is therefore a need of studies in these areas. Models and satellite remote sensing data should be used to supplement *in situ* observations.

Secondary production

Hydrodynamic processes, nutrient availability, phytoplankton, zooplankton and larval fish abundance and distribution have been investigated in some areas of Mozambique coastal waters such as the Sofala Bank during the "*Dr. Fridtjof Nansen*" Survey, September to December 2007 (Saetre and Da Silva 1979). The results showed

that zooplankton horizontal distribution was greater at the region where estuarine influence is dominant. In this region, phytoplankton biomass was concomitantly lower due to high grazing pressure (Leal *et al*. 2009).

Previous studies have also shown that maximum plankton abundance occurs over the continental shelf slope. This is a transition zone between the south-flowing Mozambique current and shelf counter current. During the night, plankton is more or less evenly distributed in the whole water column in the shelf area. The lowest plankton abundance occurred during the southern summer and the maximum values were observed in September–October period. Preliminary results from the ASCLME Project, during the Dr. Fridtjof Nansen survey 2008 in the North of Mozambique, suggest that warm-core eddies contain overall very little zooplankton as compared to cold-core eddies and frontal boundary regions.

i) Issues

- The issues related to secondary production are linked to conservation of biodiversity and fisheries production. There are therefore related to ecosystem health and productivity. Healthier and diverse ecosystems lead to higher fisheries production.

ii) Gaps

- There are few studies on plankton in the Mozambique Channel. These are focussed on Sofala Bank and North Mozambique coast (Lutjeharms 2006, Barlow 2008, Leal *et al*. 2009). There is a need to study the role of the currents and eddies on the transport and retention of the plankton. In addition, there is a need to conduct surveys of species composition in order to determine the biodiversity of the plankton in the Mozambique Channel.

Coastal zone and continental shelf

Description and extent of coastal and marine habitats

Mozambique possess the third longest coast line in the Western Indian Ocean (2,700 km). The continental shelf averages 15 to 25 km in width. However, it can be as narrow as 100 m in some places such as in Pemba in northern Mozambique. It can also be as wide as 145 km as in the case of Sofala bank. Total continental shelf area is about 104,300 km^2 (Hoguane and Pereira 2003). The Mozambique coast has been conveniently divided into three major natural ecoregions. These are: the coralline coast, the swamp coast and the parabolic dune coast. A fourth type, the delta coast, is very restricted and only occurs at the mouth of the Zambezi and Save rivers. Two highly productive areas are recognized, being the Sofala Bank and Maputo Bay. The contribution of the two areas through their rich fisheries to the economy of Mozambique is enormous. The northern coast is renowned for holding most of the marine protected areas rich in biodiversity.

Coral Reefs

The coral reefs of Mozambique are the southern continuation of the well-developed fringing reefs that occur along major sections of the fairly narrow continental shelf of the East African coast of Somalia, Kenya and Tanzania and around the offshore islands between latitude 5°N and 15°S. The reefs are broken by large river outflows and are most extensive where the shelf broadens around islands.

Fringing reefs are confined to the northern coast and extend south to Mocambo Bay (15°09'S). North of Angoche, reefs are common close to the mainland and become more extensive and shallower towards the north. From Pemba northwards, the islands are much more common almost continuous, some reaching substantial sizes. Rich reefs are found at Pinda off the peninsula south of the Lurio River, and between Pemba and Mecufi. Islands are also much more common along this northern stretch. The barrier shoal from Moma to Angoche has two strings of small islands - the southern string known as the Primeiras and the northern one known as the Segundas.

From Moma southwards to the South African border, rocky reefs with scattered coral are extensive but at only few places are they attached to islands or the mainland. Most of them occur off shore at 3-30 m depth. South of Pebane, there are few islands -those that exist such as in the Bazaruto Archipelago and Inhaca Island are relatively large and were once part of the mainland. The largest gap in coral distribution is in the Sofala Bank, with its widest shallow continental shelf and turbid waters associated with the discharge of Zambezi

River. Inhaca Island is reported to be the southernmost coral reef of the African mainland, although coral communities extend southwards into South Africa.

Mozambique corals are vulnerable to the effects of the El Niño. The 1997-1998 El Niño southern oscillation (ENSO) phenomenon caused extensive coral bleaching due to an increase in temperature beyond tolerable level (Schleyer *et al*. 1999, Motta *et al*. 2002).The regeneration of corals after the El Niño in some cases did not occur. In areas where corals are under intense fishing pressure and where human interference is high, no improvement has been observed (Schleyer *et al*. 1999). The other threats to reefs include sedimentation, flooding, beach seining, fishing nets and trampling.

Mangroves

Mangroves occur along almost the entire coast of Mozambique mostly in sheltered shorelines and estuaries. A total of 396,080 ha of mangroves occur in the entire country (Barbosa *et al*. 2001). Population growth in coastal regions, associated with the development in tourism has continued to increase the rate of mangrove depletion.

The northern sector has numerous islands (including the Quirimbas archipelago) that provide protected coastlines suitable for mangroves. Here, the topography is highly indented, the coastal plain is narrow, the rivers are not tidal and mangrove forests are mostly confined to the vicinities of their mouths. The central sector has extensive and well established mangroves because of the alluvium and freshwater discharge. The estuaries of big rivers such as the Zambezi, Púnguè, Buzi and Save are all in the central part of Mozambique. The mangroves of the Zambezi delta extend 50km inland. This mangrove zone is continuous from the south up to Quelimane covering close to 180 km of coastline. This zone is one of the largest extents of mangrove forests in Africa representing close to 50% of Mozambique mangroves (Barbosa *et al*. 2001).

The southern sector has extensive mangroves in Morrumbene estuary, Inhambane bay, Maputo bay and Inhaca Island. Maputo bay with its four main river inlets in the bay is one of the major mangrove areas in southern Mozambique (Barbosa *et al*. 2001).

The major threats to mangroves in Mozambique are:
(i) Uncontrolled exploitation for firewood, charcoal and pole production.
(ii) Clearance for agriculture (mainly to pave way for rice fields) and salt production.
(iii) Increased coastal pollution particularly discharge of sewage and industrial effluents.
(iv) Reduction of freshwater flow due to dam construction and abstraction.
(v) Uncontrolled influx of people from mainland to the coast leading to increased overexploitation of mangroves (Barbosa e*t al*. 2001).

In order to improve the marine aquaculture in Mozambique, the government created the Instituto Nacional de Desenvolvimento da Aquacultura (INAQUA). This institution has been identifying potential areas for aquaculture development in Mozambique. At the moment there are no negative impacts of aquaculture on the mangroves that have been identified in Mozambique.

Seagrass beds

Seagrass beds are a common habitat especially in the South and North of the country. Seagrasses occur in areas of gentle slope and protected conditions, forming homogeneous beds. In some cases, associated with corals reefs and algae beds. The thirteen species of seagrasses are found in Mozambique grouped into the families Hydrochartytaceae, Zoateraceae, Cymodoceae and Rupiaceae. The main species are *Cymodocea rotundata, Cymodocea serrulata, Halodule minor, Halodule uninervis, Halodule wrightii, Halophila ovalis, Halophila stipulacea,* S*yringodium isoetifolium, Thalassodendron ciliatum, Thalassia hemprichii, Nanozostera capensis* and *Enhalus acoroides*. The main threats to seagrasses are beach seining, trampling and sedimentation.

i) Issues

- In general, the major issues are loss and modification of the ecosystems and habitats due to overexploitation, use of inappropriate harvesting practices, unplanned settlements and urban expansion. The mangroves, seagrass beds and corals are experiencing various levels of threats. Most of the threats are anthropogenic.

The impacts of global climate change on coral reefs is an important issue. The El Nino of 1997 bleached corals in 90% of the Mozambique (Schleyer *et al*. 1999). The most affected reefs were those found in the north and the effects diminished considerably further south except at Inhaca Island. A collapse of coral reef structure on the seriously bleached reefs is expected in future. The fish populations on the damaged reefs, the basis of many of Mozambique's valuable artisanal fisheries, will be seriously affected in future.

ii) Gaps

- There is lack of understanding of the ecosystem structure and functioning. The interactions within and between ecosystems are complex and require a multidisciplinary approach.
- There is a need to conduct regular surveys in order to monitor the dynamics of the status and distribution of habitats, and determine the sustainable levels of exploitation.
- There is also a need to conduct research towards alternative livelihood activities and on the environmentally friendly fishing gears in order to reduce pressure on the ecosystems.
- There is also a need to develop sound integrated resource management strategies that will take into consideration ecosystem based approaches.
- There is a need to rehabilitate degraded ecosystems such as coastal dunes, corals, mangroves and seagrass beds. The capacity in this regard is limited.

Productivity of the coastal zone

Coral reefs

In Mozambique, coral reefs support 70% of artisanal fish catches (Schleyer *et al.* 1999) and provide a hugely important nursery ground for many species of commercially important marine species. The reefs in protected areas of Mozambique (e.g Lighthouse Reef – Bazaruto, Barreira Vermelha and Ponta Torres – Inhaca Island) or with limited accessibility (e.g Ponta Maunhane – Pemba), are in much better condition. They have higher values of coral cover, fish abundance and diversity and presence of fish of all size classes than reefs that are freely exploited (e.g. Sencar Channel, Goa and Sete Paus Islands) (Rodrigues 1999, Motta *et al*. 2002). Degraded reefs re-colonized by algae have a preponderance of herbivorous fish and reefs subjected to fishing pressure only have smaller sized fishes (Motta *et al*. 2002). The major threats to the productivity of reefs include global warming, sedimentation, pollution, use of destructive fishing practices and trampling. Several steps have been taken to protect coral reefs. These include monitoring reef recovery at bleaching and COTS sites and development of a management plan. This demands capacity building and financial resources (Schleyer *et al*. 1999).

Mangroves

There is no information on the productivity of mangroves in Mozambique. It is however appreciated that ecologically, mangroves play an important role as nursery and feeding grounds of many important commercial species of fish and crustaceans. Mangroves also provide a natural barrier for the prevention of coastal erosion. People in Mozambique use mangroves for building, firewood, fencing, fish trapping and medicine (Table 2). The productivity of mangroves is affected by deforestation which is a serious problem in urban centers such as Maputo and Beira. In Incomati, Benguelene Island, mangrove poles have been harvested at an annual rate of 9,234 metric tonnes/year. The vicinity of the cities of Maputo and Beira have the highest rates of deforestation.

Table 2: Uses of principal mangrove species in Mozambique (de Boer 2000)

Species	Common uses in Mozambique
Avicennia marina	Firewood, fish poles, dugout canoes, animal fodder , construction of beehives
Bruguiera gymnorhiza	Good firewood, fishing stakes, house construction
Ceriops tagal	Good firewood, charcoal, fishing stakes, poles used in house construction, timber for boat building
Rhizophora mucronata	Good firewood, fishing stakes, fish traps, poles used in house construction, bark used for dying nets

Species	Common uses in Mozambique
Sonneratia alba	Poles, firewood
Xylocarpus granatum	Good firewood, fish smoking, boat building, medicine for stomach ache

i) Issues

- The issues of major concern related to the productivity of the coastal ecosystems are resource availability and biodiversity conservation. The corals, mangroves and seagrass beds are most productive coastal ecosystems, sustaining large coastal and marine resources that in turn, provides livelihood to a large proportion of the population. This contributes considerably to the economy of the country. Unfortunately, these ecosystems are being degraded at a very high rate.

ii) Gaps

- There is a need to conduct research on the suitable indicators of the state of marine ecosystem health, including linkages between the state of ecosystems and productivity and resource availability. With regard to mangroves, there is a need to establish the main drivers determining the health of mangrove ecosystems. There is also a need to establish linkages between mangrove wetlands and the fisheries productivity in coastal areas. With regard to corals, there is a need to establish linkages between corals and fish abundance, taking into account the migratory stocks. With regard to seagrass beds, there is a need to establish linkages with fish stocks and in particular with the distribution and abundance of dugongs.

Fish and fish resources

The territorial offshore waters of Mozambique cover a surface area of about 100,000 km^2. The fisheries potential is estimated to be between 220,000 and 330,000 tonnes (Fisheries Master Plan 2010-2019). These correspond to 25,000– 28,000 tonnes of crustaceans (mainly shallow and deep water shrimps, lobsters and crabs), and 136,000 – 245,000 tonnes of marine demersal and pelagic fishes.

Various physical and ecological conditions in the three types of coastline in Mozambique determine the type of fauna present and the fishing operations that are undertaken. At the river mouths, estuaries and adjacent areas, small pelagic and demersal fish and crustaceans of estuarine waters are dominant. On the coastal islands fishing activities are concentrated mainly on demersal fish and some pelagic species. The coastal rocky sea beds support demersal fish, small pelagic fish and tuna species. In the banks and oceanic peaks, there are concentrations of tuna and small amounts of demersal species of high commercial value. The Sofala Bank, in the central part of the country has the largest proportion of the country's marine resources – both small demersal and pelagic fish.

The northern coast is characterized by the presence of rocky and coral sea bed that is exposed during low tide. This zone also has low river influence and a narrow continental shelf and sheltered islands and bays. This zone includes Cabo Delgado province and the northern and central districts of Nampula province. The most common artisanal gear type used in this zone is hand line. Fish species caught include Scombridae (*Scomberomorus commerson)*, Carangidae, Gerreidae, Scaridae and Lutjanidae in Cabo Delgado Province, Serranidae *(Epinephelus albomarginatus*, *Epinephelus fasciatus),* Lethrinidae (*Lethrinus variegates, Lethrinus lentjan),* Synodontidae (*Sinodus dermatogenis*), Carangidae and Sphyraenidae are caught in Nampula Province. As for the harpoon fishery, the main fish species include the Family Labridae (*Anampses caeruleopunctactus)*, Acanthuridae (*Nasus unicornius)* and Serranidae (*Epinephelus albomarginatus*). The fish species of family Sphyraenidae (*Sphyraena barracuda)*, Caesionidae (*Caesio varilineata)* and Clupeidae (*Ambligaster sirm)* are predominantly caught by beach seines.

Another group of fish species targeted in the artisanal fisheries is caught in the sand substratum by beach seine and gill nets. The most important species from the beach seine fishery are *Gazza minuta*, *Sardinella albella*, *Scomberoides tol*, *Chirocentrus nudus* and in the gill net fishery are *Scomberomorus commerson*, *Chirocentrus nudus* and *C. dorab*. There is no information regarding the level of exploitation for these fish species.

The central coast of Mozambique has numerous rivers and channels fringed with mangrove forests that provide sheltered estuarine areas, and sandy coasts, sometimes protected by coastal islands. It extends from two most southerly districts of Nampula province to Govuro district, in Inhambane province. The beaches of the central part (Sofala Bank) are sandy and gently sloping, which is favourable for beach seining operations. The extent of the area suitable for seining is about 1 km wide and 90 km in length from the shore (Cahanga 2001). Coastal resources found here are mainly small demersal fish and pelagic fish which strongly sustain the artisanal fisheries at Sofala Bank. These resources are fished using beach seines and gillnets. The most caught fish species are *Thryssa vitrirostris*, *Thryssa setirostris, Thrichiurus lepturus*, *Hilsa kelee, Sardinella albella*, *Sardinella gibbosa, Sillago sihama, Rastrelliger kanagurta*, *Otolithes ruber*, *Chirocentru dorab*, *Sphyraena qenie, Liza alata* and *Hemiramphus far*. The fish species that are common in hand line catches in this include *Pomadasys kaakan*, *Pomadasys maculatus*, *Scomberomorus commerson* and *Arius dussumieri*. No information regarding the level of exploitation of these fish species is available. The shrimp fishery by-catch is dominated by Sciaenidae family *(Otolithes ruber*, *Johnius amblicephalus)*. Apart from this group of fish species, other fishes caught include Haemulidae (*Pomadasys maculatum)*, Clupeidae (*Pellona ditchela)*, Trichiuridae *(Trichiurus lepturu)* and Engraulidae *(Thryssa vitrirostris)*.

The southern coast in the central area of the Boa Paz bank extends from Govuro district, in Inhambane province, to the extreme south of Maputo province. It has beaches in some areas, with sea beds sown with corals and rocks, with some sheltered bays, exposed to strong southerly winds, particularly from Inhambane area to the far south of the territory. From Bazaruto Island to Ponta de Ouro, there are sandy beaches that have small areas with coral reefs. The sandy area in some places has sandy banks that are exposed during the low tide. Other areas are covered by seagrasses that provide shelter and food for many fish species. The Inhambane (except in Inhassoro district) catches are mostly comprised of pelagic species (Carangidae, Clupeidae, Siganidae, Gerridae, Leiognathidae, and Scombridae) and a few demersal species. The important species are *Siganus sutor*, *Gerres oyena* and *Lethrinus lentjan* (Lethrinidae). The islands located near the coast of Cabo Delgado, Nampula, Zambezia and Inhambane are other areas where fishing activities are concentrated, targeting rocky seabed demersal species, some large pelagic fish and also small pelagic fish.

The artisanal line-fishery resources in Maputo Bay is comprised of various demersal and pelagic species. The most important species are *Pomadasys maculatus* and *Sillago sihama* while the target resources of the gill net fishery is *Hilsa kelee* with the by-catch comprised by *Mugil cephalus*, *Liza alata*, *L. duciae*, *Hemiramphus far* and *Rhabdosargus sarba.* Fish species caught by the beach seines are *Megalaspis cordyla* (Carangidae), *Sardinella gibbosa* (Clupeidae), *Polynemus sextarius* (Polynemidae), represented by species and families *Lethrinus variegatus* (Lethrinidae) and *Epinephelus hexagonatus* (Serranidae). The semi-industrial prawn fishing areas are located along the navigation channels of Maputo Bay and on grounds associated with the estuaries of the Maputo and Nkomati rivers at depth between 10 and 20 meters. The most important fish by-catch species in the semi industrial prawn fishery are *Leiognathus equulus*, *Gazza minuta (*Leiognathidae*)*, *Otolithes rubber* (Scianidae), *Mugil cephalus (Mugillidae*), *Pomadasys maculatus*, *Pomadasys kakaan* (Haemulidae*)*, *Hilsa kelee* and *Pellona ditchela* (Clupeidae). There is no information on the level of exploitation of these species. The magumba stocks in the bay are fully exploited with a level of mortality slightly above of the reference point.

Over 20 species of ornamental fish species were observed in small-scale beach seine catches in the Inhaca region. Amongst them the families Chaetodontidae (6 species), Scorpaenidae (3 species), Tetraodontidae (2 species), Ostraciidae (3 species) and Pomacentridae (8 species) are the most common. It is expected that many other species for value adding in the aquarium trade are caught in beach seining.

The rocky coastal seabeds along the coast of Cabo Delgado and in the north and centre of Nampula province have demersal fish, small pelagic fish and tuna species. The fishing grounds for demersal fish resources in southern Mozambique are found in the area between Zavora and Ponta de Ouro area. Fishing in this area may only be carried out from 3 nautical miles from the shore.

In the commercial line fishing the demersal fish that inhabit rocky beds are targeted. These include slinger seabream *(Chrysoblephus puniceus)*, santer seabream *(Cheimeirus nufar)*, humphead snapper *(Lutjanus sanguineus)*, blue skin seabream *(Polysteganus coeruleopunctatus)*, red porgy (*Lutjanidae*), scads (*Carangidae*) and pelagic fish such as kingfish *(Scomberomerus commersonii)*. The Sparidae account for more than 70% the catch.

Dominant species in this group are *Chrysoblephus puniceus*, *Polysteganus coeruleopunctactus* and *Cheimeirus nufar*. The groupers (Serranidae) are also relatively well represented in the catches. Neither *Chrysoblephus puniceus* nor *Polysteganus coeruleopunctactus* appears to be severely overexploited. However, Sparidae are assumed to be territorial and the recent assessment did not rule out the possibility of overfishing.

The offshore, pelagic species such as carangids, barracudas, hairtails and scombrids are found on the Mozambique continental shelf from the border with South Africa up to Angoche, and in a small area in south of Pemba. The dominant family on the inner shelf of the northern region is Carangidae, mainly *Decapterus russeli*. Clupeids and barracudas are also caught but in small quantities. In the south, the pelagic group is most abundant on the inner shelf, while the demersal group accounted for a low percentage. On the outer shelf, demersal and pelagic species contributes 36 and 55%, respectively of the total fish catches.

The narrow-barred Spanish mackerel (*Scomberomorus commerson*) is an important commercial, recreational and artisanal species that inhabits coastal waters of the Indian Ocean and the north coast of Australia and in the Mozambican coast. The *Scomberomorus commerson* is caught along the continental shelf of Mozambique. Despite its importance in the recreational and artisanal line fisheries in Mozambique, this species is one of the priorities for management. Nevertheless, the artisanal and prawn trawling fisheries has reported catches of sharks and sea turtles.

i) Issues

- The major issues threatening the fisheries are the over-fishing, use of destructive fishing practices and the degradation of the ecosystems. These related issues are discussed further in the following sections.

Catch of non-commercial threatened species.

The Fishery Law (Lei das Pescas 3/90) aims at protecting threatened species through the establishment of Marine Protected Areas such as Parque Nacional das Qurimbas, Parque Nacional de Bazaruto and Reserva Especial de Ponta de Ouro. The conservation police have been established by the Mozambican Government. Although the Fisheries Law (Lei de Pescas) gives responsibility to the Ministry of Fisheries, the ministry is yet to take concrete actions towards the management of the fisheries. The initiatives for the establishment of the marine protected areas have been led by the Ministry of Tourism and the Ministry of Environment.

Destructive fishing methods

The main destructive fishing practices in Mozambique include the use of inappropriate fishing gears such as mosquito nets, gill nets, traps and poison. These practices do not discriminate between species and they also destroy the habitats. Beach seine fishery harvests adults and juveniles of both small and large species. Generally, catches of small and juvenile shrimp outweighs those of adult shrimps.

Effects of aquaculture

The cutting of mangroves for firewood and provision of construction materials is a major cause of mangrove deforestation in Mozambique. Any pressure placed on mangroves and seagrass beds can affect other coastal ecosystems because of their interlinkages. Corals are exploited for house construction and for sale to tourists. Coral destruction is also caused by beach seining, dynamiting and diving. The areas with more serious destruction of the corals include the whole of Northern Mozambique.

Effects of tourism

Recreational fishing is practiced across the Mozambican coast where tourist resorts exist. The sector comprises ski boats, shore anglers and spear fishers. Also included are non-consumptive SCUBA divers, who depend on healthy reefs and fish resources to practice their form of recreation, much of it tourist related. Around 30-40% of catches of recreational fishing consist of demersal species mainly Serranidae, Sparidae, Lutjanidae, and Lethrinidae. Game fish catches are mainly comprised of *Scomberomorus commerson* (sierra) and *Thunus albacares* (albacore).

ii) Gaps

- In order to ensure sustainable fisheries, there is a need to adopt the ecosystem approach to management of fisheries. This requires a sound understanding of intra- and inter-ecosystem linkages. Very few studies have

been carried out in this area in Mozambique, if any. There is also a need to conduct research towards the improvement and promotion of innovative fish processing to add value on fish products, particularly with regard to artisanal catches. There is also a need for identification and promotion of alternative livelihoods to reduce pressure on the natural fish stocks and at same time secure alternative sources of income to communities.

- There is little information on the level of exploitation of the fish species targeted by artisanal fisheries. There is also limited information on by-catch species in shrimp fisheries. There is also limited information on the reproductive biology of the main species caught in artisanal fisheries. Also, no specific studies have been undertaken to examine the damage caused to the seabed by beach seines and other damaging fishing practices in Mozambique. Despite the importance of migratory species for the commercial, recreational and artisanal line fisheries in Mozambique, no genetic studies been carried out and there are no specific species management plans.

Marine Mammals

A total of 18 marine mammals are found in Mozambique. These include species of dugong, dolphins and whales. Of these, 6 are common in littoral ecosystems (Table 3). These include 3 species of migratory whales that breed in Mozambique waters, 2 species of dolphins that occur all year round and dugongs that feed on seagrass beds.

Table 3: Marine mammal species found in Mozambique. (*) indicates common species in littoral ecosystems

Mammals	Species	Common name
Dugong	*Dugong dugon**	Dugong
Dolphins	*Sousa chinensis**	Humpback dolphin
	*Turciops truncatus**	Bottlenose dolphin
	Stenella longistris	Spinner dolphin
	Stenella attenuata	Spotted dolphin
	Delphinus delpis	Common dolphin
	Steno bredanensis	Rough-toothed dolphin
	Pseudorca crassidens	False killer whale
Whales	*Balaenoptera acutorostrata**	Minke whale
	*Megaptera novaeangliae**	Humpback whale
	*Eubalaena australis**	Southern Right whale
	Feresa attenuata	Pygmy killer whale
	Kogia breviceps	Pygmy sperm whale
	Blogicephela melas	Pilot whale
	Orcinus orca	Killer whale
Seals	*Lobodon carcinophagus*	Crab eater seal
	Arctocephalus tropicalis	Sub-antartic fur seal

Dugongs

Dugongs in Mozambique are found in Maputo and Inhambane Bays. The population considered to be the largest single viable population in eastern Africa is located in the Bazaruto Bay. It has a population of about 150 individuals (Guissamulo 1993, Muir *et al.* 2004). However, recent observations indicate that Bazaruto Bay dugong population is declining due to over-fishing in the main channels (Muir *et al.* 2004). It is believed that a few individuals still inhabit Maputo Bay. Sporadic dugong sightings have also been reported in the Quirimbas Arquipelago and ilha de Mozambique. A single dugong was sighted in the open sea near Zavora, 100 km south

of Inhambane during a survey undertaken by the Oceanographic Research Institute in 1993.

Dolphins, Whales and Seals

A total of seven species of dolphins inhabit the littoral waters off Mozambique. The most common species in inshore waters are Indo-pacific bottlenose and humpback dolphins. These are found in Maputo Bay and the Bazaruto archipelago. In Maputo Bay, humpback dolphin abundance was estimated at 105 individuals (Guissamulo and Cockcroft 2004). Aerial surveys conducted between 2003 and 2005 in Bazaruto provided an estimate of 235 individuals (Muir *et al.* 2004).

From the seven species of whales recorded in Mozambican waters, Humpback whales (*Megaptera novaeangliae*) and Minke whales (*Balaenoptera acutorostrata*) are common waters. The coast is also known as a winter breeding ground for whales which migrate from the Southern Ocean. Maputo Bay and adjacent waters are also breeding grounds for southern right whales (*Eubalaena australis*). However, this species has not been seen in the bay recently (Muir *et al.* 2004).

Humpback whales are found in open waters between Ponta do Ouro and Inhambane. The largest number of individuals was recorded off Zavora, 100 km south of Inhambane bay (Muir *et al.* 2004). Minke whales also occur along the coast between Ponta do Ouro and Inhambane Bay. However, according to Hatton and Munguambe (1997), these species do not enter Maputo or Inhambane Bays. Only the southern right whale appears to face threats from fisheries (Muir *et al.* 2004).

Two species of seals are reported for the Mozambican coast although the sighting of one sub-Antarctic seal (*Arctocephalus tropicalis*) must be considered as unusual as it is usually found in the cooler waters off the southern Cape.

i) Issues

- Endangered species are depleted by destructive and non-selective fishing gears, and by destruction of ecosystems that support them. Marine mammals are also vulnerable to the destruction of habitat, accidental and intentional catches and pollution (Guissamulo 1993). Little is known about the extent of marine mammal bycatch in Mozambique. Entanglements in gillnets appear to be a major cause of dugong mortality along the whole coast. The level of this threat has increased since the early 1990s alongside an increase in gillnet use. Interview with fishers confirmed that humpback dolphins are also caught in drift gillnet fishery (Guissamulo and Cockcroft 1997). Gillnets affects small coastal cetaceans, particularly bottlenose and humpback dolphins. A marked decline in coastal dolphin populations was observed in the early 1990s. Intentional captures also contribute to the decline of humpback dolphins (Guissamulo and Cockcroft 1997).

ii) Gaps

In order to reduce incidents on endangered species, there is a need to conduct research on the selective and environmentally sound fishing gears, and avoid the destruction of the ecosystems that support the endangered species. Furthermore, there is a need to conduct research on the restoration of the critical ecosystems such as mangroves, seagrass beds and coral reefs. The main inappropriate fishing gears threatening endangered species re the drifting gillnets, bottom trawls, beach seining, dynamite and poison. In general there is a need to:

Come-up with mitigation measures to reduce marine mammal by-catch. Marine mammals (whales and dolphins) are an internationally protected species and as per Mozambique's Forests and Wildlife Regulation (Decree 12/2002 of 6 June) catching, touching, killing, feeding or disturbing marine mammals is prohibited.
Carry out an assessment of dugong population, distribution and trends in Bazaruto Bay, southern Quirimba Archipelago and Maputo Bay.
Conduct research on the breeding patterns of the dugongs. Mortality of young animals can threaten the continuity of the population.
Set up a dugong satellite-tracking program in Bazaruto National Park to track long distance movements.
Map seagrass habitats and determine the extent, health and the carrying capacity of seagrass beds in Mozambique.

Reptiles

Marine Turtles

The Mozambican hosts five species of marine turtle including the green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*) and leatherback turtles (*Dermochelys coriacea*) (Louro *et al.* 2006, Costa *et al.* 2007). The most common species in the northern section of the coast is the green turtle, but hawksbill, loggerhead and olive ridley turtles are also common. Nesting activity peaks from August to October in the Primeiras and Segundas Islands. In the Quirimbas Archipelago, particularly in Quirimbas National Park, mating turtles have been observed in August and September. Nesting takes place from January to April with the peak occurring in March (Costa *et al.* 2007).

Loggerhead, green, leatherback, hawksbill and olive ridley turtles are known to occur along central section of coast. Nesting by loggerheads occurs between October and February (Louro *et al.* 2006). This section of the coast is an important nesting area for loggerhead and leatherback turtles (Gove and Magane 1996, Louro *et al.* 2006). Hawksbill nesting is limited to the northern section of the coast. Studies conducted in 2004 and 2005 revealed that this species also forages in the coastal waters off southern Mozambique (WWF 2005).

Guissamulo (1993) reported turtle captures in Maputo and Bazaruto Bays, and more recently Gove *et al.* (2001) analyzed the effects of the prawn fisheries on marine turtles in the Sofala Bank. Gove *et al.*, (2001) estimated that between 1932 and 1954, 36 marine turtles were accidentally caught every year in the Sofala Bank during the prawn fishery season. Although not all turtles are killed, a great majority are eaten by the fishermen. Under Maritime Fishing Regulation, the use of Turtle Excluder Devices (TEDs) in trawl prawn fishing is a requirement, but this regulation is not followed.

i) Issues

- Despite legislative protection, marine turtle populations in Mozambique are under increasing pressure from human population. The close proximity of coastal towns and villages to marine turtle habitats and burgeoning tourist development present threats to turtles and their habitats on shore and at sea (Gove and Magane 1996). Anthropogenic threats include loss and degradation of nesting and foraging habitats, hunting for meat and carapaces for the manufacture of tortoise shell, collection of eggs, as well as accidental capture in various fisheries (Louro *et al.* 2006).
- According to Louro *et al.* (2006) due to the lack of information from remote areas, it is difficult to pinpoint areas where marine turtle mortality is high. However, turtle mortality is believed to be widespread throughout the entire coastline of Mozambique. Nevertheless, Sofala Bank Vilankulos to Inhassoro and Barra-Tofo-Tofinho and Bilene deserve special attention since in these area turtle mortality rates are very high (Gove *et al.* 2001, Gove and Magane 1996, Pereira *pers. Comm.*).

ii) Gaps

In order to prevent the loss of marine turtles, there is a need to protect the ecosystems that support them such as coastal dunes. There is a need to map these habitats, monitor the status of their conservation and establish marine protected areas. The coastal development plans should consider the protection of these habitats.

Specifically, there is a need to:

- Conduct surveys on the distribution of marine turtles along the whole coast.
- Conduct studies on the growth and foraging habits of the species.
- Determine the level of the human impact over marine turtle populations in different stages of its life cycle.
- Build capacity - both financial and human and establish long-term sustainable monitoring programs.
- Strengthen collaboration between institutions and experts in Mozambique.
- Strengthen Mozambique Marine Turtle Working Group in order foster research, conservation and management.
- Establish links with programs supported by Non- Governmental Organizations, for capcity-building, sharing information and data.

Coastal and Marine Birds

The main seabird species are *Pelecanus onocrotalus*, *P. ruescens*, *Ciconia episcopus*, *Anastomus lamelligerus*, *Ephippiorhynchus senegalensis*, *Mycteria ibis* and *Sterna caspia* (Beilfuss and Bento 1997). According to Le Corre and Jaquemet (2005), sixteen species of seabird breed in the Mozambique Channel totalling more than 3 million pairs. This group is dominated by a single species, the sooty tern (*Sterna fuscata)* which represents 99% of the total number of birds. Observations on board of the Fridjof Nansen Cruises in 2007 counted a total of 6,396 individuals (from Pemba to Maputo). Seabirds breed are known at Coroa (Primeira Archipelago) and Puga Puga (Segunda Archipelago). Although the former island is protected by traditional beliefs, eggs are collected and adult birds are caught by the local fishermen.

i) Issues

- Seabirds are threatened by destruction of habitats that sustain them and by destructive fishing practises. Depletion of these endangered species will result into loss in biodiversity. Studies conducted by de Boer and Longamane (1996) and de Boer (2000) demonstrated that human activities in intertidal habitats have serious impacts on shorebirds. They observed a negative correlation between foraging time and human presence. Exploitation of littoral organisms by the local population is common along the Mozambican coast. This represents a potential threat to the conservation of the shore bird since birds are depended on these organisms. The accelerated growth of the tourist industry along the Mozambican coast also poses a serious threat to the conservation of the shore birds. In Mozambique, seabirds are sources of high protein food to local communities. However, harvesting of both eggs and adults is unsustainable and it affects the population dynamics of marine seabirds (Le Corre and Jaquemet 2005).

ii) Gaps

- There is a need to map the extent of the critical bird habitats and determine factors controlling their health and sustainability.
- Conduct studies on the diversity of shorebirds including abundance in coastal areas, with emphasis on the northern part of the country.
- Up-date information on colonies of seabirds along the coast.
- Map the nesting sites of the seabirds.
- Conduct studies on the effects of pollution on coastal and marine birds.
- Evaluate the impact of the tourism industry on the shorebirds behaviour and abundance.

Exotic and invasive species

Ballast water

International shipping industries are responsible for the majority of alien species invading foreign waters including Mozambique waters. Over 3,000 marine species travel around the world in ships' ballast water on a daily basis. An assessment of the impacts caused by ballast water in Mozambique has not yet been done. The country has three (3) large harbors where large vessels can bring in alien species.

Aquaculture and diseases

The Mozambique aquaculture industry is young. While the culture of freshwater species such as tilapia has existed for many decades (since 1950), the cultivation of marine species has emerged only since 1995 (Ministry of Fisheries 2006). The main marine species farmed in Mozambique are native. These include black tiger prawn (*Penaeus monodon),* Indian white prawn *(P. indiscus, P. japonicus, Feneropenaeus indicus),* pink prawn *(Macrobrachium monocerosi*), Kuruma prawn (*Modiolus philippinarum*), bivalves, (*Perna perna, Meretrix meretris, Modiolous philippinarum, Eumarcia pauperculata, Sacrostrea cucullata, Cassostrea gigas, Veneruspis Japonica)* and mud crab *(Scylla serrata*).

The exotic species farmed are seaweeds such as *Kappaphycus alvarezii* and *Eucheuma spinosum* - red algae (Ministry of Fisheries 2006). These exotic seaweed species were introduced from Zanzibar, Tanzania in the late 1990s (FAO 2006-2009). Exotic seaweeds are farmed in Northern Mozambique (Cabo Delgado and Nampula Provinces) in shallow areas close to the shore. In 2008 the total production of seaweed was about 70 tonnes (INAQUA 2008).

Invasive Crown-of-thorns

The Oceanographic Research Institute (ORI) has carried out studies on the crown-of-thorns starfish (COTs) *Acanthaster planci* in Mozambican coral reefs (Table 4). Most of the outbreaks of COTs are small, localized and isolated. Poisoning with sodium bisulphate was recommended for controlling outbreaks around Bazaruto Island. Most of the COTs were also physically removed by volunteers at Bazaruto within a year (Schleyer 1998). Consideration should be given to the eradication of COTs, such as the one done in a two-mile reef in Bazaruto Island, in view of the small size of the reefs and the nature of the damage observed in the area (Schleyer and Celliers 2005). Further studies are also required in order to formulate strategies on the management of COTs in Mozambique.

Table 4: ORI record of COTS damage and outbreaks on some reefs of Mozambique (Schleyer 1998)

Data	Locality	Co-ordinates	Depth (m)	Observations
October 1994	Two-mile Reef, Bazaruto Archipelago, Mozambique	21° 48.6'S 35° 29.9'E	13	Observed ±40 COTS and extensive reef damage in a 70 min dive. Size estimated to be 30-35 cm.
February 1996	Baixo de San Joao, Mozambique	26° 21.5'S 32° 58.4'E	23	Observed 5 COTS on severely damaged reef; measured one (58 cm); very little left alive on the reef.
February 1996	Reef S of Baixo de San Joao, Mozambique	26° 24.1'S 32° 58.3'E	26	Observed considerable reef damage but no COTS.
February 1996	Ponta Techobanine, Mozambique	26° 37.8'S 32° 54.8'E	19	Observed no COTS but very extensive feeding scars in a band through a bed of *Acropora austera*.

ii) Gaps

- There has been no assessment of the exotic marine species introduced via ballast waters and their impacts in Mozambican coastal ecosystems.
- There is no monitoring of exotic marine cultivated species and their impacts in Mozambican coastal ecosystems.
- Data regarding COTs abundance, distribution, biomass and area of impact on the Mozambican coast is limited.

Table 5. The principal marine species of Mozambique

Taxa	Nº of species	Reference
Marine flora		
Microalgae	224	Critchley *et al*. (1994)
Seagrass	13	Bandeira (2000); Bandeira *et al*. (2002)
Mangroves	9	Barbosa *et al*. (2001); Bandeira *et al*. (2002)
Invertebrates (corals)		
Hard corals	151	Riegl (1996)
Soft corals	30	Schleyer *et al*. (1999)
Mammals		
Dolphins e whales	15	Guissamulo & Cockroft (1996)
Dugongs	1	Guissamulo & Cockroft (1996)
Seals	2	Guissamulo & Cockroft (1996)
Reptiles		
Turtles	5	Fisher *et al*. (1990)
Marine Birds	25	C. Bento (2003, pers. comm.)

3. HUMAN ENVIRONMENT

Coastal and island populations

Mozambique has a total of 45 coastal districts (Figure 2). The current population of Mozambique is 20.5 million. Of the total population, almost 70% live in the costal districts. The districts with large populations are Maputo City, Massinga, Nampula, Nacala-a-Velha, Alto Molocué, Milange Morrumbala, Mocuba, Maganja da Costa, Ile and Angónia. Low numbers of people (less than 90 000) can be found in Matutuine, Govuro, Muanza, Chiringoma, Guro, Lago, Macomia, Quissanga, Mecuti, and Palma.

The districts with high population density are Maputo, Marracuene, Manhica, Bilene, Xai-Xai, Zavala, Jagamo, Homoine, Nicuadala, Namacuere, Angoche and Pemba (Figure 3). The districts with high numbers of females are Matola city, Beira city, Murrumbala, Maganja da Costa, Ille, Moma, Ilha de Moçambique, Angoche Monapo, Erati, Mucuba and Maputo Cidade (Figure 4). The southern and central districts have the highest number of literate females. With regard to migration, the population of southern coastal districts tends to migrate to South Africa while those from other districts tend to migrate to Maputo City.

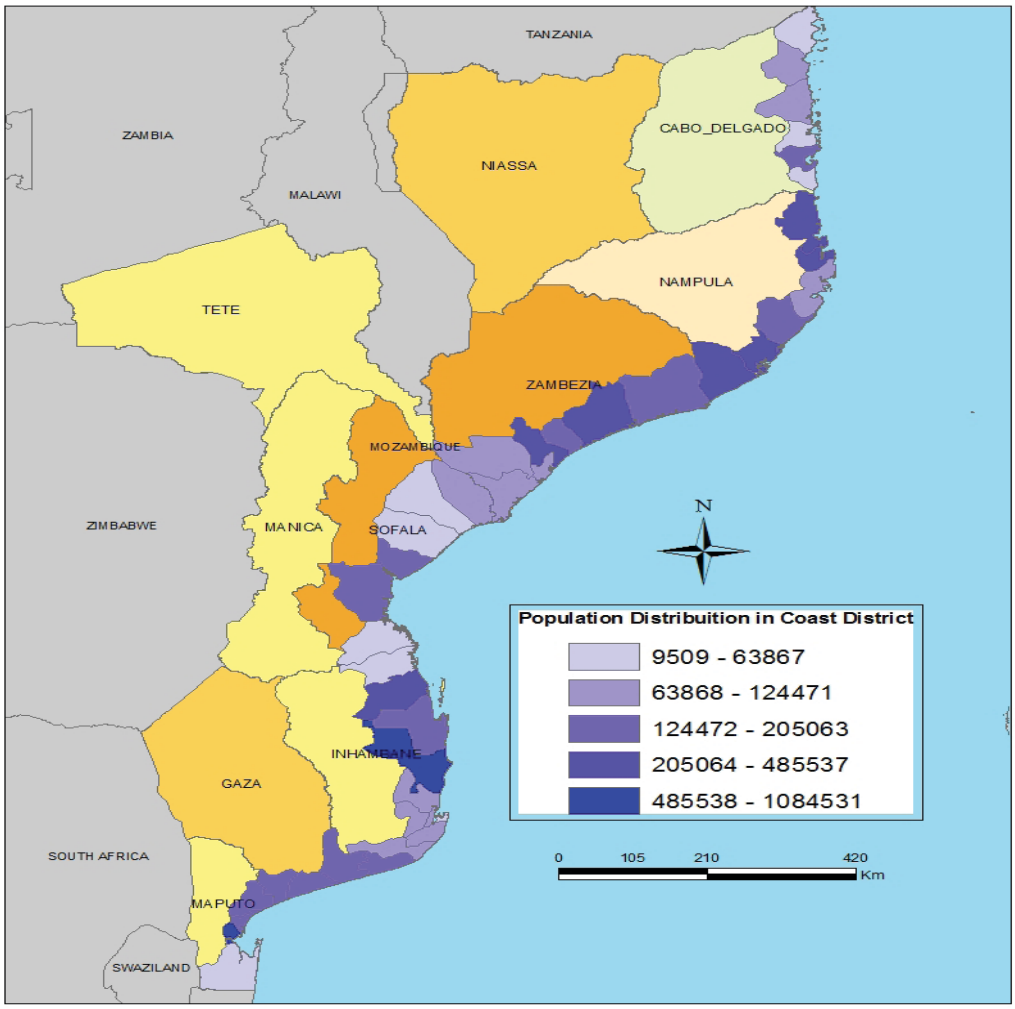

Figure 2: Total current population by district (INE 2007)

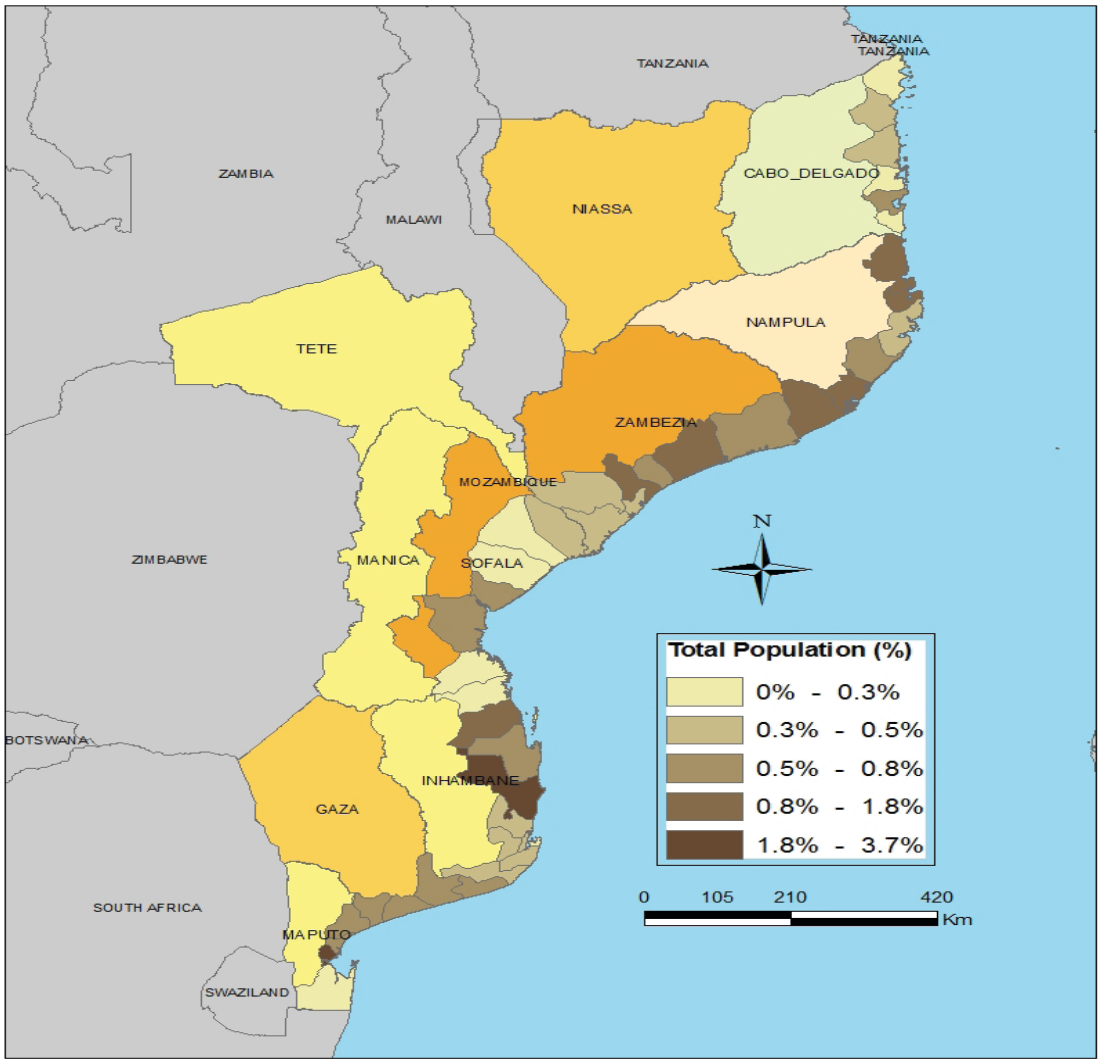

Figure 3: Percentage of the total population by district (INE 2007)

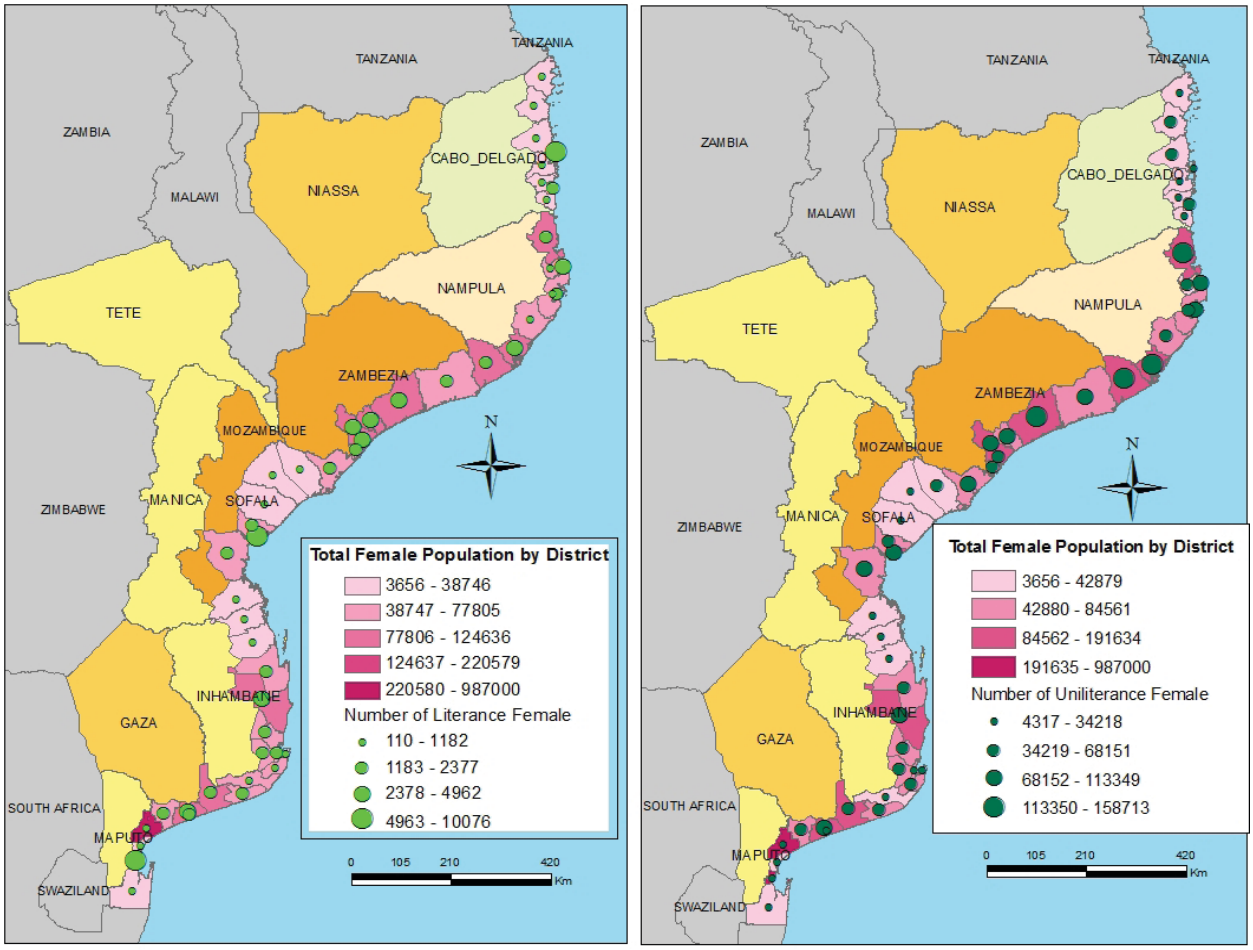

Figure 4: The gender distribution and level of literacy in coastal districts (INE 2007)

Sites of religious or cultural significance

Mozambique has a total of 118 important cultural sites, most of which are located within the coastal zone. Nampula and Maputo city have more than 15 cultural sites. In the Central coast, there are a total of 8 cultural sites, of which 6 are located in Sofala. Zambezia has a smallest number with a total of two sites. In the Southern coast region, there are 34 sites with Maputo having the highest number (18) and Gaza having 4 sites (Figure 5).

The coastal area of Mozambique has four main religions: Catholic, Protestant, Zion and Islam. Islam is practised by a large number of Mozambican people. This is followed by Protestant and Catholic denominations of the Christian faith religion. In Cabo Delgado province, religion is considered very important and it determines educational and cultural habits.

Mozambique has six linguistic groups that are divided by regions: North, Central and South. In each of the regions, there is a dominant language group. For instance, in the northern districts the dominant language group is *Emakhuwa* while in the central region, *Cisena* and *Echuabo* dominate. In the south, *Xichangane* is dominant (Figure 6).

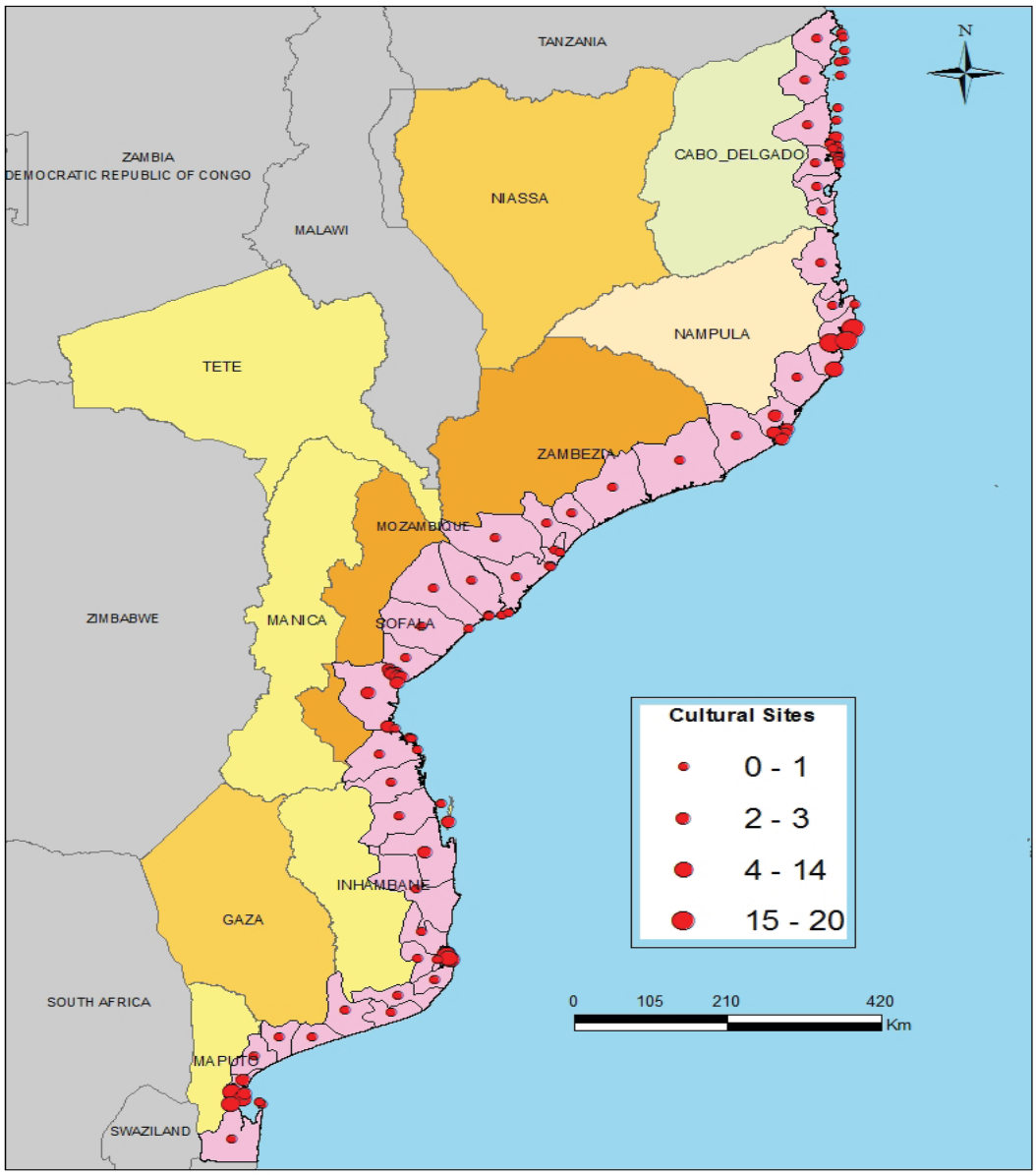

Figure 5: Spatial distribution of the religious and cultural sites in coastal districts (MISAU 2002)

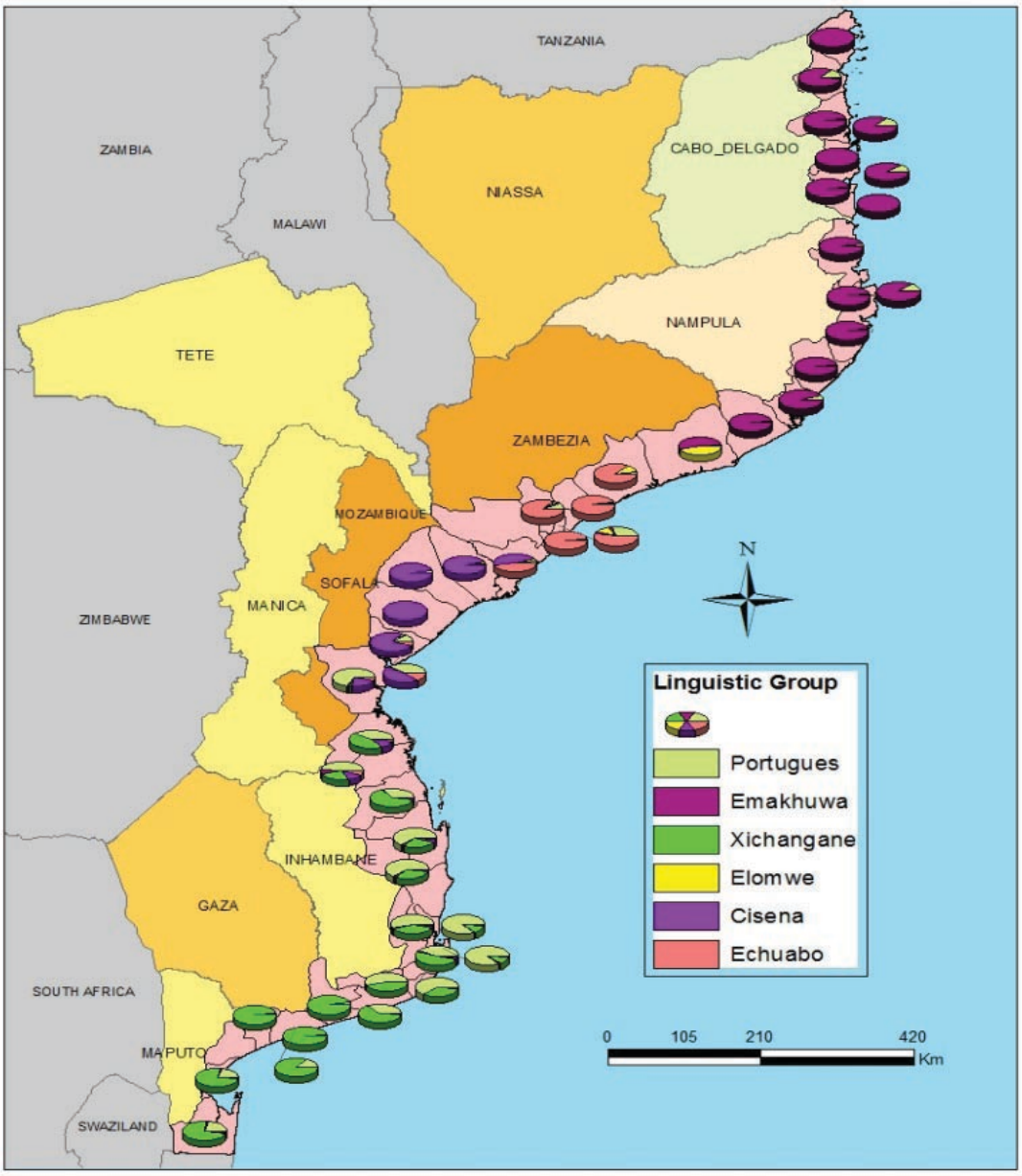

Figure 6: Spatial distribution of the linguistic groups in the coastal districts (MISAU 2002)

Infrastructure

Mozambique has three international airports namely Maputo, Beira and Nampula (Figure 7). There are also four airstrips located in Pemba, Quelimane, Vilanculos and Maputo. Most of these are located within the coastal zone. Secondary airstrips are located in Matutuine, Bilene and Mocimboa da Praia. There are also two separate railway networks connecting Maputo and Beira with the hinterlands. The main ports are Maputo, Beira, Nacala and Pemba. Most of the health facilities are concentrated within the coastal region, with Maputo having a total of 20, Angoche with 16, and Mandlakazi with 15 health facilities. Mozambique has two mobile phone operators, namely Mcel and Vodacom. The Mcel network coverage is more than 70% in the coastal districts.

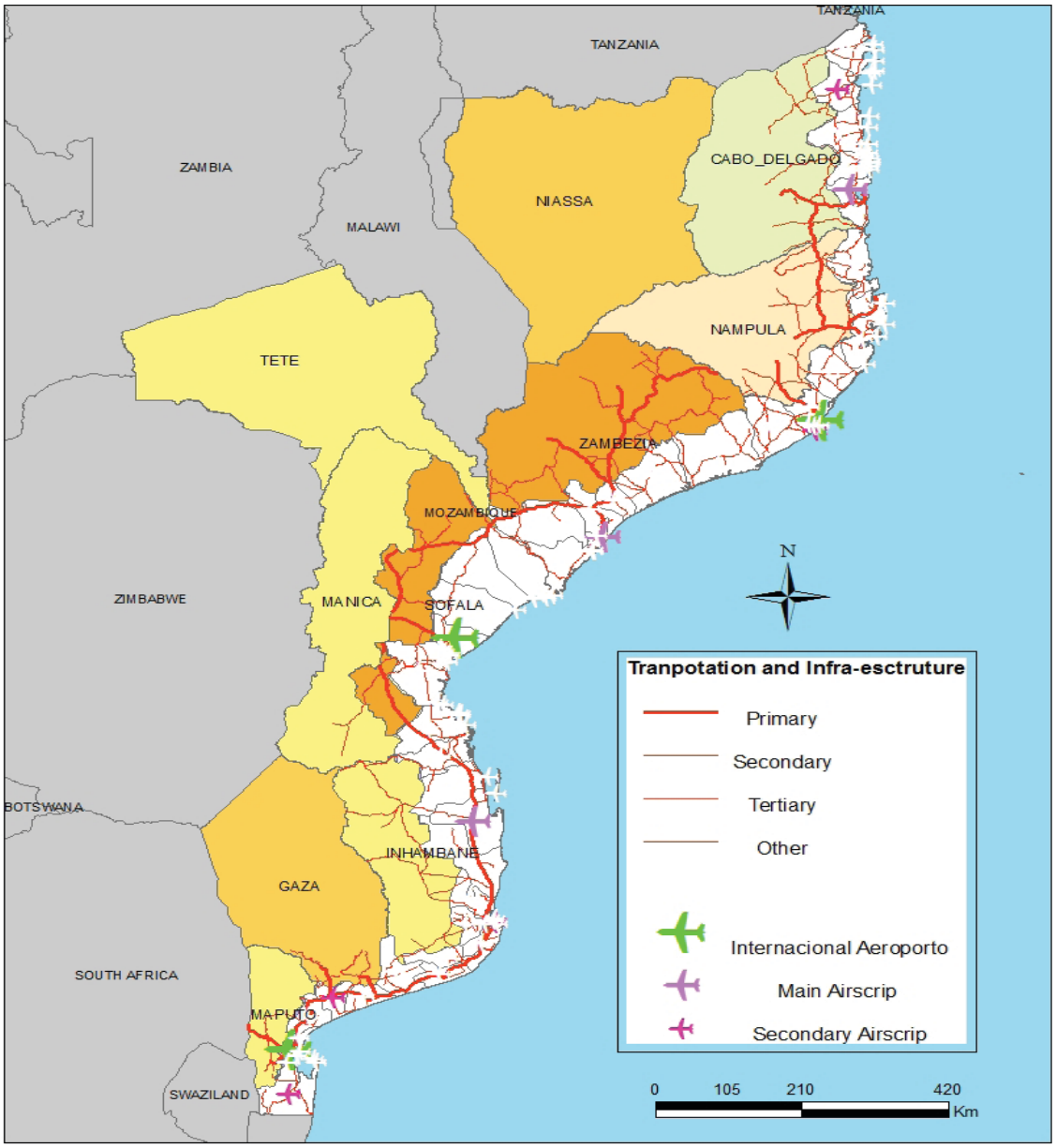

Figure 7: Roads and airports of Mozambique (CENACARTA 1997)

4. COASTAL LIVELIHOODS

A comprehensive coastal livelihoods assessment has been carried out. Chapter summaries are presented below, and the full Coastal Livelihoods Assessment may be found in Annex XII for further information.

Small-Scale Fisheries

The fisheries and aquaculture sector contributed 1.6% of the GDP in 2009. The small-scale fishery in Mozambique is mainly comprised of artisanal fishery. The semi-industrial fishing fishery employed over 351,700 people in 2007 of which 2% were women. It also accounts for 93% of the country's total marine fish catch, 91% of which is caught by the subsistence and artisanal fishers and 2% by the semi-industrial fishing sub-sector. Income levels in the small-scale fisheries are largely dependent on position within the sector, whereby, three broad positions are classified: Boat and gear owners, crew and fishers. Income in the sector is also dependent on region and subsequently distances to markets.

Many structural constraints are apparent in the sector. For example, weak infrastructure has negatively affected processing, trade and the commercialization of the small-scale fishery's products. Credit and financial services are also weak, which again affects trade and innovation in the sector. Similarly, inadequate fisheries administration capacity at the national and local levels has reduced surveillance, regulation and data collection in the sector. High levels of poverty and lack of employment alternatives have placed pressure on coastal resources, subsequently resulting in environmental degradation. There are, however, a host of strengths and opportunities that can be capitalized upon to mitigate these constraints. For example, the potential for aquaculture can help in stimulating alternative income streams and hence reduce the risk of over-exploitation. The international demand for marine fish products should also provide an incentive to further develop the sector. Likewise, strategies for credit concession, along with the availability of new technologies, should expand the sector's overall competitiveness.

It is also promising to note the commitment for the decentralization and co-management being displayed by the government. For example, in the artisanal fishery, the issuing and charging of licenses, as well as enforcement of fisheries regulations as well as the collection of fines are now starting to be managed by district administrators. Likewise, co-management committees have integrated local chiefs from fishing villages into the administrative process as a means of sustaining traditional management techniques. Nevertheless, despite the fact that the actual rate of law enforcement is no more than 50% in the entire sector and less than around 15% in rural areas, 75% of the entire fisheries sector administration is still under the responsibility of the Ministry of Fisheries and fisheries provincial directorates. There is therefore opportunity to further strengthen the decentralization process in the fisheries sector.

Tourism

Tourism contributed 3.2% to GDP in 2003, employing 356,000 people. With nearly 76.8% of total tourist expenditure coming from Africa-based residents, South Africa and the SADC region represent the largest tourist biggest source markets, making up an estimated 51% of total arrivals. On average, tourists spend five nights in the country, spending an estimated USD 45 per day. Nevertheless, despite the sector's growing importance in the Mozambican economy, little empirical data and information is currently available.

Several constraints have been identified in the tourism sector which could slow down the growth in the future. For example, revenue leakages, which are common in many African tourism markets, have become highly constrictive to local development, as majority of goods and services purchased in the sector are outsourced. Weak capacity is also problem for the sector, as it not only negatively affects infrastructure and planning, but it also severely constrains the implementation of policies that could potentially improve the sector. Likewise, the country's poor business environment, its vulnerability to climate change and the prevalence of several low quality investment projects have all been highlighted as threats to the sector. Also, the informal nature of value-added businesses in the sector continues to make it difficult for the government to both monitor and recover taxes.

There are, however, many strengths and opportunities that are apparent in the sector. For example, the country's spectacular natural attributes, extensive bio-diversity and rich traditional culture are all comparative advantages that should help the sector move forward. Similarly, the lure of bush-beach tourism in the south, along with the country's well developed recreational diving industry, are both strengths that could be built upon in the future. There are also opportunities for developing vocational training and entrepreneurism within the sector, which could both be utilized as a means of formally integrating local communities into tourist-based activities. The government's commitment to both decentralization and private sector-driven sustainable development should also support growth and change in the sector in the coming years. Thus, if greater coordination and participation can be instilled in the sector, and combined with more effective policy implementation, tourism has the potential to continue to grow and benefit local communities and the entire nation for many for years.

Mariculture

Mariculture employs around 2,000 people in commercial seaweed farming, 80% of whom are women, and less than 1,000 people in commercial prawn farming. Aquaculture is a small developing activity in the Mozambican economy. There are also experimental projects underway in finfish and mud crab, which highlight the opportunities for further development in the sector. The country's good quality seawater, its ideal environment for prawn farming, along with its large areas identified as suitable for mariculture development, should contribute to the growth of this sub-sector.

Like all developing sectors, however, there are constraints that challenge further development in the aquaculture sector. For example, limited infrastructure for research and development in the sector has constrained the adoption of appropriate technologies. Similarly, lack of hatchery facilities and seed has constrained small-scale development. Also, lack of marketing experience in aquaculture and strong international competition in prawn farming has made access to key further market difficult. Theft and vandalism, as well corruption at the provincial level, also highlight the challenges apparent in the sector.

In many cases, these constraints are less significant considering the strengths and opportunities prevalent in the sector. For example, an investor friendly environment, the potential for diversification into new species, the opportunities for the development of an industrialized prawn and marine finfish culture sub-sector, as well as national departments willing to support the sector, all highlight the potential inherent in the mariculture sub-sector in Mozambique. Although there are currently inadequate training and support services, the development of a realistic and achievable mariculture development plan by the governing authorities could assist in ensuring that these opportunities in the sector are realised.

Agriculture

The Agricultural sectors contribute immensely to the economy of Mozambique. The two sectors contributed 25% to GDP in 2009 and between 10% and 15% of total exports. Cassava and Maize represent 50% of the total value of production and it has been estimated that a 20% increase in output in these staples could potentially reduce poverty by 19%. Livestock has also become an important source of income, with 31% of households utilizing it as a source of income in 2002, an increase of 17% from 1996. The sector has however, receded in recent years, most evident in the fact that 42% of households received some income from non-farm enterprises in 2002. This drop in production has been attributed to the development of aluminium exports, along with the increase in other large export projects since 2000.

Environmental degradation and over-exploitation of natural resources has become a problem in the country's coastal zone, largely a result of a combination of a number of variables such as poverty, lack of alternative employment and increased population pressure. For example, the utilization of cropping, as well as firewood and charcoal production, to supply urban centers has resulted in extensive deforestation of coastal forests. Mangrove forests have also been over-exploited and converted into other land uses that generate higher returns, such as real estate and even garbage dumps. Nearly 15,000 ha of mangroves have been degraded across seven provinces. The government has however, taken many steps to reverse this over-exploitation. For example, decentralization and community level management are being utilized as a means of promoting sustainable use of natural resources in the coastal zone. Likewise, current forestry policy aims at not only creating incentives in

the use of secondary species, but also promoting the rehabilitation and effective conservation of protected areas in the coastal zone. Similarly, in planning and management, there is a common perception in Mozambique that in order to alleviate pressure on coastal resources, alternative streams of income have to be provided.

Overall, there is clearly an acknowledgment by stakeholders and government of the importance of the sustainable use of coastal resources in relation to promoting employment and alleviating poverty. Despite the lack of capacity and knowledge of resource management at the community level, support from NGOs, as well as a commitment to participatory resource management, highlights the positives moving forward. While an over-dependence on tourism could become problematic and a strong South African economy may facilitate outward investment, Mozambique's rich and extensive natural resource base, along with the country's commitment to conserving its forests, should allow the sector to reach its maximum potential in the future.

Energy

Activities in oil and biofuels are currently limited, with only natural gas being produced from twelve wells at the Pande/Temane gas fields. The field's present capacity is 3 billion m^3/yr, with the government accruing 5% of the revenue from production. The downstream oil industry is dependent on imports through Maputo, Beira, and Nacala ports, all of which provide a supply corridor to adjacent, landlocked countries. The country has one processing facility in Temane, along with three pipeline routes. Two of these pipelines are gas pipelines with links both to domestic customers as well as to South Africa. The other is an oil pipeline that is linked to Zimbabwe. Mozambique is considered to have the largest biofuels production potential in Africa, but no commercial activities have yet been initiated.

Many constraints have been identified in the energy sector, possibly limiting its development. For example, weak capacity at Temane processing plant has been highlighted as a constraining factor impacting on the expansion of gas extraction and exportation. Also the country's limited capacity to exploit its own natural resources has also been identified as a weakness. The dominant position of the private-sector (investors) in relation to government and local communities has also been documented as a weakness, while the lack of social and environmental concerns in emerging-market companies has been identified as a threat. It is also likely that increases in oil and gas activity will increase the threat of spills, while a failure to comply with domestic regulation, particularly in biofuels companies, has also been documented as a potential threat.

Numerous strengths and opportunities have however, been identified in the sector, many of which could open up new opportunities for employment in the coastal zone. For example, two oil refineries, port and storage upgrades, as well as three new pipeline projects, are all currently being planned. The government has also developed a national biofuels strategy (2009), with support from the African Development Bank and DFID. This has led to two biofuel projects being planned in Gaza and Manica, respectively. Biofuels development in Mozambique are also under international scrutiny, which means the sector could benefit from 'best practices' support. Also, land availability, the strategic geographic position of country, as well as the presence of knowledgeable NGOs, have all been identified as great strengths in the sector. Thus, if the respective opportunities in oil, gas and biofuels can be realized and civil society can become more involved in extractive industry activities, it is likely that the sector will provide great benefits to Mozambican coastal communities in the near future.

Ports and Coastal Transport

An extensive coastline, along with ten ports, highlights the strength and promise of coastal transport in Mozambique. Traditionally, the government played a dominant role in the administration of ports. However, since the end of civil conflict in 1992, reforms have led to the introduction of joint ventures into the transport system. This has facilitated rapid reconstruction and development in the sector. Ports of Maputo, Beira and Nacala are now effectively operated by private-sector port operators. Reconstruction of railway network and rail services that were destroyed during in the in civil conflict have also facilitated growth in trade. Further rehabilitation of the railway lines could expand cargo exports from South Africa, the DRC, Zambia, Zimbabwe and Malawi, which could be beneficial to both coastal economies and the agriculture sector.

Due to its low lying coastal plain, most of the ports, with exception to Pemba and Nacala, have been developed

in shallow bays and estuaries, which pose problems in handling large modern ocean-going vessels. Also high costs of maintenance dredging are constraints in port development. Corruption and interference in private-sector operations have also become a hindrance, while lack of training institutions and weak manufacturing sector may also pose challenges to the expansion of the sector. Despite these constraints, the efficiency resulting from the privatization of the ports, along with the transformation of customs procedures and increased investment in the sector, highlight the promise of ports and coastal transport in the country.

As a whole, the sheer scale of the country's coastline magnifies the importance of ports in Mozambique, particularly as a means of developing trade. The country's extensive natural resource base, along with the opportunities for mining development, could potentially facilitate this growth even further. This will in turn have great benefits to the coastal communities, particularly those found in the areas under the influence of Beira and Nacala ports. While over-dependence on foreign capital for development and the potential for South Africa to obstruct Gauteng route is a potential future threat, the opportunities for development in the sector are abundant and the subsequent spillovers this could have in coastal regions, highlights both the huge potential of the sector to contribute towards the economic development in the coastal region of Mozambique.

Coastal Mining

Coastal mining is one of the Mozambique's fastest growing sectors. The sector is focused on the production of aluminium, coal, titanium, zircon and rutile from coastal sand dunes. Mining contributed 1.6% of total GDP in 2006 with investments increasing from 101 million USD in 2004 to 804 million USD in 2008. All the aforementioned minerals are being produced for export, making the sector a vital source of foreign exchange. The processing of alumina in the Mozal aluminium smelter alone accounts for over half of the country's export earnings. Coal mining in Tete Province will soon become one of the most important economic activities in the country and will impact central and northern Mozambique.

Many of the mines are also being utilized for the development of the communities within which they operate. For example, the Moma Mine has facilitated the formation of the Moma Development Association, which is not only promoting the provision of secondary employment opportunities, but is also contributing to the development of schools, health care and financial services for rural communities. Similarly, Mozal smelter production has led to the creation of the Mozal Community Development Trust, which has contributed to health care, education, housing projects and training programs for local communities. The government has also been a positive actor in the sector, particularly as evident in the development of public-private partnerships, which have been crucial in the development of infrastructure, as well as in its commitment to environmental regulation in the mining sector.

As a whole, while the mining sector has been a very positive asset for the country, there are several constraints that are evident. One of the most challenging aspects is the potential for Mozambique to fall victim to the 'natural resource curse', whereby the influx of investment around the mining sector could facilitate the appreciation of the metical (local currency), which has the potential of making all other sectors uncompetitive and, thus reduce overall economic growth. Also, lack of coastal zone management, as well as lack of attention to the non-mining provinces, also highlights some of the challenges surrounding the sector. Nevertheless, the opportunities for further growth in employment, the potential for gold and coal production in Tete, as well as technology transfers and greater NGO involvement, all highlight the great potentials in the sectorpositives.

Conclusions

Each sector has had, and will continue to have a distinct impact on the socio-economic and environmental status of the coastal communities in Mozambique concerned. There are many constraints that remain constant across sectors, such as weak infrastructure, the over-exploitation of natural resources and the potential for the 'resource curse', all of which have had a widespread impact on all of the key sectors. There are also numerous strengths and opportunities apparent, including the potential for spillovers from more successful sectors, the empowerment of local communities and an extensive natural resource base. As a whole, while each of the seven sectors have their own distinct institutions and processes that are unique to the sector in question, they are nevertheless extensively linked economically, socially and environmentally.

One common constraint documented throughout all the sectors is that of weak capacity and limited infrastructure. However, despite the various constraints, numerous advances have been made. Overall, the benefits of investment and growth in energy, mining and the ports and coastal transport sectors cannot be underestimated. The potential for these sectors to generate spillovers and facilitate the growth of alternative income streams in coastal communities is extensive. The same can be said for growth in substitute sectors such as aquaculture, mariculture, tourism and horticulture, all of which highlight the significance of not only reducing the over-exploitation of coastal resources, but also of mitigating poverty in the process. These advances in sustainable socio-economic development will also be strengthened by the government's commitment to decentralization and co-management, particularly in the small-scale fishery and agriculture and forestry. In promoting these participatory management schemes, the government has the opportunity to empower local communities and allow them to become responsible for the resources on which their livelihoods depend. Coastal communities should also continue to see social benefits from tax revenue and community development organizations, both of which have been fostered by growth in the mining sector. Thus, while numerous socio-economic and environmental challenges remain prevalent in the country, Mozambique clearly has the potential to not only continue to grow economically, but also to do so in an inclusive and sustainable manner.

5. POLICY AND GOVERNANCE

A comprehensive report was prepared on Policy and Governance, which is Annex V to this MEDA. A summary is presented below.

Administrative Regions

Mozambique is made up of ten provinces and twelve main cities are located along the coast. These are Mocimboa da Praia, Ibo, Quirimba, Pemba, Quionga, Quissanga (Cabo Delgado), Angoche, Moma, Nacala, Member, Chinde, Maganja da Costa, Pebane (Zambezia), Machanga (Sofala), Quissico, Maxixe, Morrumbene, Massinga, Inhassoro, Vilanculos (Inhambane) Zonguene, Bilene, Xai-Xai, Chidenguele (Gaza), Matutuine, Ponta de Ouro, (Maputo province). The National Environmental Policy is main policy that governs environmental management in Mozambique Environmental law, decreed by Resolution No. 5 / 95, 3 August recognizes the need to control the increasing environmental degradation. The law also establishes specific regulations for sound management and use of coastal resources. It integrates socio-economic aspects with environmental issues.

i) Issues

- Most of the towns are poorly planned and lack adequate infrastructure for water supply, wastewater management, among others. At national level, the ministry of State administration has the governance jurisdiction.

ii) Gaps

- Lack of physical planning for roads, water supply, electricity, etc.
- Lack of coordination in the planning of rural and urban settlements.
- Lack of infrastructure like roads, water supply, wastewater treatment plants, etc.
- Lack of integrated coastal development plans and zoning.
- Lack of policies for the management of the coastal zones.
- Lack of an organized database on governance and coastal policies, strategies for the coastal districts.

Territorial Waters and EEZ

The Exclusive Economic Zone (EEZ) in the north of Mozambique borders Madagascar, Tanzania, and Comoros, and the remaining area is not enclosed. The EEZ stretches 200 nautical miles from the coastline as defined in the Law of the Sea (law n ^{0} 4/96). Mozambique imposes national legislation over its EEZ for the preservation of the marine environment and scientific research. There is however limited mechanism for the control of access to marine waters under the jurisdiction of Mozambique.

Legislation

Mozambique has specific legislation that addresses the use of resources in the coastal and marine waters (http://www.legisambiente.gov.mz). These includes the Law of the Sea of Mozambique (Law No. 4 / 96, 4 January), the Environmental Law (Law No. 20/97 of 7 October 1997). The latter establishes the basic principles of biodiversity protection and bans inappropriate practices that violate the conservation principles. This law is also important in the conservation of biological resources, especially those threatened with extinction. The environmental law also grants the government the responsibility of ensuring that measures are taken for the protection of species threatened with extinction as per Decree 45/2006 (http://www.legisambiente.gov.mz).

The government has also approved the national environment policy by Resolution No.5/95 (http://www.legisambiente.gov.mz). This policy is the basis for the sustainable development of the country.

The major gaps includes lack of supervision of the existing programs by responsible institutions and lack of effective legislation on Exclusive Economic Zone that result in illegal use of the resources in this zone.
Continental shelf extents (current claim and any proposed extensions)
The Mozambique Law of the Sea was approved in December 1995 and its implementation started in January 1996. According to this legislation, the continental shelf extends to 200 nautical miles from baseline and this comprises the bottom and subsoil adjacent to sea water including the continental shelf. Sea level rise and subsequent alteration of the coastline has necessitated Mozambique to claim an extended continental shelf. This claim has been made by the Sea and Frontier Institute (IMAF).

The main issues include limited technical capacity. However, a multi-sectoral technical working group coordinated by IMAF is addressing issues concerning national maritime zone. There is however a lack of experts on the law of the sea and its implementation.

The implementation of national legislation that domesticates international law is a major challenge in Mozambique. There is also a weakness in linking the requirements of international convections to national legislation. The implementation of legislation is further complicated by weak governance structure. In some cases, there is a problem of overlap of institutional mandates complicating implementation of certain aspects of the law of the sea.

National, Provincial and local authorities in coastal/marine affairs

The authorities in Mozambique that are relevant in the management of coastal and marine environment operates at the following levels:
National level: Ministry for Coordination for Environmental Affairs (MICOA).
District level: MICOAs District Representatives.
Administrative station: Station administrator.

The Mozambique Maritime Authority is responsible for overseeing, monitoring and controlling activities within the marine waters of Mozambique in order to maintain law and order and territorial integrity. In case of a threat to territorial integrity, the responsibility lies with the armed forces. With regard to ports, the Mozambique Port Authority is responsible for their administration and management. This includes supervision of port operations and ensuring that port services are efficient, safe and environmentally sound. The Provincial Directorates of MICOA main activities are inter-sectoral coordination, provincial planning and management of exploitation of natural resources.

The main gaps include limited capacity of local authorities to police activities in the coastal zones including the EEZ.

NGOs/Private sector

The role of the private sector in coastal zone management is limited. However, NGOs play a role in the management, development and exploitation of coastal and marine natural resources. A few NGOs are active in conducting research and in spearheading conservation initiatives and community involvement. Since 1995, the WWF has been active in Mozambique and it has undertaken several studies and supplemented several conservation efforts of the government. For instance, WWF has proposed the islands of Primeiras and Segundas in Zambezia province to be declared as protected areas.

International Relations and Conventions

Mozambique is party to a number of international multi-lateral environmental agreements. The country has also domesticated some of the international conventions (http://www.legisambiente.gov.mz). For instance, environmental legislation has taken onboard shared water course principles (Resolution No. 31 / December 2000) defined in the SADC protocol on shared water courses, which the country has ratified. The country has also ratified through resolution No 12/2001 of 20 March 2001, the protocol on the development of tourism.

Mozambique has also entered into a partnership agreement on fisheries with the European Union (EU) for a period of five years (2007-2011). This grants opportunities for EU vessels to fish for tuna and related species in Mozambican seas, in exchange for a financial package for implementing the fisheries sector development programme. Mozambique has also signed the Southern Indian Ocean Fishing Agreement (SIOFA) aimed at promoting the exploitation and sustainable management of fisheries resources in southern Indian Ocean high seas. Mozambique is also party to the Convention on International Trade of species of Flora and Fauna threatened with extinction, the Nairobi Convention on the protection, management and development of the marine and coastal environment of the Western Indian Ocean. Mozambique has participated in conference of parties of different conventions.

6. PLANNING AND MANAGEMENT

National Disaster Management Plans

Mozambique is prone to natural disasters by virtue of its location downstream of major international rivers such as the Zambezi and the Inkomati. In addition to flood risks, the country is also prone to tropical cyclones that travel up the Mozambique Channel, particularly in the period between January and March each year. On average, two or three tropical cyclones affect the country. The most prone areas are the coastal areas of Nampula, Zambezia, Sofala and Inhambane provinces.

Mozambique has however put in place some measures to address natural disasters. These include the establishment of an institution for coordination of disaster mitigation efforts in the country. There is also the National Institute of Calamities Management (INGC) that works with local authorities to identify training needs of target groups and development of awareness-raising programs, among others. INGC is also enhancing cross-border cooperation and, in the long-run it aims at eliminating challenges caused by different political and administrative cultures. The government has also established the National Operations Centre for Emergency (CENOE) based in Maputo and Regional Operations Centres for Emergency based in Vilanculos, Caia and Nacala.

The Government of Mozambique has since 1998 prepared annual contingency plans. The new contingency plan has incorporated lessons learnt after the floods of 2000 and 2001. A 10 year Master Plan for the mitigation of natural disasters is also in place. Implementation of contingency plans is based on the seasonal rainfall forecasts issued by the National Institute of Meteorology, which has the mandate of monitoring and issuing early warnings related to extreme weather events and tropical cyclones. The preparation and implementation of the contingency plan is done by the Disaster Management Board whose members include all government institutions, non- governmental and United Nation agencies that play important roles in the management of natural disasters. The awareness and communication of plans is done by the provincial representatives of INGC, local authorities and the local communities.

In 2005, the Government of Mozambique agreed with UNESCO IOC to establish a national centre for disseminating tsunami warnings. The centre was established at the National Institute of Meteorology. The centre has a system that allows reception of tsunami warnings from Japan or United States of America through the internet or through the global telecommunication system (GTS). The tsunami monitoring is coordinated by Meteorology Institute (INAM). The IOC of UNESCO has also established a system for monitoring earthquakes in three institutions, namely INAHINA, INAM and INGC.

ii) Gaps

- The contingency planning in Mozambique only takes into account three natural disasters, namely floods, drought and tropical cyclones. However, it does not address potential oil spill disasters that could be caused by crude oil tankers that pass through Mozambique Channel. In case of oil spillage, there are no clear measures to be taken in the coastal zone.
- There is lack of integration of various existing warning systems in the country such as weather, food security and nutrition, vulnerability analysis and monitoring of river systems and coasts.
- There is also lack of information management systems with clear definitions and decision-making systems as well as a lack of efficient communication systems especially in areas most prone to disasters.
- The mapping of flood prone does not cover all the basins of Mozambique.
- Forecasting tsunamis requires real time measurements and dissemination of information on seismic waves and sea level. There is a need to establish a network of oceanographic buoys, integrated into the global network for monitoring seismic waves and tsunamis. Furthermore, for successful mitigation of the effect of cyclones, there is a need to forecast their occurrence, path and strength, and predict the resulting surges along the coast. This requires capacity building in hydrodynamic modelling.

Environmental Sensitivity Mapping

In order to strengthen the ability of Mozambique to prevent human losses and economic disruption caused by natural disasters, USAID has assisted Mozambique to establish an Integrated Information Network for Decision-making (MIND). One of MIND's major accomplishments was the production of an Atlas for Disaster Preparedness and Response in the Limpopo Basin that was published in 2003. This work unified in a single, authoritative source, accurate maps, recent data and information on floods, cyclones and droughts. The Atlas contains maps and data from the Limpopo Basin focussed on "traditional" atlas topics (roads, schools, population and soils). It also provides detailed scenarios of how different socio-economic groups obtain their livelihoods, including scenarios of the likely impacts of various disasters on households and local economies.

Also, with the support of a United States Geological Service (USGS) technical expert assigned to MIND, the Regional Authority of Water (ARA-Sul) has developed an hydrologic model for the Limpopo Basin as a means of mitigating the adverse effects of floods in Limpopo and Incomati rivers. ARA-Sul has developed flood risk maps, which identify flood risk areas depending on the predicted hydrometric levels.
In 2004/2005, drought affected southern and central Mozambique. The government and its partners then developed a response plan to meet the critical needs of the population. The SETSAN led process succeeded in generating consensus and producing credible and timely information which was considered to be a significant improvement over the past. In 2005 SETSAN produced a report on the "Analysis of Chronic Vulnerability to Food Security". SETSAN (2005) presented key indicators of chronic vulnerability by district or province. The World Food Program in support of the Master Plan for the Prevention of Natural Disasters is developing risk maps focussed on floods, droughts and cyclones for the district of Chicualacuala.

In the area of health, the Ministry of Health has mapped of cholera risk areas throughout the country as part of its contribution to disaster response plans. Also, INGC in partnership with the United Nations Development Programme (UNDP), and the Governments of Denmark and Germany is undertaking a study on adaptation to climate change in Mozambique. MICOA,-the Office of Coastal Management and the Fisheries Research Institute have also mapped the most important marine ecosystems in Mozambique. Mozambique has also passed framework environmental law which make EIAs mandatory for all private and public development projects that are likely to have an impact on the environment.

i) Issues and Gaps

- There is a need to define common criteria for characterizing and ranking disasters in Mozambique. There is also a need to build capacity for monitoring processes related to the occurrence of disasters, and to develop vulnerability maps for the different types of disasters. A high population growth rate of 2.5% per year is a matter of concern since in the near future concentration of population along the coast would cause more stress to the coastal ecosystems.
- Integrated planning is a challenge to Mozambique where the population pressure coupled with the poverty and limited development often results into uncontrolled harvesting of natural resources and poor land use practices. There is a need to move from sectoral disintegrated planning to cross-sectoral and holistic planning. This requires adoption of multidisciplinary and multisectoral approaches and sharing of data and information across key sectors.

Areas Under Special Management

The coastal zone of Mozambique has various natural resources, which include fisheries, coastal and marine fauna and flora that sustain about half the population of Mozambique living in these areas. These resources also directly or indirectly support the country's economy. The main threat to the sustainability of the resources is related to ever increasing pressures, both anthropogenic and natural. There are also conflicts in the use of resources, overexploitation and destruction of habitats. Due to the proximity to South Africa, Mozambique has experienced rapid economic growth. The government is fast-tracking development and is currently promoting "mega-projects", two of which are currently the largest investments in Sub-Saharan Africa (an aluminium factory and iron and steel factory) both located within Maputo Bay.

i) Issues and Gaps

- The main issue is sustainable development. There is a need to preserve the environment but at the same time use resources to alleviate poverty and sustain the economy. The current situation is that the development of the country is based on traditional activities, which are mostly based on the harvesting and exporting of raw materials. This leads to rapid depletion of natural resources and degradation of the critical habitats. A desirable scenario is where livelihood and economy activities are diversified and processing of the natural products is promoted so as to add value to goods destined for export. This requires implementation of integrated development plans, which takes into consideration the environmental issues, across all key sectors.
- In Mozambique, the Ministry for the Co-ordination of Environmental Affairs (MICOA) has mainly a co-ordination and regulatory role rather than an implementing role. In this regard it should work with other line ministries and sectors to ensure that environmental considerations are incorporated into sectoral policies, programmes and activities.
- There are no clear regulations or guidelines for harvesting of fish for aquarium trades as this is a considered to be somewhat new and "grey" area. The fisheries department is supposed to issue licences based on the opinion/approval of MICOA. However, communication between the agencies rarely occurs due to the lack of clearly established guidelines. The sensitive habitats and species in Mozambique, such as mangroves, have a certain level of protection. Local communities may harvest mangrove products but commercial exploitation is not permitted.
- Marine research is mainly carried out by Universities and fisheries institutes. Mozambique has provided, and continues to provide significant support to university-based marine biological research in the Department of Biological sciences at Eduardo Mondlane University. There is however a need to strengthen coordination between sectors in order to assure integrated and sustainable development. Capacity for marine research needs to be strengthened.

Monitoring, Control and Surveillance

There is very limited monitoring, control and surveillance (MCS) in the use of coastal and marine natural resources in Mozambique. The government lacks capacity for effective planning and implementation of regulations. In order to address this shortcoming, the government has cooperated with a number of NGOs and donor agencies. For instance in 2002 the Government, through the Ministry of Fisheries, requested NORAD to carry out a study on planning of cost-effective fisheries monitoring, control and surveillance in Mozambique. In this research, the Government recognized that the local institutions/authorities have little or no capability to respond to illegal fishing by large industrial vessels, as none of the agencies charged with maritime surveillance and control have a significant sea-going capability. The activities of on-board inspectors are not effective. There is also acute shortage of skilled human resources in government Ministries. Establishment of Vessel Monitoring System (VMS), revision of the fisheries legislation, and co-management initiatives are difficult to implement if not impossible due to lack of capacity in the Ministry of Fisheries and other related institutions.

In terms of sustainability of MCS, it is important to note that operation of patrol vessels and surveillance aircraft is the most costly component of an MCS system. While capital costs may be funded from external sources, the operating costs must be secured from recurrent budgets and through the internal funds generated from fishing licences, quota fees and vessel certification fees. This requires a substantial financial commitment in the order of at least US$5,000 per patrol vessel day and up to US$1,000 per surveillance flight hour (approximately US$2 million per year). The operating costs of the chartered maritime patrols can partly be financed by development assistance for a period of up to three years. During this period the value of the patrols, responsibility for continued operation and sustainability should be determined. The revenues derived from the sale of fishing licences and vessel certificates are likely to be sufficient to finance the patrol costs. An increase in the proportion of fishing licence revenue is also be envisaged. Sustainability will not be achieved unless the issue of weak human capacity is addressed through a comprehensive human resources development planning.

i) Issues

- The main issue is lack of patrols and surveillance of the coastal and marine waters, particularly in the major fisheries of the country. The surveillance and control is expensive for Mozambique. Part of the solution is adoption of participatory approach, involving various key stakeholders. Involvement of coastal communities in enforcement is however difficult because people traditionally practice conservation and preservation of

nature based on cultural rituals which are not compatible with the current conservation principles. The use of inappropriate fishing technologies in artisanal fishery is also an issue that need to be addressed. Most fishermen cannot afford expensive fishing gear, and in some instances they do not appreciate the value of the fishing gears recommended by the Fisheries Ministry.

ii) Gaps

- There is no specific monitoring, control and surveillance (MCS) for a wide diversity of fisheries in Mozambique. Ideally each fishery requires an individually designed suite of complementary MCS measures. However, many MCS components can be combined to enable cost-effective use of scarce human, financial and technical resources. The Mozambique's fisheries resources are threatened by lack of an effective MCS system.
- There is also lack of regulation of new enterprises that are being developed along the coast. Most of these are not subjected to EIA process and have negative environmental impacts in the coastal zones. The implementation of EIAs is generally weak in Mozambique. There are also weaknesses in national planning and education among the local communities. Planning is still non-participatory to a large extent.

7. COST-BENEFIT ANALYSIS

The Mozambican GDP in 2009 was US$ 9.65 billion (National Institute of Statistics 2010). Agriculture is the largest contributor to GDP at 25%, with trade and repair services (14%), manufacturing (12.9%), transport and communication services (9.4%) and real estate and business services (5.4%) also contributing significantly (Figure 8, National Institute of Statistics 2010). The fisheries and aquaculture sector (which includes inland fisheries) contributed 1.6% and accommodation and restaurants only 1.5% to GDP in 2009 (National Institute of Statistics 2010).

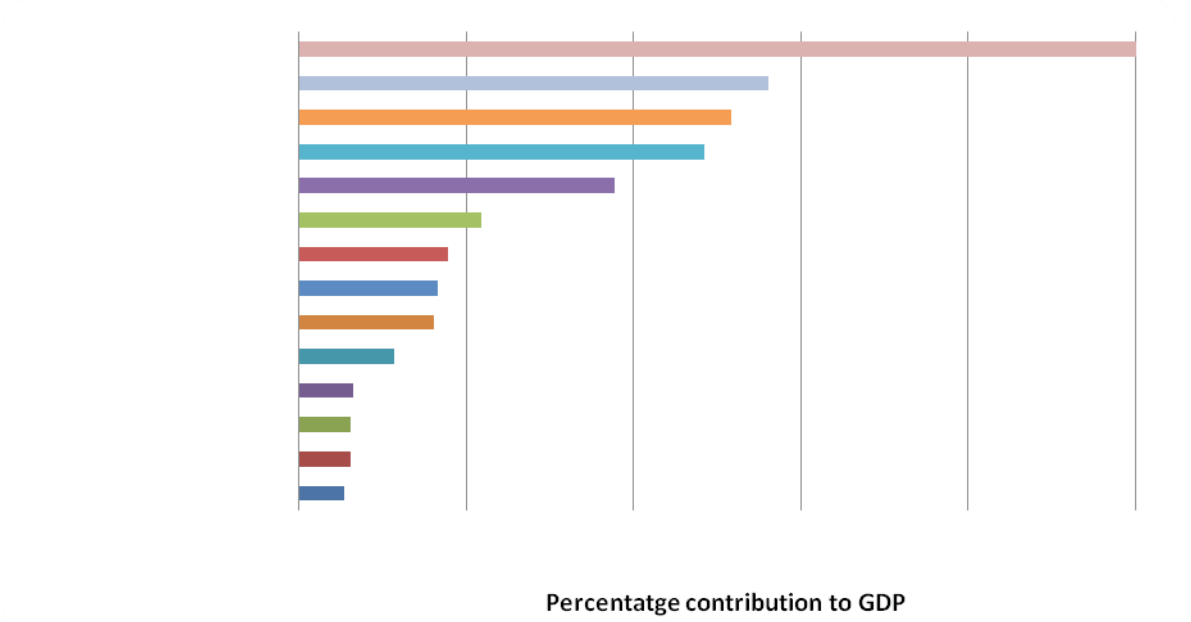

Figure 8: Percentage contribution of each sector to Mozambican GDP in 2009

Fisheries

The Mozambican fishery sector is divided into three subsectors; industrial, semi-industrial and artisanal fisheries. During a four year period between 2004 and 2008, there was an overall increase in the domestic fish production in Mozambique. However, this increase was a result of a 71% increase in production by artisanal fishermen. During this same four year period, production by the commercial fishery declined by 39%. In 2008, 15% of the domestic fish production came from commercial fisheries whilst 84.3% was from the artisanal fisheries (Table 6, USAID 2010). Currently the fisheries sector contributes approximately 1.6% to the Gross Domestic Product (GDP) (National Institute of Statistics 2010).

Table 6: Total fish landings (tons) by sub-sector 2004-2008 (USAID 2010)

Subsector	2004	2005	2006	2007	2008
Commercial	30210	26248	27926	19377	18437
Artisanal	60379	57747	63973	72894	103364
Total	90589	83995	91899	92271	121801

The industrial and semi-industrial fishery

The shallow water shrimp is the most commercially valuable marine resource and is the second most important species by volume, accounting for 29%, followed by the deep water shrimp at 8% (USAID 2010). Other commercially important species include fish, langoustine, crab, cephalopods and lobster. The marine semi-industrial fishery consists of approximately 106 vessels with 1700 fishers (CLA Report 2010, USAID 2010). These vessels are distributed among the Southern Sofala shrimp trawling fishery, the Maputo Bay shrimp trawling fishery, Limpopo River mouth shrimp trawling fishery, the Angoche shrimp trawling fishery, and the line fishery on coastal rocky beds (CLA Report 2010). There are 76 vessels involved in the trawl fishery and 30

involved in the hand line fishery (Table 7, USAID 2010).

Table 7: The number of industrial and semi-industrial vessels in Mozambique (USAID 2010)

Type of fishing	Industrial		Semi-Industrial	
	Vessels	No. employed	Vessels	No. employed
Trawl	67		76	
Hand line	2		30	
Purse seine	47			
Long line	76			
Total	192	6300	106	1700

The most commercially valuable marine resource, the shallow water shrimp, is currently fully exploited, while the deep water shrimp and other marine species offer the potential for increased catches (USAID 2010, Table 8).

Table 8: Commercial marine fishing production (tons) by species or groups for 2004-2008 (USAID 2010)

Species	2004	2005	2006	2007	2008
Shallow water shrimp	8106	8520	7393	7046	5395
Deep water shrimp	993	1774	1803	1366	1448
Fish	484	660	665	764	649
Langoustine	132	149	94	153	100
Crab	184	158	107	125	74
Cephalopods	195	165	114	138	42
Lobster	2	1	8	8	4
Bycatch	1 354	1830	1725	895	670
TOTAL	11 450	13 257	11 909	10 495	8382

Average export prices over the period 2004-2008 (USAID 2010) were used to calculate the gross value of the commercial fishery sector (Table 9). The gross output of the commercial fishery is estimated to be some US$63.5 million.

Table 9: Estimated gross value of the Mozambican marine commercial fishery (USAID 2009)

Species	Catch (tons)	Trade value (US$/ton)	Value (2009 US$)
Shallow water shrimp	5 395	8 356	46 430 816
Deep water shrimp	1 448	8 356	12 461 876
Fish	649	4 514	3 017 474
Langoustine	100	8 732	899 417
Crab	74	6 508	496 055
Cephalopods	42	5 094	220 384
Lobster	4	8 732	35 977
Bycatch	670		-
TOTAL	8 382		63 561 998

Artisanal Fishery

The artisanal fishery accounts for approximately 85% of domestic fish production and has been increasing steadily over the past few years (Table 10, CLA Report 2010, USAID 2010). Fish are the most important in terms of volume for artisanal fishermen, accounting for 72% of production (USAID 2010). Fish caught in

the inland fishery are the second most important at 18% (USAID 2010). Other important resources include bivalves, mangrove crabs, shallow water shrimp, squid and octopus (CLA Report 2010).

Table 10: Artisanal marine fishing production (tons) by group for 2004-2008 (USAID 2010)

Species	2004	2005	2006	2007	2008
Shallow water shrimp	3783	4555	1367	838	2087
Paste shrimp			2018	2022	2443
Fish	51908	50024	57457	45511	74870
Crab	202	161	176	121	254
Cephalopods	255	239	247	551	773
Lobster			5	33	1
Shark	268	893	776	746	181
Other	3962	1875	1926	2351	2156
Bycatch				5522	2268
TOTAL	60378	57747	63972	57695	**85033**

Table 11: Estimated gross value of the Mozambican marine artisanal fishery (2009)

Species	Catch (tons)	Value (US$/ton)	Value (2009 US$)
Shallow water shrimp	2087	6740	14 488 371
Paste shrimp	2443	3087	7 767 787
Fish	74 870	3370	259 881 257
Crab	254	2190	572 948
Cephalopods	773	2950	2 348 761
Lobster	1	8732	8 994
Shark	181		
Other	2156	3370	7 483 692
Bycatch	2268		
TOTAL	85 033		292 551 809

Artisanal fishermen that own boats and gear earn substantially more income than those that work as crew or fish independently. The boat and gear owners have an annual average income of approximately US$4900 (US$408 per month, 2009 Dollars) whereas those that fish independently earn an average annual income of US$680 (US$60 per month, 2009 Dollars) (CLA Report 2011).

Table 12: The number of fishers involved in the different artisanal fisheries (ASCLME CLA report 2011)

Fishing Method	Resource	Area	Fishers
Beach seining	Small pelagics, penaeid shrimps	Central and south zones	81 300
Beach seining	Demersals	North and south zones	
Line Fishing	Demersals	The whole coast	19 300
Gillnets	Pelagics and demersals	The whole coast	34 700
Traps	Demersals and benthos	The whole coast	9100
TOTAL			144 400

Table 13 is a summary of the different economic value measures that were calculated during this study for the commercial and artisanal fisheries in Mozambique.

Table 13: Summary of the economic values for the fisheries sector in Mozambique

Sector	Gross economic output (turnover) $ millions	Number of jobs
Industrial and semi industrial	63.5	8000
Artisanal	292.6	144 400
TOTAL	356.1	152 400

Coastal agriculture, forestry and natural resources

According to these results, the average annual gross income to households from forest resources is approximately US$200 in Bazaruto, US$363 in Chirindeze and US$224 in Vilanculos (Suich 2006). Coastal forestry and agriculture is however considered based on their dependence on coastal ecosystems. Mangroves, coconut and casuarina trees are examples of such habitats that are dependent on coastal space and as a result should be considered here. There is however very little information in the literature about use, production and economic value of these agricultural products.

Mariculture/aquaculture

Seaweed cultivation has increased significantly over the last decade and in some areas along the coast it is an extremely important livelihood opportunity providing a secure and constant source of income (CLA Report 2011). Large areas of lagoon and lengths of the coastline are suitable for either off bottom and shallow water culture or for deep water and line culture (CLA Report 2011).

Energy

Mozambique is set to become a major natural gas producer in Africa with substantial reserves being established over the past few years (GlobalData 2010). Currently there are four proven gas fields Mozambique - Pande, Buzi, Temane and Inhassoro (GlobalData 2010).

In 2009 the developed and undeveloped reserves in the Pande and Temane fields was 1667 billion cubic feet equivalent (bcfe). At a cost of US$6.25 per million cubic feet in 2009, the value of these fields can be estimated at US$10.5 million.

Ports and Coastal Transport

Maputo is the main port situated approximately 100 km north of the South African border. Other important ports are Beira, Chinde and Nacala with smaller fishing and leisure ports including Inhambane, Vilanculos, Sofala, Quelimane, Angoche and Pemba (CLA Report 2011).

In 2002 the Mozambican ports handled approximately 8.2 million tons of cargo. The revenue generated from the ports (transport of cargo, transport of passengers and port handling) in 2009 was estimated to be US$60 million (National Institute of Statistics 2010).

Coastal mining

There are large mineral deposits in Mozambique but exploration has been constrained by the civil war and poor infrastructure (CLA Report 2011). Mining and quarrying contributed 0.3% to the GDP in 2002 and employed 0.5% of the economically active population in 1997 (Maher 2004). Informal sand mining (largely illegal) is conducted along the entire coastline and is very extensive. However production amounts and values are unknown.

Coastal tourism

Tourism in Mozambique has been steadily increasing over the last decade. The principal tourism product in Mozambique has been the pristine beaches, overall biodiversity and cultural uniqueness (CLA Report 2011). Coastal tourism is important in Mozambique with the focal points and activities concentrated on the southern and northern parts of the Mozambican coastline, with the central coastline being less popular as a tourist destination because of the high fluvial sediment loads from the large river systems (CLA Report 2011). The largest concentration of coastal tourism development is found in the southern region of the country, particularly in Inhambane Province (CLA Report 2011). The Bazaruto Archipelago and the coastal resort town of Vilanculos in Inhambane Province are both popular tourist destinations. The primary focus and main tourist activities along the coast include recreational diving, sports fishing, spear fishing, birding, luxury island lodges and resorts, quad biking, snorkelling, visiting cultural heritage sites and swimming with dolphins and whale sharks (Suich 2006, CLA Report 2011).

From the Social Accounting Matrix (SAM) conducted by Jones (2010) the contribution of tourism to the Mozambican GDP in 2003 was calculated at US$137.8 million or 3.2%. Foreign tourism accounted for 1% of this, whilst domestic tourism accounted for 2.2% (Jones 2010).

Table 15: Profile of foreign tourism expenditure for 2003 (Jones 2010)

		Leisure		
	Business	Self-drive	Others	Weighted avg.
Expenditure (daily US$ pp)				
Accommodation	56.8	25.9	32.6	38.5
Food & Restaurants	21.6	14.5	8.9	16
Other	19.6	13.8	18.6	16.8
Total	98	54.1	60.1	71.3
Average stay (number of days)	3	3	7	3.8
Spend per visit (US$ per day)	294.1	162.3	420.8	259.7
Total number of visitors ('000s, annual)	161.6	195.6	83.8	
Total expenditure (US$ million)	47.5	31.7	35.3	

Table 16: Estimates for travel and tourism contribution to GDP, employment and visitor exports for Mozambique in 2011 (WTTC 2011)

	MZN bn	US$ bn	% of total	Growth
Direct contribution to GDP	11.5	0.34	3.1	6.5
Total contribution to GDP	26.7	0.8	7.2	7.7
Direct contribution to employment*	243		2.6	1.5
Total contribution to employment*	581		6.3	2.3
Visitor exports	8.3	0.25	8.3	2.9
Domestic spending	11.7	0.35	3.2	7.7
Leisure spending	11.6	0.35	3.2	4
Business spending	8.5	0.26	2.3	8
Capital investment	3.3	0.09	5.2	9.4

* '000 jobs

Other ecosystem services

Coral reefs, mangroves, coastal forests and seagrass beds provide a number of ecosystem goods and services. These important habitats all provide shelter and food for a number of marine organisms, provide habitat and nursery areas for juvenile fish and invertebrates provide resources for many communities along the coast and play an important role in attracting tourists and eco-tourism activities to the Mozambican coastline. The ecosystem goods and services that these habitats provide were valued by UNEP/Nairobi Convention (2008),

based on Costanza *et al*. (1997). These values are however calculated using generic global values and should therefore be considered with caution.

Table 17: Valuation (million US$) of regulatory services provided by coral reefs, mangroves, coastal forests and segrass beds (UNEP/WIO-LaB Project 2008 based on Costanza *et al*. 1997).

	Seagrass	Coral Reefs	Coastal Forest	Mangroves
Climate regulation			39.9	
Disturbance regulation		511.4	0.9	724.1
Water supply			1.4	
Erosion control			43.8	
Nutrient cycling	833.9		164.8	
Waste treatment		10.8	15.6	2 612.7
Biological control		0.9		
Habitat refuge		1.3		65.9
TOTAL	833.9	524.5	266.4	3 402.7

Distribution of coastal value and role in poverty alleviation

Fisheries

With approximately 70% of the population living below the poverty line, Mozambique is considered to be one of the world's poorest countries (Afonso 2004). Around 50% of the Mozambican population is illiterate and although there has been significant progress with education, there are serious gaps in the human resources capacity of the country (CLA Report 2011). Coastal and marine resources are therefore extremely important for the majority of the Mozambican population and there is a great dependence on these resources for both food and employment. Most of the artisanal households along the coast engage in a number of economic activities, such as farming, trade of fish, and tourism. However, for the majority of the coastal population, fishing is the most important source of income and food security (CLA Report 2011).

Tourism

The tourism sector is growing significantly and in certain coastal provinces, like Inhambane, provides employment and income to a number of households.

Mariculture

Mariculture is in its infancy in Mozambique and has a similar situation to that of South Africa, where the input costs are high and the entry of small enterprises is difficult. Most of the mariculture in Mozambique is situated along the central coastline and is predominantly prawn and shrimp farming. Although these farms provide some employment to local people, the current benefit distribution is thought to be unequal and the impacts of alleviating poverty minimal.

Agriculture and Forestry

Subsistence agriculture and forestry products are extremely important for household income in Mozambique. A high percentage of households rely on agriculture for their main income, especially in coastal areas where the land is predominantly more fertile and accessible for cultivation (CLA Report 2011). Primary production involvement and time allocation for women in the coastal zone lies mainly in subsistence agriculture and natural resources collection (CLA Report 2011). The agricultural sector engages approximately 80% of the labour force and contributes 25% to GDP (National Institute of Statistics 2010). Large proportions (90%) of these labourers are however engaged in the family farm sector which is characterised by a high labour force and low mechanisation.

Table 18 presents a summary of the contribution of coastal resources to national income and poverty alleviation in Mozambique. The estimated total contribution (without regulatory services) to the Mozambican economy is in the order of some US$650.2 million.

Table 18: Summary of the contribution to national income (million US$) of the different activities and their contribution to poverty alleviation in Mozambique.

Activity		Contribution to national income (Million US$)	Jobs	Contribution to poverty alleviation
Renewable resource extraction	Commercial	63.5	8000	Important – for food and for national income
	Artisanal	292.5	144 400	Extremely important for poverty alleviation
Non-renewable resource extraction		82.5	± 4000	Becoming increasingly more Important – jobs and national income
Coastal Tourism		145	± 100 000	Very important – jobs and opportunities for small entrepreneurs
Coastal agriculture & forestry			Most Coastal Inhabitants	Small-scale/subsistence agriculture extremely important. Commercial agriculture – declining employment but important for national income
Mariculture		6.7	± 3000	Important in some areas – jobs and alternative livelihoods
Ports/harbours		60		Important – jobs and national income
Regulatory services		5 028		

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