



## **Global Environment Facility**

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GEF MSP Sub-Saharan Africa Project (GF/6010-0016):

“Development and Protection of the Coastal and  
Marine Environment in Sub-Saharan Africa”

# **KENYA NATIONAL REPORT PHASE 1: INTEGRATED PROBLEM ANALYSIS**

**Johnson M. Kazungu (National Team Coordinator),  
Daniel Munga, Saeed M. Mwanguni and Jacob Ochiewo**

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## **Executive Summary**

This report is a culmination of the Integrated Problem Analysis process on priority issues carried out on the Kenyan marine and coastal resources and the identification of underlying causes, within the GEF MSP Sub-Sahara Africa Project on Integrated Problem Analysis.

The Kenyan coast runs in a southwesterly direction from the Kenya-Somali border in the north, at 1°41'S to 4°40'S at the border with Tanzania. It lies in the hot tropical region where the weather is influenced by the great monsoon winds of the Indian Ocean (UNEP, 1998). The Kenyan coast falls within the Eastern African Region, which on an ecosystem perspective, falls within the Somali Current LME (Alexander, 1998).

The most distinctive features of the coast include the continuous fringing coral reef from Vanga-Funzi in the south to Malindi Bay in the north; the Tana River, which discharges through a major wetland system into Ungwana Bay; the Sabaki River, which discharges just north of Malindi; Mombasa inshore water areas, with its main harbour at Kilindini that serves many of the Eastern African countries; the Lamu Archipelago in the north with its extensive mangrove forests and Wasini Channel in the south, separating the mainland from the Wasini Islands and some other smaller coral islands.

The Kenyan total population is 28.9 million people, with approximately 2.4 million people dwelling along the coastal areas, where coastal resources provide food, shelter, fuel, medicine and employment. The population is un-evenly distributed with the national average density standing at 44 persons km<sup>-2</sup> and that at the coast ranging from 10 - 280 persons km<sup>-2</sup>.

The coastal and marine environments of Kenya are extremely rich in resources. However, they are the least studied among the Kenyan natural environments and there are information gaps in the data and information base. Climatic seasonality has a significant impact on the activities of coastal communities, influencing fishing, agriculture and other economic activities. Fish catches depend on the state of the sea, hence reflecting the seasonality of the fishing activities. The economy in the urban centres depends heavily on maritime trade and harbour activities, commerce and tourism, with the latter heavily dependent on the rich biological diversity and the health of the environment. In the rural areas, the main economic activities include food production particularly agriculture and fisheries and small-scale enterprises and retail services. Agricultural practices along the coast of Kenya are predominantly small-scale but there are some plantations of coconut and sisal.

The various socio-economic activities put tremendous pressure on the critical marine and coastal habitats include coral reefs, estuaries, mangroves, and seagrass meadows, which are addressed by this report.

### **Scaling and Scoping Exercise**

Through the GIWA process for identifying hot spots and sensitive areas, five hot spots and five sensitive areas were identified for analysis, which upon scaling the Mombasa Inshore Water areas, Malindi Bay and Ungwana Bay emerged as the priority hot spots, while Malindi/Watamu Marine Park and Reserve, Wasini Channel, Ngomeni Mangrove swamps are the sensitive areas.

Upon scoping of the GIWA issues for the prioritised hot spots and sensitive areas, the issues of concern were found to be similar for both. The issues are modification of ecosystems or ecotones, over-exploitation of fisheries and other living resources and suspended solids.

According to expert assessment, the overriding issues are modification of ecosystems or ecotones, over-exploitation of fisheries and other living resources and destructive fishing practices.

It was perceived that in the future, impacts of the issues would worsen. The issues were henceforth assessed for both environmental and socio-economic impacts.

## Assessment of Environmental and Socio-economic Impacts

### Environmental Impacts

The environmental impacts of Issue No. **13: Modification of Ecosystems or Ecotones**, including community structure and/or species composition is of anthropogenic origin. A high load of suspended solids discharged through the river Sabaki has made this estuary devoid of mangrove vegetation unlike in other estuaries. The sediments have similarly impacted the coral system leading to shadowing of the corals extending into the Malindi Marine Park and Reserve. Sea-grass communities have suffered a loss of biodiversity. Beach accretion has led to loss of frontage for some beach hotels impacting on their aesthetic value and becoming less attractive for the development of tourism in the Malindi Bay. Variations of freshwater discharges are thought to have impact on fish biodiversity in the estuaries, though indicator information is lacking.

Productivity and biodiversity is high in mangrove habitats. Birds use mangrove forests as roosting grounds and watering points whereas mangrove estuaries serve as nursery grounds for juvenile fish. Despite these important functions, mangroves have been exploited for building materials and fuel wood for both export and the local market. In Gazi and Lamu in particular, noticeable reduction of mangrove cover is due to over-harvesting, though monitoring data is missing. Due to both industrial and domestic pollutants, the mangrove creek of Tudor has lower fish diversity compared to that of Gazi creek. Complete clearing of mangroves has taken place in the Ngomeni Swamps to give way to solar-salt pans. This is expected to lead to loss of productivity in the creek and a decline in the recruitment for the Malindi/Ungwana Bay Fisheries.

Seagrass meadows are appreciated to be one of the most productive and high biodiversity habitats. Many fish species spend part of their lives in one or more of the three habitats, establishing the aspect of transboundary between mangroves, seagrass meadows and coral reefs. Trawling activities in the Ungwana Bay have had significant negative impacts on the seagrass beds and the threatened species, which use this habitat. Dead turtles have been sighted in the Ungwana bay, with their death attributed to the trawling activities.

Coral reefs are important fishing grounds for artisanal fishermen. They are also a source of sand for the beaches that attract tourism. Unfortunately, the Kenyan reefs have experienced degradation due to over-fishing and bleaching leading to coral deaths and changes in community structure. Over-exploitation in the Diani reef was reported to have altered the delicate predator-prey ecological balance resulting in the coral-eroder sea urchins dominating and damaging the coral reefs. The reefs are subjected to over-fishing, shelling and damage through trampling, which has resulted into changes in their productivity and biodiversity. Due to high seawater temperatures brought about by the *El Nino* Southern Oscillation phenomenon, coral bleaching occurred in 50-90% of corals in the Kenya coast with a negative impact on reef fisheries.

The national and transboundary consequences associated with the modification of ecosystems or ecotones include:

- cross border movement of fishermen due to decline in the fishery;
- impacts on migratory species; and
- loss of aesthetic value and revenues from international tourism.

Issue No. **14: Over-exploitation of Fisheries and other Living Resources** was also identified. The fisheries resources along the Kenyan coast are of two types, artisanal or subsistence fisheries and commercial fisheries. The artisanal fisheries is concentrated between the coral reef and the shore, while the commercial fisheries is composed of demersal fish, shrimp and lobster in the Bays of Malindi and Ungwana. The artisanal fishery is considered fully exploited with over-fishing now taking place in the reefs with ensuing changes in community structures.



The environmental impacts of the fishing activities include: -

- coral reef degradation adversely affecting productivity and biodiversity;
- destruction of seagrass habitats by trawlers, impacting on productivity and fish diversity;
- excessive by-catch and disposal; and
- impact on threatened marine species that frequent the seagrass beds, e.g. dugongs and turtles.

Finally Issue No. **7: Suspended Solids** was also identified. Sediment input into the marine environment result from river discharges and surface run-off, especially during the rain season. This results in increased levels of suspended solids in marine waters with negative environmental impacts. Such impacts include: -

- deposition of suspended sediments on the coral reef system of the Malindi Marine Park and Reserve resulting in shadowing of the corals and loss of aesthetic value of the system;
- decline in biodiversity in the coral reefs and seagrass meadows;
- disappearance of seagrass species, as in the Malindi Bay, due to excessive suspended solids loading;
- beach accretion, which occurred in Malindi Bay resulting into loss of beach frontage; and
- negative impacts to fishery productivity in the major habitats.

### Socio-economic Impacts

On socio-economic grounds, modification of ecosystems and/or ecotones has reduced their capacity to support the basic human needs of food, fuel and shelter for thousands of coastal dwellers. The modification has also led to reduced fish catches, loss of aesthetic value and reduced income from tourism. This has caused changes/loss in employment opportunities for local communities as well as in changes in the social structures and conflicts in resource use.

In some of the hot spots, there is evidence of loss of cultural heritage. At Ngomeni, mangrove swamps have been cleared to give way for salt pans, while at Gazi Bay, uncontrolled harvesting has led to loss of land through erosion of the shoreline. Once modified, ecosystems are costly to restore and it takes very long to achieve the restoration.

Mangrove wetlands provide significant flood and storm control functions, protecting coastal infrastructure and settlements. Modification of the mangrove ecosystem has resulted in the damage to coastal infrastructure and settlements. If modification of mangroves and other coastal wetlands continues, re-establishment and maintenance expenditures for protecting coastal infrastructures and settlements would be high indeed.

Prawn trawling in the Ungwana Bay has been going on since the 1970's bringing in vital foreign currency, but it has also resulted in habitat and community modification with the destruction of other fisheries and loss of income for subsistence fishermen. Prawn trawling has also resulted in conflicts between the trawler operators and the artisanal fishermen, leading in concerns on issues of inter and intra-generational equity.

Traditionally, the coastal communities have depended on fisheries and mangrove exploitation. At the moment, the Kenyan **reef fishery** shows signs of over-exploitation. It is evident that fish catches have been declining over the years with a decline in aggregate fishery revenues, while the fishing effort has remained high especially in the artisanal sector. Thus over-exploitation of fisheries and other living resources has caused reduced amounts of available protein for human consumption. This contributes to the reported cases of increased malnutrition and in the Coastal region.

There is documented evidence of a decline of sea turtles and marine mammal populations in Kenya's waters attributed to intensive hunting primarily for their meat and oil. Since turtles are endangered/threatened species, such over-exploitation/indiscriminate killing may result in their extinction and loss of our cultural heritage.

River discharge and surface run-off bring in large volumes of sediments into the marine environment resulting in high levels of **suspended solids**, in the water. The sediments result in reduced tourism/recreational opportunities as it interferes with the aesthetic value of beaches, coral reefs and mangroves. Malindi Bay and Malindi/Watamu Marine Park and Biosphere Reserve, a hot spot and selected sensitive area, respectively, are the most impacted by suspended solids. As a result, some tourist hotels have lost their beach frontage with consequent loss of tourism business and increase in unemployment to many hotel employees.

Suspended solids have caused increase in water treatment costs with adverse impacts on the coastal dwellers. Water treatment, particularly the coagulation element has become too costly considering the high sediment loads brought in by the river. A decrease in number of some locally extant seagrass species has been reported in Malindi Bay, which is a hot spot experiencing heavy siltation.

From time to time dredging of the navigational channel in the Mombasa inshore water areas is necessary to maintain the depth required for shipping activities. The costs of dredging indicate the significance of the impacts of suspended solids on the Kenyan coastal waters.

### **Causal Chain Analysis of Priority Issues**

#### Immediate and Technical Causes

Land use changes and unsustainable harvesting practices were identified as the prevalent immediate causes for modification of mangrove ecosystems, estuaries, sea-grass beds and coral reef ecosystems. Additional immediate causes are partial conversion due to pollution contributing to modification of mangroves, and partial conversion due to global temperature changes contributing to modification of coral reefs.

The immediate causes contributing to over-exploitation of fisheries are changes within the sector, decreased habitat/nursery ground and level of recruitment, and shift in fish population distribution.

Immediate causes identified as major contributors to suspended solids include soil and sediment erosion, land use changes, and runoff and storm waters.

#### Sectoral Pressures

The most prevalent economic sector exerting pressure on modification of the habitats is urbanisation. Other sectoral pressures in descending order of prevalence are fisheries, agriculture, forestry, industry, tourism, transport, energy and natural forces. The contributions of natural forces to sectoral pressures were not considered for further analysis.

The sectors that contribute to the immediate causes for over-exploitation of fisheries and other living resources are fisheries, urbanisation, agriculture, tourism, fisheries and natural forces.

The corresponding sectors contributing to suspended solids are agriculture, forestry, urbanisation and natural forces.

## Root Causes

Social changes affecting modification of habitats and suspended solids include population pressure, poverty and inequality, beliefs and values, and low levels of education. The same social causes, with the exception of beliefs and values, affect over-exploitation of fisheries and other living resources.

Institutional governance is a common driver affecting modification of habitats. Other institutional drivers include, little government commitment and limited civil society empowerment, which affect modification of sea-grass beds and coral reefs. All the three institutional drivers also affect over-exploitation of fisheries and other living resources. On the other hand, institutional governance, limited civil society empowerment and insufficient international assistance affect the issue of suspended solids.

The economic structures affecting modification of habitats include the development models and macro-economic policies in place, little private sector commitment and micro-economic structures. Macro-economic policies and little private sector commitment affect both over-exploitation of fisheries and suspended solids.

## Environmental Management and Sectoral Policies

Land use-change policies and tools are common environmental management responses to the modification of habitats, over-exploitation of fisheries and suspended solids. Fisheries regulations address environmental problems associated with modification of mangroves, seagrass beds and coral reefs, and over-exploitation of fisheries. The modification of mangroves is specifically addressed by forestry legislation and other major project decision-making policies, so are those policies that deal with spills and solid waste management. Water pollution management policies address modification of estuaries, whereas urban and soil conservation policies address suspended solids.

Pertinent legislation to address land use changes include Land Planning Act, Cap. 303, Physical Planning Act No. 6 (1996), Town Planning Act, Cap. 134, Environmental Management and Coordination Act of 2000, Agriculture Act, Cap. 318, Forest Act, Cap. 385, and the Land Adjudication Act, Cap. 244. Apart from the Physical Planning Act and the Environmental Management and Coordination Act, the other legislation is sectoral.

The Fish Industry Act, Cap. 378 and the Government Fisheries Protection Act address the fisheries sector, whereas the Forest Act, address the forestry sector. The Environmental Management and Coordination Act, and the Physical Planning Act address regulations governing major project decision-making. Policies concerned with the management of oil spills and solid waste and other forms of water pollution are found in the Merchant Shipping Act, Cap. 389, Territorial Waters Act, Cap. 371, Water Act, Cap. 372, Public Health Act, Cap. 242 and the Environmental Management and Coordination Act. The soil conservation policy is covered by the Agricultural Act, while the Land Planning Act, the Town Planning Act, the Environmental Management and Coordination Act, and the Public Health Act address the urban policy.

Most of the legislation addresses the concerns of regional and international agreements, e.g. the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the East African Region (Nairobi Convention 1985) and the Convention on Biological Diversity (UNCED, 1992).

However, the effectiveness of the policies and/or tools in protecting the environment are compromised by inconsistencies in some of the laws developed, inadequate implementation of the policies or tools, gaps in the monitoring or availability of data, and ineffective enforcement of the policies or laws.

## Community Responses

Community based initiatives associated with the issues are community mangrove conservation groups, community beach management groups, small-scale aquaculture ventures and other conservation initiatives by NGOs and CBOs. The mangrove initiative includes conservation groups based at Mida creek (Malindi), Mombasa, Kipini (Ungwana Bay) and Gazi Bay, with the technical support from KMFRI and financial support from NGOs. The beach management initiative includes conservation groups based at Diani, Gazi, Shimoni and Vanga in the southern coast. Constraints that affect the groups include inadequate financial support, limited scientific and technical support, limited awareness on problems and solutions associated with the mangrove environment, poverty and lack of alternative means of livelihood, and inadequate government support, both financial and technical.

## Market Responses

Six market responses overlap across the different issues. These responses include private sector participation in urban waste management (e.g. Mombasa and Malindi), development of “fuel efficient stoves”, intensification of commercial prawn trawling and artisanal fishing (e.g. Malindi and Ungwana Bay), fishermen’s cooperative societies, expansion in small-scale fish processing industry, and commercial logging and mangrove harvesting (e.g. Lamu). Other market responses associated with, particularly the modification of mangrove habitats include expansion in solar-salt production (Ngomeni and Lamu), liberalisation of the petroleum industry and growth in the number and size of firms dealing in or utilising petroleum products (in Mombasa). Commercial prawn farming, new tax policies on importation of forest products (timber), low-cost housing development, use of mangrove wood as industrial fuel and use of mangrove for construction of tourist facilities are the other responses.

## **Gaps and Weaknesses in the Assessments**

Generally, knowledge gaps in terms of monitoring data of impacts and comprehensive information on the ecosystems are over-whelming. Knowledge gaps are evident in immediate causes, sectoral pressures, root causes and also responses. Specific areas of deficiency are presented as follows;

- lack of data on some environmental impact indicators. Only one time assessment data is available in most cases. The quality of data cannot be determined since sampling frequencies could not be ascertained;
- data from geological studies are available but the units of measurement used do not tally with the units prescribed in the GIWA impact indicator checklist;
- valuation data is lacking and where some little data is available, the form in which it is presented makes it difficult to fit in the GIWA data and extension tables; and
- much of the socio-economics information available is qualitative in nature.

In view of the scarcity of valuation data, studies should be undertaken to provide appropriate data upon which concrete management decisions can be made. The little available information should be analysed alongside proxy indicators and the socio-economic impact assessment studies need not to be restricted to the GIWA format, any sensible format of presentation should be acceptable.

## **Recommendations**

The most significant or key sectoral pressures and root causes were considered in interventions on the issues.

- *intervention to reduce pressure of land use changes on the mangrove habitat* - the industrial sector (solar-salt production) and macro-economic policies (i.e. that favour solar-salt production) are to be targeted;

- *intervention to alleviate pressure on mangroves due to over-harvesting* - the forestry sector, and poverty and inequality, beliefs and values, institutional governance (e.g. effectiveness of forestry management policies) and macro-economic policies are to be considered;
- *intervention to alleviate impacts of partial conversion of mangrove habitats due to pollution resulting from spills and solid waste disposal* - transport, industry and urbanization, including population pressure and institutional governance are to be targeted;
- *intervention to alleviate pressure on estuaries due to excessive siltation (land use changes)* - the agriculture sector, and population pressure and low level of education are to be addressed;
- *intervention to alleviate pressure on coral reefs due to unsustainable harvesting practices* - the fisheries sector (artisanal), including empowerment of community conservation groups are to be targeted;
- *intervention to alleviate pressure on coral reefs due to land use changes* - agriculture and urbanization and including poverty and inequality are to be addressed;
- *intervention to reduce pressures on sea-grass resources due to over-fishing (trawling in Malindi and Ungwana Bays)* - the fisheries sector is to be targeted. Related issues of destructive fishing practices, and excessive by-catch and discards are to be addressed;
- *intervention to reduce suspended solids due to soil and sediment erosion, and land use change* - agriculture and forestry sectors, including poverty and inequality, low level of education, beliefs and values, institutional governance, insufficient international assistance and macro-economic policies are to be addressed;
- *intervention to reduce suspended solids from storm water runoff* - urbanization, poverty and inequality, institutional governance and market are to be addressed; and
- *policy structure* - There is need to review and strengthen existing policy structures, and institutional capacity to ensure effective implementation and enforcement.

## KENYA COUNTRY PROFILE



### Geography and Environment

Surface area:	<i>total:</i>	582,650 sq km
Coastline:		580 km
Maritime claims:	<i>continental shelf:</i>	200-m depth or to the depth of exploitation
	<i>exclusive economic zone (distance from shore):</i>	200 NM
	<i>territorial sea:</i>	12 NM
EEZ:		142,364 km <sup>2</sup> (41,452 NM <sup>2</sup> )
Natural resources:		limestone, soda ash, salt barites, rubies, fluorspar, garnets, wildlife, hydropower, titanium, silica sand and common salt (solar salt)
Land use:	<i>arable land:</i>	7%
	<i>permanent crops:</i>	1%
	<i>permanent pastures:</i>	37%
	<i>forests and woodland:</i>	30%
	<i>other:</i>	25% (1993 est.)
Irrigated land:		660 sq km (1993 est.)
Environment - international agreements:		Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Marine Life Conservation, Nuclear Test Ban, Ozone Layer Protection, Ship Pollution, Wetlands, Whaling
party to:		
	<i>signed, but not ratified:</i>	none of the selected agreements

### Population

Population:	28.7million (1999 Census)
Population growth rate :	2.9%
<i>national:</i>	3.1%
	47.5 years
	34.8%
	<i>in the coastal zone:</i> 4.64 % (1995-2015)
Life expectancy :	<i>total population:</i>

Urban population (% of total 1999):	7.6%
Urban population annual growth rate:	2.4 million (8% of total population)
Population living within 100 km from the coast:	49 persons km <sup>-2</sup> (1999) 10 to 280 persons km <sup>-2</sup>
Population within coastal zone	<i>total population:</i> 78.1%
Population density	<i>average:</i> male: 86.3% <i>in coastal zone:</i> female: 70% (1995 est.)
Literacy:	
(definition: age 15 and over can read and write)	
<b>Economy</b>	
GDP: purchasing power parity	\$45.6 billion (2000 est.)
GDP - real growth rate:	1.4% (1999 Economic Survey)
GDP per capita: purchasing power parity	\$1,500 (2000 est.)
GDP composition by sector:	
<i>agriculture, forestry and fisheries:</i>	26.9% (Fisheries contribution to GDP is 0.3%) (1999)
<b>(manufacturing) industry:</b>	13.2%
<i>services:</i>	47.4% (1999 est.)
<i>tourism</i>	12.5% (of which coastal tourism accounts for 60%)
Population below poverty line:	46.4% (1992 est.)
Labor force:	11.6 million (1999)
Labor force - by occupation:	agriculture 75%-80%
Unemployment rate:	50% (1998 est.)
<b>Industries:</b>	small-scale consumer goods (plastic, furniture, batteries, textiles, soap, cigarettes, flour), agricultural products processing; oil refining, cement; tourism
Industrial production growth rate:	0.5% (2000 est.)
<b>Electricity</b> - production:	4.225 billion kWh (1999)
Electricity - production by source:	<i>fossil fuel:</i> 31% <i>hydro:</i> 67% (1999 est.)
Electricity - consumption:	4.075 billion kWh (1999)
Electricity - exports:	0 kWh (1999)
Electricity - imports:	146 million kWh (1999)
<b>Agriculture</b> - products:	coffee, tea, corn, wheat, sugarcane, fruit, vegetables; dairy products, beef, pork, poultry, eggs
Exports:	\$1.7 billion (f.o.b., 2000 est.)
Exports - commodities:	tea, coffee, horticultural products, petroleum products, fish, cement
Imports:	\$3 billion (f.o.b., 2000 est.)
Imports - commodities:	machinery and transportation equipment, petroleum products, iron and steel
<b>Currency code:</b>	KES
Exchange rates:	Kenyan shillings per US dollar - 78.5299 (January 2002), 78.733 (2001), 76.176 (2000), 70.326 (1999), 60.367 (1998), 58.732 (1997), 57.115 (1996)
<b>Water Resources and Uses</b>	
Internal flows	20 billion cu. m. 1999
Flows from other countries	10.0 billion cu. m. 1999
Total resources per capita cu. m <sup>3</sup> :	1,027
Annual freshwater withdrawals:	2.0 billion cu. m
% of total renewable resources:	6.8
% for agriculture:	76
% for industry:	4
% for domestic:	20





## CHAPTER 1

### 1. Introduction

#### 1.1 The Biophysical and Socio-Economic Characteristics of the Kenyan Coast

Kenya has a land area of 580,000 km<sup>2</sup> and lies astride the equator. It has a coastline bordering the Indian Ocean, which runs 580 km long in a south westerly direction with different, marine and coastal wetlands rich in biodiversity. Climatic condition variations in the country are attributed to SE Monsoon winds (blowing between April and September) and the NE Monsoons (October to March), marine influence in the coast and by altitude inland. The mean rainfall in the coast region ranges from 1,397 mm in the south decreasing to 889 mm in the north and occurs in two periods. The long rains start during the inter-monsoon period and last from March to June, while the short rains occur in October to December.

The total Kenyan population is 28.9 million people (1999 Census), increasing by 25% in 10 years. The coastal population (1999 Census) is 2.4 million, giving an increase of 28% in 10 years. The share of the coastal population is 9% of the national population. The population growth rate for the coast is 3.1%, which is higher than the national average at 2.9%. The increase in coastal population is attributed to the rural-urban migration phenomenon in search of employment or business opportunities. While the population density for the country as a whole stands at 44 persons, that along the coast ranges from 10 to 280 persons km<sup>-2</sup>, indicating increased pressure in the dense areas.

The coastal economy is heavily dependent on maritime and harbour activities, fisheries, commerce and tourism. Tourism contributes 12.5% of the GDP to the country, of which, coastal tourism accounts for 60%. Fisheries contribution to GDP is 0.3% to the national economy, of which, only 4.2% is marine fisheries with the rest coming from inland water bodies.

#### 1.2 The Kenyan Coastal Habitats

There are a number of coastal habitat types in Kenya but for purposes of this project, particular attention is paid to coral reefs, estuaries, mangroves and seagrass meadows, because of their dominance and key role in the socio-economic well-being of the coastal communities and significant contribution to the national economy. The main features of these selected habitats are discussed below.

##### 1.2.1 Coral Reefs

A fringing reef system spans the length of the coast from the Kenya/Tanzania border in the south to Malindi Bay in the north, breaking into patch reefs northward to Somalia. These reefs create protected inshore lagoons that are characterised by patches of coral, seagrass meadows and sand. The coral reefs occur as coral flats, lagoons, reef platforms and fringing reefs. The total area of coral reef in Kenyan waters is approximately 50,000 ha. This reef system supports important economic activities such as artisanal fishery and tourism. The artisanal fishing is practiced in the coral reefs and seagrass beds along the entire inshore waters, where it is estimated that this fishery employs about 10,000 fishers and is the most important fishery along the coast of Kenya. However, this coral reef supported fishery is threatened by over-exploitation as the studies carried out so far indicate. For example, the increase in sea urchin populations has been attributed to reduction in their predator population. Over-exploitation in the Kenyan coral reefs also impacts on other reef organisms such as cephalopods, crustaceans, holothurians or gastropods. Some populations have totally been wiped out in some areas, for example shells, lobsters, and sea-cucumbers. Large quantities of shells and corals are known to have been collected from some coral reef areas namely Lamu, Kiunga and Shimoni. Many species are probably being over-exploited and careless collection methods have led to serious habitat damage. Despite controls, large quantities of corals and shells are still exported from Kenya (UNEP, 1998).

### **1.2.2 Estuaries**

The coast of Kenya has a number of estuaries which came about as a result of sea level rise (land subsidence) during recent geological time. These include Mombasa, Shimo la Tewa, Kilifi, Turtle Bay and the area around Lamu. These estuaries are the flooded lower courses of rivers that about 18,000 years ago flowed to a shoreline that may have stood about 160 m lower than it does today. The estuaries are sheltered from high-energy waves and receive fine-grained sediments from inflowing streams. Their shores have been colonized by mangrove trees and associated plants. However, some major human-induced changes have taken place in these estuaries. The clearing of mangrove forests for example, has exposed the soft shores and has therefore caused erosion. On the other hand, increasing amounts of sediment brought down by rivers such as the Tana and Sabaki, are fed into the inshore environment, leading to accretion (UNEP, 1998). The deposited sediment has caused beach accretion that has impacted negatively on tourism.

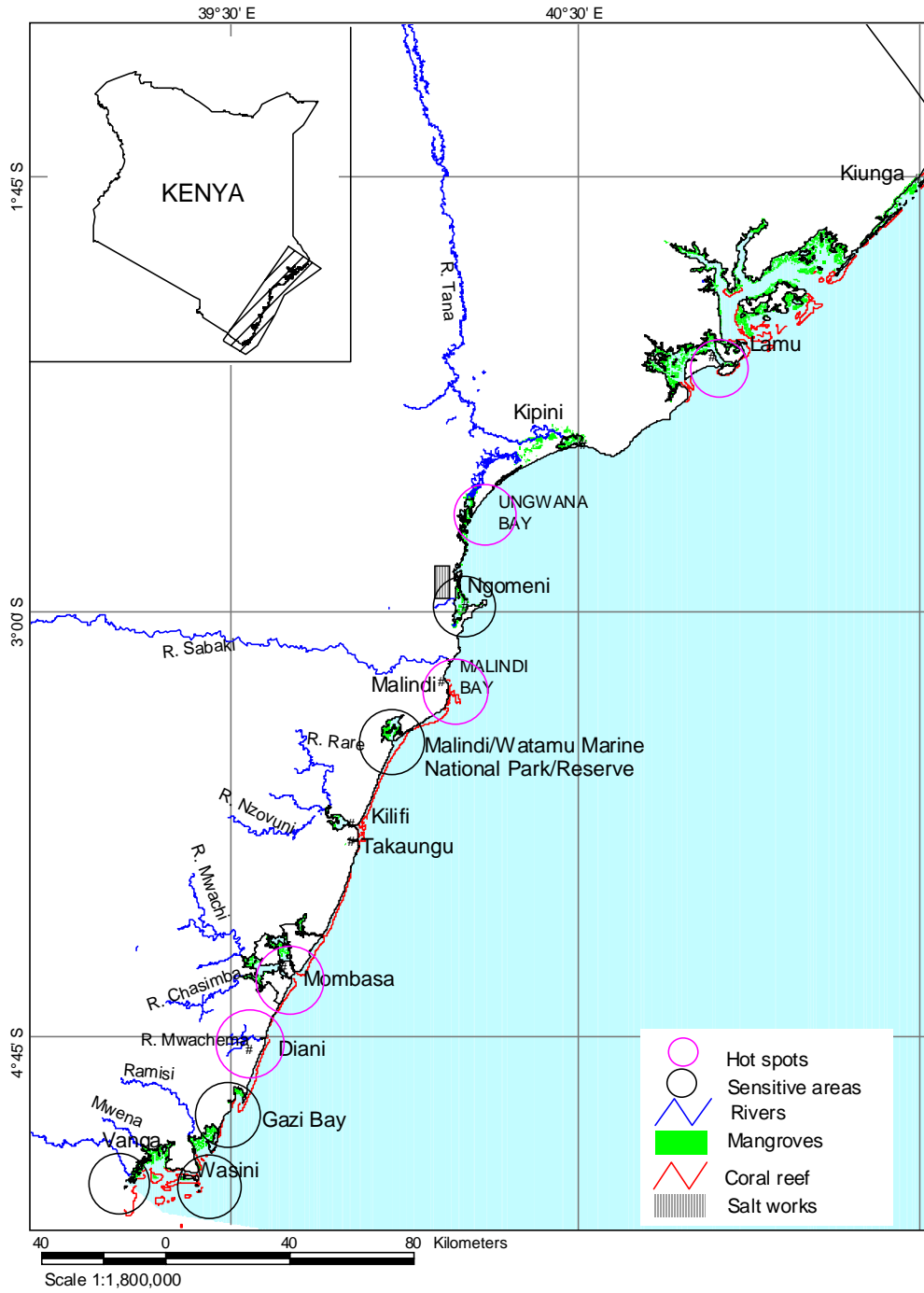
### **1.2.3 Mangroves**

The Kenyan coast has 530 km<sup>2</sup> of mangroves with the largest stands occurring in the Lamu area and the Vanga-Funzi system. There are 8 species of mangrove trees and shrubs found along the Kenya coast. The mangrove habitats are threatened by over-exploitation. Mangroves have been exploited in Kenya for generations and the poles have been/are being exported to the Arabian peninsular for building material. The coastal dwellers have traditionally exploited the rich natural products of the mangrove swamps as well as various parts of the trees themselves. The local consumption of mangrove products such as building poles, firewood and charcoal is very high. The mangrove forest has also been cleared in many places to give way for salt works and prawn farms to a smaller extent. Loss of mangrove since pre-agricultural times is thought to amount to 70% (UNEP, 1998). They are also important habitats for many terrestrial and aquatic plants and animals that are of considerable significance to the Kenyan coastal economics.

### **1.2.4 Seagrass Meadows**

Seagrasses are marine flowering plants, found predominantly in sandy and muddy areas where their roots can penetrate and provide easy anchorage. Seagrass meadows provide a habitat for a variety of commercially important fish species. Seagrass beds are trawlable using large mesh-size nets (trawl nets) and various species of rays, holothurians, octopus, etc, are caught in this manner. In Kenya, these areas are also the feeding grounds for the endangered species such as the green turtle, the hawksbill turtle and the dugong (UNEP, 1998). The greatest direct threat to seagrass meadows in the Kenya coast is destruction by bottom trawl nets, but also due to the excessive sedimentation of shallow coastal waters resulting from erosion of the agricultural land upstream.

COASTAL ECOSYSTEMS, HOT SPOTS AND SENSITIVE AREAS IN KENYA





## CHAPTER 2

### 2. The Identification of Hot Spots, Sensitive Areas, and Overriding Issues

#### 2.1 Methodology

The GIWA methodology was used to identify hot spots, sensitive areas and overriding issues. Five hot spots, an equal number of sensitive areas and three overriding issues were selected. Characteristics of the selected hot spots, sensitive areas and overriding issues are presented below.

#### 2.2 Description of Hot Spots and Sensitive Areas

##### 2.2.1 Hot spots

###### **Mombasa Inshore Water Areas:**

This hot spot suffers from microbiological pollution, chemical pollution, eutrophication, suspended solids, solid wastes, spills, over-exploitation of fisheries and mangrove resources and destructive fishing practices. The port of Mombasa that serves almost the whole of East Africa is located here.

###### **Lamu Inshore Water Areas:**

This site suffers from microbiological pollution, suspended solids, solid wastes and modification of ecosystems or ecotones.

###### **Ungwana Bay:**

The site experiences destructive fishing practices, excessive by-catch and discards from trawling activities, suspended solids and modification of ecosystems. On transboundary aspects, a number of foreign owned trawlers fish in this bay and approximately 98% of what they catch is sold outside the country. The Bay harbours some of the endangered species that need conservation e.g. Green Turtles.

###### **Malindi Bay:**

The site experiences suspended solids (especially silt deposition from River Sabaki), over-exploitation of fisheries resources (trawling and artisanal fishing) and modification of ecosystems. Malindi Bay has some endangered species such as the Green Turtles that need conservation. In terms of transboundary elements, wastage of juveniles in one jurisdiction may affect earnings in another jurisdiction.

###### **Diani Reefs:**

The area suffers from destructive fishing practices, over-exploitation of fisheries resources and modification of ecosystems (through combined impacts of the above plus construction of seawalls that transfer or accelerate coastal erosion to other adjacent areas). The site contains a rich biodiversity of both fauna and flora.

##### 2.2.2 Sensitive areas

###### **Vanga Creek:**

The site experiences destructive fishing practices, over-exploitation of fisheries resources, microbiological pollution and modification of ecosystems. The site is located at the boundary between Kenya and Tanzania and is traversed by River Uмба that has its source in Tanzania.

**Wasini Channel:**

The site experiences destructive fishing (especially by fishermen from a neighbouring country who use dynamite and beach seines), over-exploitation of fisheries resources and loss and modification of ecosystems.

**Gazi Bay:**

The site experiences over-exploitation of fisheries resources (fishermen from a neighbouring country operate alongside local fishermen), destructive fishing and modification of ecosystems (due to over-harvesting of mangroves and coastal erosion).

**Ngomeni Mangrove Swamps:**

The site suffers from loss and modification of ecosystems due to the presence of salt works that have completely cleared mangrove forests to create salt pans.

**Malindi/Watamu Marine National Park and Reserves:**

The site experiences suspended solids that impact on the coral gardens, modification of ecosystems from over-harvesting of mangroves and trampling on corals, and microbiological pollution from domestic sewage. This site has been designated a Biosphere Reserve under the Man and the Biosphere Programme of UNESCO.

**2.2.3 Overriding issues**

The following overriding issues were identified:

- over-exploitation of fisheries and other living resources;
- modification of ecosystems or ecotones, including community structure and/or species composition; and
- destructive fishing practices.

**2.3 Scaling: Prioritisation of Hot Spots and Sensitive Areas**

During the first national meeting it was noted that the methodology for prioritising hot spots and sensitive areas is good as it provides a standardized method of rating sites. The ratings make it easy to compare sites on a regional or global scale hence rational decisions can be made. Using this methodology we were able to rationally obtain three prioritised hot spots namely Mombasa Inshore Water Areas, Malindi Bay and Ungwana Bay. The scores for Ungwana Bay and Diani Reefs tallied and we selected Ungwana Bay because it is a national priority site. We also obtained three prioritised sensitive areas namely Malindi/Watamu Marine National Park and Reserves, Wasini Channel and Ngomeni Mangrove Swamps.

**Key features of the summary list of prioritised hot spots and sensitive areas**

Seven different GIWA issues were recorded, namely microbiological pollution, suspended solids, loss of ecosystems or ecotones, over-exploitation of fisheries and other living resources, excessive by-catch and discards, and distractive fishing practices. Of the seven issues, three were dominant and the same for the prioritised hot spots and sensitive areas, namely modification of ecosystems or ecotones, over-exploitation of fisheries and other living resources, and suspended solids.

The overriding issues identified according to expert assessment were modification of ecosystems or ecotones including community structure and/or species composition, over-exploitation of fisheries and other living resources, and distractive fishing methods, which are by and large in agreement with the issues associated with the hot spots and sensitive areas.

#### **2.4 Scoping: Prioritisation of Issues**

The seven issues associated with the hot spots and sensitive areas were subjected to the scoping procedure for prioritisation. From the first Kenya National Experts Meeting, the scoping methodology was noted to be adequate in prioritising the issues that were identified from each of the selected sites. The methodology is well presented and gives room for a detailed assessment of issues before a score is awarded. The reporting tables provide a good framework for arriving at issues with the highest scores that in turn happen to be the overriding issues.

##### **Final outcome (summary of the scoping exercise)**

The seven key issues were presented in the table together with the corresponding average total score per issue. The average scores of the perceived future change have also been presented per issue. All average scores under the perceived future change are positive indicating the likelihood of impact worsening. The issues that have higher average scores also have higher average scores of perceived future change. The final score from each issue helps us rank them and from the final ranking we are able to tell which issues to zero on to. Hence the three prioritised issues are modification of ecosystems or ecotones including community structure and/or species composition (issue 13), over-exploitation of fisheries and other living resources (issue 14) and suspended solids (issue 7).

## CHAPTER 3

### 3. Assessment of Environmental and Socio-Economic Impacts

#### 3.1 Environmental Impacts

The environmental impacts of the prioritised GIWA issues on critical marine ecosystems or habitats were discussed with reference to the identified hot spots and sensitive areas, wherever possible.

##### 3.1.1 Issue 13: Modification of Ecosystems or Ecotones Including Community Structure and or Species Composition

The critical habitats composed of estuaries, mangrove swamps, coral reefs, and seagrass meadows are subjected to various anthropogenic influences that are detrimental to their productivity and biodiversity

###### 3.1.1.1 Estuaries

These generally occur in sheltered areas and receive sediments from in-flowing rivers. The major rivers discharging into the sea include the Tana and Athi-Galana-Sabaki complex, while the minor ones are Mwache, Kombeni, Goshi, Voi, Mwachema, Kidogoweni, Ramisi, Uмба and Mkurumuji.

The Tana River is approximately 850 km long. It has a catchment area of 95,000 km<sup>2</sup>. It discharges 4,000 million m<sup>3</sup> of freshwater annually into the Ungwana Bay, with peak flow occurring between April and June. It also discharges some 3 million tonnes of sediment per year. The Sabaki River (also called Athi and Galana upstream) is 650 km long, has a catchment area of 70,000 km<sup>2</sup>, discharges 2,000 million m<sup>3</sup> of freshwater and 2 million tonnes of sediment annually. The Sabaki river discharges into the sea north of Malindi with high volumes of suspended solids and nutrients loading which influence the productivity of the Bay.

#### Environmental Impacts

##### Sabaki Estuary and Malindi Bay

As a consequence of the high loads of suspended solids discharged through the Sabaki estuary:

- there is an absence of mangrove vegetation, unlike in other estuaries along the Kenya coast; and
- the coral ecosystem extending into the Malindi National Marine Park and Reserve has been negatively impacted (Obura, 1995) as evidenced by the shadowing of corals.

As a result of the high sediment discharges and deposition:

- the seagrass communities have been impacted on negatively resulting in a reduction of species diversity (Wakibia 1996); and
- beach accretion is dominant, such that beach hotels have lost their beach frontage. Due to the nature of the river sediment being deposited (brown sand and silt) the aesthetic value of the beach along the Malindi Bay has been reduced considerably making it less attractive to the development of tourism.



### 3.1.1.2 Mangrove Ecosystems

Mangroves are found in estuaries or where there is fresh water input. For example, in the Mida Creek, where there is no surface freshwater inflow, the mangrove forest is maintained by freshwater from underground seepage that is estimated at about 56,940 billion m<sup>3</sup> per year (Kitheka 1998). Most estuaries except the Sabaki have mangrove cover. None of the recorded mangrove species is endemic to Kenya. Productivity and biodiversity is high in the mangrove habitat. Birds use mangrove forests for roosting while the mangrove creeks serve as feeding grounds for juvenile fishes in addition to other uses.

#### Environmental Impacts

Due largely to human impacts on mangrove vegetation, the following is presented as the status of this habitat in the Kenyan Coast:

- mangroves are heavily exploited for the traditional uses of providing poles for the building industry and for fuel wood both for local and export markets. In Lamu and Gazi in particular, there is noticeable reduction in mangrove cover due to over-harvesting, though no data is forthcoming due to lack of monitoring;
- due to extensive human activities including pollutant loading both from industry and domestic sources in the Tudor Creek, compared to the more pristine mangrove creek of Gazi, the Tudor creek has lower fish diversity; and
- complete clearing of the mangrove habitat (over 5,000 ha) has occurred in the Ngomeni Swamps to pave way for the construction of solar salt pans. Potential impacts expected, as a result of this action is loss of productivity in the creek and a decline in recruitment for the Malindi/Ungwana Bay fisheries.

### 3.1.1.3 Seagrass Meadows

This habitat, which occurs in sandy and muddy environments in the lagoons between coral reefs and the mangroves, is the least studied in Kenya. It is recognized as one of the most productive and with high biodiversity. Twelve species of seagrass have been recorded in Kenya occurring all the way from Vanga in the south to Lamu in the north coast. In Diani 10 species have been recorded with densities varying from  $7.36 \pm 2.04$  to  $133 \pm 40.07$  g dw/m<sup>2</sup> (Uku 1996). These densities are low when compared to those obtained by Ochieng and Erftenmeijer (1996) who reported a mean biomass of 760 g/m<sup>2</sup> at the Mombasa National Marine Park and Reserve. It is evident that the biomass recorded from the protected area is significantly higher indicating a higher productivity. In Gazi for example, the fisheries density is the highest, indicating the good state of the seagrass meadows. A study of the fish community in the Gazi creek, a mangrove-fringed estuary with inter-tidal and sub-tidal seagrass beds established a highly diversified assemblage of fish species. In the seagrass areas, 41 families composed of 85 species were documented. It is known that many fish species spend part of their life in one or more of the three habitats, hence the transboundarity between the mangrove, coral reef and seagrass meadows indicating the ecological interaction of the three.

#### Environmental Impacts

Trawling activities in the Ungwana Bay have had significant negative impacts on the seagrass beds and on threatened species, which use this habitat. These include the dugong, *Dugong dugon* categorized as vulnerable, and the Green Turtle, *Chelonia midas* and the Hawksbill Turtle, *Eretmochelys imbricata*, both categorized as endangered species. Thus the dugong and turtle species are under threat not only from being strangled in fishing nets, but also from the destruction of the seagrass meadows occasioned by the trawling activities. Indeed, dead turtles have been sighted in the Ungwana Bay whose death has been attributed to incidental catches by trawlers (Wamukoya *et al.* 1996).

## Transboundary Elements

Sightings of migratory turtle species in the seagrass beds in the Ungwana Bay and Lamu have been reported. It is understood that these species use the Bay as grazing grounds but breed elsewhere in Australia (Wamukoya *et al.* 1996 and cross-references). It is noteworthy that in the most recent marine aerial survey, the migratory species were not sighted or identified probably partly because they no longer frequent the area as a result of the trawling activities in the seagrass beds.

### 3.1.1.4 Coral Reefs

Coral reefs occur along most of the Kenya coast covering approximately 50,000 ha. A fringing coral reef, broken at the mouths of rivers, creeks and bays extends from Kisite in the southern part of Kenya to Malindi in the north coast. In the stretch from Lamu northwards patch reefs and fore reef slopes predominate. The coral reefs are highly productive with high biodiversity. With an estimated maximum sustainable yield of 5 – 10 tons/km<sup>2</sup>/yr, coral reefs are important fishing grounds for artisanal fishermen. In addition, the coral reefs, including the sandy beaches and lagoons, form the main attraction for tourists to the coastal area. Kenyan reefs have experienced degradation due to over-fishing and bleaching resulting in changes in community structures and coral deaths.

#### Diani Reef

Diani is the most developed tourist resort in the South Coast. Recent surveys of the condition of the inner lagoon reef at Diani indicated a high level of degradation (McClanahan *et al.*, in prep). Abundance and diversity of corals recorded were lower than in protected sites in Kenya or northern Tanzania (McClanahan and Mutere, 1994; McClanahan & Obura, 1995). Eight families of reef fish were censused during a recent study. The mean figure from five study sites for total wet-weight of fish from the eight families was 68 kg/ha. This is comparable to other unprotected reefs in Kenya (McClanahan & Obura, 1995), which were consistently below 100kg/ha between 1988 and 1993. Total wet-weight of the same fish families in 3 Kenyan marine parks were much higher, ranging between 800 kg ha<sup>-1</sup> and 1,500 kg ha<sup>-1</sup>.

Anthropogenic activities that impact on the reef include tourist activities and artisanal fishing. Over-exploitation of reef resources has been attributed with interference with the delicate predator-prey ecological balance with adverse effects on the coral reef. Over-fishing on the inner reef lagoon was attributed with the removal of the coral-eroder sea urchin *Echinometra mathaei* that enhanced degradation of the reef (McClanahan and Muthiga 1989, Muthiga & McClanahan 1987). It is generally recognized that most unprotected coral reefs are subjected to over fishing, shelling and degradation, with resultant changes in productivity and biodiversity (McClanahan 1997, McClanahan & Mutere 1994, McClanahan & Obura 1996).

#### Coral Bleaching

The 1997 - 98 *El Nino* Southern Oscillation phenomenon was characterized by unprecedented high seawater temperatures, with daytime low tide highs of over 32<sup>0</sup>C. Consequently bleaching occurred in 50 - 90 % of corals along the entire Kenya Coast (Obura 1999). It was reported that in the fringing reef coral mortalities ranged between 66 and 80% in shallow waters (Obura *et al.* 2000). It has been suggested that coral bleaching and the impacts of over fishing have delayed the recovery of coral reefs.

#### National and Transboundary Consequences

- decline in productivity and biodiversity of coral reefs can result in loss of livelihood to artisanal fishermen who depend on the reef;

- degradation of coral reefs can adversely affect marine species, including migratory species, which spend part of their life cycles in the coral habitats; and
- degraded coral reefs result in loss of aesthetic value and revenues from international tourism.

### 3.1.2 Issue 14: Over-exploitation of Fisheries and Other Living Resources

The fisheries resources can be divided into two categories, artisanal or subsistence fisheries and commercial fisheries. Artisanal fisheries concentrate in shallow inshore waters of depths not exceeding 20 m. The main fishing grounds are coral reefs and lagoons, mangrove estuaries and seagrass meadows. The commercial fisheries are composed of demersal fish, shrimp and lobster in the Ungwana Bay and Malindi Bay.

#### 3.1.2.1 Artisanal Fisheries

The artisanal fishery targets an approximate area of 2,000 km<sup>2</sup> with a productivity of 5.5 tonnes km<sup>-2</sup>. The potential productivity for tropical reefs is estimated at 5.0 tonnes km<sup>-2</sup>. Thus the artisanal fishery is considered to be fully exploited (Sanders *et al.* 1990). However, a number of studies have indicated over-fishing of coral reefs (e.g. Muthiga & McClanahan, 1987) with ensuing changes in community structures. Observations made by Nzioka (1981) and Mwatha (1998) on the reef fish *Scolopsis bimaculatus* and parrot fish *Leptoscarus vaigeinsis*, respectively, described the issue as growth over-fishing.

#### 3.1.2.2 Commercial Fisheries

A trawling survey for shallow water shrimp in the Ungwana Bay and Malindi Bay, off the Sabaki estuary by R.V. Shakwe in 1969 and 1971 estimated current biomass of 333 tonnes and maximum sustainable yield (MSY) of 350 tonnes. A demersal trawl fish survey in Ungwana Bay in depths less than 200 m by R.V. Fridtjof Nansen in 1980 – 1983 estimated a virgin biomass of 17,000 tonnes and MSY of 1,700 tonnes.

### Environmental Impacts

Most perceived impacts of over-fishing by commercial trawlers in especially the Ungwana Bay and Malindi Bay lack supporting documented data. However, various reports on impacts of over-fishing on particularly coral reef systems have been documented (e.g. McClanahan & Muthiga 1987).

- over-fishing in coral reef habitats has been shown to cause reef degradation and adversely affect the productivity and biodiversity;
- trawling for shallow water shrimp in the Ungwana Bay has resulted in destruction of the seagrass habitat, and impacted on productivity and fish diversity (as evidenced by claims of diminishing catches by artisanal fishermen);
- excessive by-catch and its disposal is an important issue of concern; and
- threatened marine species that frequent seagrass beds in Ungwana Bay, namely dugongs, the Green turtles and the Hawksbill turtle are at risk from shrimp trawlers, which often catch them in their trawl nets and kill them.

### 3.1.3 Issue 7: Suspended Solids

The main sources of sediment input into the marine environment include the major rivers, mainly the Tana and the Athi/Sabaki. Likewise the minor rivers, such as Kombeni, Mwache, Goshi, Voi, Mwachema, Mkurumuji, Ramisi and Uмба also discharge suspended solids into the coastal waters. Surface run-off also makes its contribution particularly during the rain season. Sediment discharges into the marine environment have been recorded for the major rivers and also for the minor rivers.

While the minor rivers discharge between 0.2 and 29.8 tonnes of sediment per day, the river Tana according to data recorded at Garsen, contributed 1,661 tonnes per day of sediment in the month of October, 1979; 2,304 tonnes per day in August, 1980; and 3,387 tonnes per day in August, 1982. On the other hand, the Sabaki River, with data recorded at the Baricho water treatment works intake gave the following results; October 1979, 74 tonnes per day; May/July/November 1980, 3,769 tonnes per day; June-October 1981, 846 tonnes per day; January-March 1982, 195 tonnes per day; June/August 1984, 111 tonnes per day; and in August 1994 at the river mouth, 143 tonnes per day.

## **Environmental Impacts**

Sediment loading into the marine environment has been found to impact on the estuary in the Malindi Bay, the coral reefs in the Malindi National Marine Park and Reserve and on the seagrass meadows. Specifically, the following have been observed:

- deposition of suspended solids on the coral system of the Malindi Marine Park and Reserve results in shadowing of the coral ecosystem with the consequent loss of the aesthetic value of this system making it less attractive to tourists;
- decline in biodiversity in the two major habitats i.e. the coral and seagrass meadows;
- the disappearance of seagrass species in the Malindi Bay probably due to suspended solid loading has been reported;
- sediment deposition and beach accretion, which have occurred in the Malindi Bay have resulted in the loss of beach frontage to some beach hotel establishments resulting in loss of tourism revenues; and
- there is potential negative impact to fisheries productivity as the major habitats, are impacted by suspended solids. This will translate to decreased fish catches and earnings from fishing.

## **3.2 Socio-Economic Impacts**

### **3.2.1 Issue Number 13: Modification of Ecosystems or Ecotones Including Community Structure and or Species Composition**

In Kenya, modification of ecosystems and/or ecotones is a very significant issue on socio-economic grounds. Unabated degradation of ecosystems and habitats leads to their reduced capacity to support the basic human needs of food, fuel and shelter. An assessment of the cross-border fishing activities between Kenya and Tanzania that are sharing marine resources reveals that modification of ecosystems has led to reduced fish catches in both countries and hence a diminishing means of livelihood. The conflict between fishermen from the two countries is now being dealt with at the East African Community (EAC) level. The most notable degraded habitats and/or ecosystems include mangroves, coral reefs, seagrass meadows and beaches. For generations these habitats and/or ecosystems have been supporting the means of livelihood to thousands of coastal dwellers in Kenya. Modification of ecosystems have resulted into the loss of their aesthetic value a characteristic on which tourism depends. The loss of aesthetic value due to siltation and beach accretion in the Malindi Bay have led to loss of income and foreign exchange from tourism as a number of tourist hotels have lost their beach frontage. The present situation in Malindi is that out of 4 beach hotels, three have closed down, and the last one is operating at less than half capacity, and one investor was forced to abandon the construction of another hotel at an advanced stage. As a result many hotel employees lost their jobs and income, while the economy lost the corresponding foreign exchange earnings. Regionally, modification has caused loss of existing and potential income from fishing and tourism. Conversely, modification of ecosystems has caused changes/loss in employment opportunities for local communities as well as the resultant changes in the social structures. In areas where trawling is practised, modification of the fishing grounds has led to loss of existing income to artisanal fishermen thereby causing resource use conflicts between the artisanal fishermen and trawler operators.

In selected hot spots, there is evidence of modification or loss of cultural heritage. At the Ngomeni mangrove swamps for example, a large stretch of mangroves has been cleared to give way for salt pans. At Gazi Bay, uncontrolled mangrove harvesting has led to loss of land due to erosion of the devegetated shoreline. Cultural heritage is therefore put in the balance. Once ecosystems are modified, the costs of restoration are too high and it takes too long to bring an ecosystem back to its original state. The survival of future generations may be compromised. However, despite these critical socio-economic impacts, no comprehensive valuation studies have been conducted in Kenya on the corresponding socio-economic impact measures. Using the limited information available, the Government of Kenya recognised the socio-economic and environmental significance of habitat and community modification and responded by establishing Marine Protected Areas to protect the critical habitats, conserve biodiversity and enhance inter and intra-generational equity. To date, the Kenya Government is spending approximately US\$ 560,000 per year towards Marine Park management.

According to an valuation study by Emerton (1999), the direct costs of conserving three of Kenya's Marine National Parks - Kisite, Malindi and Watamu were calculated by analysis of the annual budgets of the Kenya Wildlife Services, the national agency responsible for their management. In total, staff, equipment, infrastructure and maintenance costs for the three Marine National Parks were in the financial year 1994/95 equivalent to some US\$0.28 million at 1999 prices. When this figure is scaled up to cover all the Marine Parks and Reserves along the coast of Kenya, we obtain a total expenditure of approximately US\$ 560,000 in one year. This figure however, does not reflect the total economic value of the target coral reef and mangrove ecosystems in Kenya. These ecosystems support fisheries, which is a major source of livelihood to many of the coastal dwellers. They also support tourism, which is a significant employer and a leading foreign exchange earner in the country. However, besides the positive gains from tourism, it also impacts negatively on the coral reefs in Kenya through trampling, diving, snorkelling, boating and pollution.

Currently, there is evidence that modification of coral reef and mangrove ecosystems in Kenya force fishermen and other coastal dwellers to experience reduced capacity to meet basic human needs (food and fuel). Nationally, the objectives of achieving high and growing per capita incomes have not been fully met in recent years. Between 1980 and 1989, the average growth rate of per capita income was only 0.4 percent per year and between 1990 and 1995, the rate was a negative 0.3 percent per year. Rapid and sustained per capita income growth has remained an elusive target (Republic of Kenya, 1997). The welfare of majority of the people has declined as evidenced by the increase in the number of Kenyans living below the absolute poverty line. Kenyan coral reefs show signs of over-exploitation with increase in sea-urchin population and decrease in perceived catch (Malleret-King, 2000). The high urchin densities, the absence of urchin predators and the medium term decline in hard substrate cover, indicate that the condition of the lagoon is a result of fishing pressure. The survival of the fishing communities is therefore put in the balance, unless sustainable resource utilisation practices are put in place. There is need for comprehensive valuation studies to generate data on this issue to guide integrated resource management decisions.

Modification of the mangrove ecosystems of the Kenyan Coast results in damage to coastal infrastructure and settlements. A valuation study on the Tana Delta Wetlands (Ungwana - Bay) show that the wetlands and mangroves of Tana Delta provide significant flood and storm control functions, protecting coastal infrastructure and settlements. This function was partially valued by looking at the damage avoided to roads and bridges by the control of annual floods. The valuation study computed a total present value of Ksh.275 million (US\$4,583,333) in terms of re-establishment and maintenance expenditures avoided (Emerton, 1998). When scaled up to capture the functions of such ecosystems along the entire Kenyan coastline, a total present value of US\$13,749,999 is obtained for the flood and storm control function of the mangroves. If modification of mangroves and other coastal wetlands continue, this amount would be lost towards re-establishment and maintenance expenditures for protecting coastal infrastructures and settlements. This is by all standards quite a high value for a developing country and therefore mitigating measures are required to alleviate further degradation/modification.

At Mambrui in Malindi Bay, decrease in number of locally extant plant species has been reported. In 1972, four locally extant seagrass species were documented but in 1992, only two could be traced (Wakibia, 1995).

Modification of seagrass beds due to prawn trawling in the Malindi and Ungwana Bays has resulted in increased conflicts between artisanal fishermen and trawler operators. The artisanal fishermen attribute the decline in their fish catches to the indiscriminate and destructive fishing practices of the trawlers with the associated excessive by-catch and discards.

### **3.2.2 Issue Number 14: Over-Exploitation of Fisheries and Other Living Resources**

Over-exploitation of fisheries and other living resources causes reduced economic returns to many coastal dwellers in Kenya. This is further manifested by the loss of high quality protein food for human consumption. Fisheries and mangroves are important livelihood sources for many of the coastal communities along the coast of Kenya. Traditionally, the coastal communities depended on fisheries and mangrove exploitation. Presently, the Kenyan reef fishery shows signs of over-exploitation (Samoilys, 1988; Wells and Sheppard, 1988; McClanahan and Obura, 1995; Watson, 1996; Glaesel, 1997; Muthiga, 1998; Fisheries Department-catch statistics, 2000). Besides, it is documented that 70% of a Kenyan coastal fishing community depends on the coral reef fishery for 80% of its income (Malleret-King, 2000).

Statistics from the Fisheries Department (2000) indicate that fish catches have been declining over the years. For example, between 1998 and 1999, fish catch declined by a total of 1,612 tonnes while the fishing effort remained high especially in the artisanal sector. There is decline in aggregate marine fishery revenues amounting to US\$ 450,000. Between 1998 and 1999, the decline in fishery revenue was higher at US\$ 742,857, corresponding to a decline in fish catches during that period. Decrease in fish catch results in the subsequent decrease in local human consumption of fish protein. It is estimated that the average decrease in local human consumption of fish amounts to 31 kg per capita. This definitely contributes significantly to the reported cases of malnutrition in the coast of Kenya since many households depend solely on fishing both as a source of protein and for their means of livelihood. In 1998, 3,888 malnourished persons were reported (Republic of Kenya, 1998), representing an increase in morbidity rate of 216 persons per 100,000 population in the Coast of Kenya.

Prawn trawling in the Ungwana Bay has been going on since the 1970's. For the last decade, trawlers have had an average annual landing of 334 and 640 tons of prawns and fish respectively. These catches are associated with about 70-80 % by-catch in weight, which includes juveniles of commercial fish species and endangered species, such as sea turtles. Other problems associated with prawn trawling include benthic habitat destruction and conflicts between the trawler operators and the artisanal fishermen. In 2000, artisanal fishermen from Malindi Bay and Ungwana Bay raised alarm over the impacts of trawlers on their catches. Issues of inter and intra-generational equity and the survival of the artisanal fishermen are becoming critical causing conflicts in the use of common resources. However, the Government also needs foreign exchange which this sector generates through trawling. There is therefore need to conduct a comprehensive valuation study to generate information and data for rational management of the fishery.

Recent reports have documented evidence of a decline of sea turtles and marine mammal populations in Kenya's waters (Jarman, 1966; Watson, 1973; Pertet and Thorsell, 1980; Kendall, 1986; Olendo, 1993). Records show that there has been a drastic decline in dugong population over years from 67 animals in 1973 (Watson, 1973) to a record of only 3 animals in 1980 (Pertet and Thorsell, 1980). This implies that 64 Dugongs could have disappeared between 1973 and 1980. Dugong meat and other products have numerous uses that have remained the driving force behind their being hunted. This has been attributed to intensive hunting primarily for their meat and oil. Thus, over-exploitation, but also incidental catches appear to be the main factors threatening dugong population in Kenya. Accidental drowning in trawling nets and set nets by the ever increasing commercial and artisanal fishermen pose

a considerable threat to the survival of the dugong population in Kenya particularly in Ungwana Bay. It has been reported that mortalities from accidental drowning is significant but it is very difficult to obtain precise figures.

During one survey 13 green turtles and many other turtle species were found dead in various stages of decomposition or as shell remnants along the beaches in Ungwana Bay. Some of the dead turtles were intact indicating that they were not slaughtered for food, but could have drowned in trawl nets before washing ashore. This implies that the deaths could be as a result of human predation on nesting females or the fishing activities in the outlying areas as incidental catches in trawl nets, as this is an area with high trawling activities. Since turtles are endangered species, such over-exploitation or indiscriminate killing may result in their extinction. There is need for a study to determine the viability of traditional approaches to conserving such endangered species.

### **3.2.3 Issue 7: Suspended Solids**

Increased levels of suspended solids result in reduced tourism and recreational opportunities as it interferes with the aesthetic value of beaches, coral reefs and mangroves. The most affected sites are Malindi Bay, a selected hot spot and Malindi/Watamu Marine Park and Biosphere Reserve, a sensitive area. Before the slump in 1998, tourism was a leading foreign exchange earner in the country and employed thousands of coastal dwellers. The Malindi town, which is located within the Malindi Bay, owes its development to tourism revenues. Currently, almost all tourist hotels along the Bay have lost their beach frontage with consequent loss of tourism business and closure. This is further manifested in loss of employment to many hotel employees.

Kenya experiences increased costs of coastal protection from waves, flooding from major river systems and erosion. Many sea walls have been erected at major tourist development centres to protect them from shoreline erosion that has been threatening many of the coastal developments. This impact is most felt at north and south of Malindi Bay, Mombasa and Diani all of which are hot spots and Malindi/Watamu Marine Park and Biosphere Reserve and Ngomeni Mangrove Swamps which are sensitive areas.

Suspended Solids have caused increase in water treatment costs with adverse impacts on the coastal dwellers. For example, the Baricho water supply plant in the Malindi Bay area was designed to produce 80,000 m<sup>3</sup> of water per day from River Sabaki (Ministry of Water Development, 2001 pers. comm.). The plant could not continue functioning as planned due to high volumes of suspended solids that required high expenditures on chemical coagulation agents. The water supply plant had to change her source of water intake from the River Sabaki itself to wells dug close to the river. The plant is currently producing only 55,000 m<sup>3</sup> per day (i.e. a reduction of 25,000 m<sup>3</sup>). The water department which is the government agency responsible for water resources development finds that water treatment, particularly the coagulation element has become too costly because of the high sediment loads carried by the river.

A decrease in the number of some locally extant seagrass species has been reported in Malindi Bay. It is documented that four locally extant species were reported in 1972 at Mambui in Malindi Bay but, in 1992 only two species remained available (Wakibia, 1995). Coincidentally, the decrease has occurred at Malindi Bay which is a hot spot that is experiencing heavy siltation. Besides, the decrease is tremendous and worrying, considering that this change has occurred within a period of only twenty years.

There is regular dredging of the navigational channel and in the Mombasa port area to maintain the depth required for shipping activities. The associated costs of dredging are indicative of the significance of the impacts of suspended solids on the Kenyan coastal waters.

## **CHAPTER 4**

### **4. Causal Chain Analysis**

#### **4.1 Issues**

There are three issues that were prioritised according to their environmental and socio-economic impacts on coastal ecosystems, namely

- i) modification of ecosystems and ecotones including community structure and/or species composition;
- ii) over-exploitation of fisheries and other living resources; and
- iii) suspended solids.

The issues were subsequently taken through a causal chain analysis procedure closely following the GIWA methodology.

#### **4.2 Methodology**

##### **4.2.1 Immediate Causes**

For each issue immediate or technical causes were identified and the relative percentage contribution to the issue indicated. Of the immediate causes only those contributing 30% or more to the issue were considered for further analysis. Considering the lack of similar previous assessments, the best expert knowledge of the situation on the ground was used to determine the percentage contributions. The immediate causes were characterised using available published information and expert knowledge to qualify and/or quantify them. The compiled information was presented in characterisation tables as appended (see Annex VIII Appendix 2 - Summary table for characterisation - table: immediate causes).

##### **4.2.2 Sectoral Pressures**

The sectoral pressures affecting the immediate causes were next identified and their relative percentage contributions determined. In the case of sectoral pressures, further analysis was performed on those contributing 20% or more to the immediate causes. The sectors that were studied included agriculture, urbanisation, industry, energy production, tourism, transport and fisheries. Available information and data was used to determine the changes in resource use patterns, resource use activity(ies) and resource use practice(s) that directly or indirectly exert pressure on the immediate causes. The output was presented in the characterisation tables for sectoral pressures (see Annex VIII Appendix 2: Summary table for characterisation - table: sectoral pressures).

##### **4.2.3 Root Causes**

The underlying root causes were considered in clusters as follows; social changes which included demographic changes, institutional drivers which encompassed institutional governance, insufficient international assistance, limited civil society empowerment and little government commitment, and economic structure which included little private sector commitment, development model and macro-economic policies, and regional/global wealth distribution. The root causes were characterised and links established with sectoral pressures and responses and the output presented in tables as appended (see Annex VIII Appendix 2: Summary table of characterisation - table: root causes).



#### 4.2.4 Responses

Responses favouring or mitigating resource use were considered with reference to issues of governance (regulations, laws, policies, projects and institutions), market and community responses.

Environmental management policies and the tools used to address immediate and/or root causes were considered in the following areas; water pollution, spills and solid wastes, land use changes, major project decision making, fisheries regulations, forestry, soil conservation and urban policies. For each policy area, the nature of the tool and/or policy, link to sectoral pressure and/or immediate cause and link to international agreement, programme or policy were identified. Also assessed were the effectiveness of the tool and/or policy and the causes of the ineffectiveness. The output was summarised in tables as appended (see Annex VIII Appendix 2: Summary table for characterisation - table: responses).

Sectoral policies and tools that drive sectoral pressures were identified and assessed according to the following activity sectors; urbanisation, agriculture, fisheries, industry, tourism, energy, transport and forestry. Similarly, for each sector the nature of the tool and/or policy in use, links to sectoral pressure and/or immediate course, and link to international agreements, programme or policy were identified. An explanation of how pressure on the issue is increased and reasons for implementation of the policy or tool was given and the output presented in a table of responses (see Annex VIII Appendix 2: Summary table of characterisation - table: responses).

Community initiatives, including NGOs that could provide a positive response to alleviate pressure on the issue were identified and barriers or constraints to their implementation mentioned (see Annex VIII Appendix 2: Summary table of characterisation - table: community responses).

Market forces and/or private sector initiatives contributing to or alleviating the issue were identified, and constraints towards positively addressing the issue pointed out (see Annex VIII Appendix 2: Summary table of characterisation - table: market response).

### 4.3 Issue 13: Modification of Ecosystems or Ecotones Including Community Structure and/or Species Composition

#### 4.3.1 Immediate Causes and Sectoral Pressures

##### 4.3.1.1 Modification of Mangrove Ecosystems

As earlier stated, mangrove swamps along the coast of Kenya cover approximately 53,000 hectares and loss of mangrove cover since pre-agricultural times is estimated to be 70% (UNEP, 1998). Four immediate causes were identified to be exerting direct pressure on modification of these mangrove ecosystems (see Figure 2). These causes include land use changes (30%), increased sediment supply (10%), unsustainable harvesting practices especially commercial and subsistence wood harvesting (30%) and partial conversion as a result of spills and solid waste disposal (30%). Out of these causes, land use changes, unsustainable harvesting practices and partial conversion as a result of spills and solid waste disposal are more significant.

Land use change due to solar salt production (industry) has resulted in a reduction of mangrove cover of over 5,000 ha. at Ngomeni. To date, solar salt production is tending to expand to other areas such as Lamu, and the impact is expected to be more severe. The cost of production of solar salt is low while there is high demand for salt in both the domestic and regional markets. Considering the current status and the projected trends, the industry has contributed about 80% to land use changes in mangrove areas with corresponding degradation and or loss of mangrove ecosystem.

Extensive over-harvesting of mangroves has been carried out at Gazi creek and Mombasa inshore water areas to provide firewood for both calcium and brick manufacturing. Subsistence and

commercial exploitation of mangroves is carried out along the entire coast of Kenya to meet the increasing demand for firewood and building poles, and provide a means of livelihood to local people, while export driven exploitation is localized in Lamu District. The mangrove pole is the principal building material for temporary and semi-permanent houses in most coastal urban settlements in Kenya. The traditional subsistence harvesting of mangrove is always selective while commercial harvesting is often indiscriminate and destructive. Therefore the leading economic sectors under unsustainable harvesting practices are forestry (50%) and urbanization (30%).

Partial conversion as a result of spills and solid waste disposal is characterized by minor spills, leakages during off-loading of crude petroleum oil and bunkering occurring during normal shipping activities in the Mombasa harbour. In 1988, a crane accidentally punctured a fuel oil storage tank, spilling 5,000 tonnes of its contents into the Makupa creek, Mombasa, resulting in almost total destruction of approximately 2 ha of mangrove cover with adverse impacts on community structure. In addition, disposal of solid waste in a mangrove area in Mombasa has caused destruction of mangroves. Domestic solid waste is not sorted prior to disposal resulting in hazardous and toxic contaminants getting into the mangrove environment. The economic sectors that exert pressure leading to partial conversion of ecosystems include transport (40%), industry (30%) and urbanization (20%). The contribution of the transport sector is higher because it encompasses all shipping activities that pose a growing threat of near-spills and minor spills.

#### **4.3.1.2 Modification of Estuaries**

Two immediate causes have been identified as having direct pressure on the issue (see Figure 3). These are land development, which contributes 60% of the pressure; and unsustainable harvesting practices 40%.

The land use practices that impact on estuaries are agriculture and the keeping of livestock that contribute 50% of the pressure, while damming activities on Kenya's major rivers to generate electricity to meet energy needs, contributes 30% of the pressure.

Bad agricultural practices in the river basin and marginal areas, and the keeping of large herds of livestock have resulted into loss of vegetation exposing the soils to erosion. Consequent to this, we find increased turbidity in the Tana and Sabaki estuaries. Increased sediment loads have resulted in siltation, which has led to a decline in water quality and the accretion of the shoreline as seen in the Malindi Bay. The quest to meet the energy needs through hydroelectric power generation by damming activities have led to reduced stream flow, denying the estuaries the much needed freshwater inflow to sustain this ecosystem as exemplified by the River Tana, where, the flow is now less than 50% of that measured in the 1950's. This has led to the subsequent reduction of watering points for birds.

Unsustainable harvesting practices, which contribute 40% of pressure on estuaries is fuelled by urbanization and its demand for forestry resources – wood for building material and as a source of fuel. The demand for agricultural products has also intensified farming activities, further contributing to estuarine problems. It is observed that many coastal settlements/urban centres are located in the vicinity of mangrove estuaries. This has in effect accelerated the depletion of estuarine resources impacting the ecosystem in the process. Notable examples of such urban centres are Lamu, Malindi and Mombasa, where impacts on fisheries and other socio-economic activities such as bee keeping affecting livelihood means have been reported.

#### **4.3.1.3 Modification of Seagrass Meadows**

There are two immediate causes identified as having direct pressure on the issue (see Figure 4), namely:

- i) unsustainable harvesting practises attributed with 70%; and
- ii) land use changes, attributed with 30% of the pressure.

Commercial trawling for primarily prawns is a major fisheries activity carried out in the rich seagrass beds in Ungwana Bay and Malindi Bay, resulting in over-fishing of the resources and destruction of the habitat.

Land use activities that exert pressure on the issue are in the agricultural sector attributed with 70% and urbanization with 30%. Bad agricultural activities along the major river basins, e.g. R. Tana and R. Sabaki enhance soil erosion, resulting in the introduction of high loads of suspended sediments in the river(s), which eventually discharge into the sea leading to siltation of seagrass (e.g. Ungwana and Malindi Bays). Urban centres, which are most often located near estuaries such as Mombasa and Malindi, are sources of pollution from urban wastes, such as excessive loads of nutrients and microbial contaminants to the seagrass resources.

It is noteworthy that in the Ungwana Bay and Malindi Bay unsustainable fishing practices, dominated by commercial prawn trawling, are the main cause of the modification of the seagrass ecosystem.

#### 4.3.1.4 Modification of Coral Reef Ecosystems

There are three immediate causes identified (see Figure 5) that exert direct pressure on the issue namely:

- i) unsustainable harvesting practices attributed with 35%;
- ii) land use changes attributed with 30%; and
- iii) partial conversion of the coral reef ecosystem as a result of global temperature changes, attributed with 30% of the pressure.

The sectors that contribute significant pressure on unsustainable harvesting practises and hence on the issue, include fisheries attributed with 45% and urbanization and tourism attributed with 20% each. Fishing in the coral reefs is predominantly artisanal. Increased fishing effort in terms of number of fishers and man-hours and use of destructive fishing gears e.g. spear guns and beach seines, has resulted in over-fishing in the coral reefs by artisanal fishers. An example is the Diani reefs, which experienced degradation with accompanying changes in the ecological balance and community structure because of over-fishing. Growing urbanization has in turn increased the demand for fish and other resources obtained from coral reefs, and thereby increasing pressure on the habitat. Tourism activities in the coral reefs cause direct pressure e.g. boating and reef walking, whereas collection of ornaments including shells and ornamental fish for the tourist market add indirect pressure on the coral ecosystem. Generally, with the exception of protected areas, most coral reef areas along the coast are under pressure from over-exploitation.

Land development activities that increase pressure on the issue include urbanization attributed with 30%, agriculture sector 30% and the tourism sector with 25%. Coastal urban centres, including Mombasa, experience poor waste management because of inadequate (as in Mombasa) or non-existent waste disposal facilities and infrastructure, such as sewage treatment and/or sewerage facilities. The problem of waste management is further compounded by unplanned urban settlements or slums, which lack essential services, such as drinking water and sanitation services. Thus coral reef systems are subjected to loads of potential pollutants through storm water runoff and untreated sewage discharged in inshore waters, particularly by suspended solids, excessive nutrients and microbial pollutants (Munga *et al.* 1993, Mwanguni and Munga 1997).

With the exception of two beach hotels in the Mombasa North area and one beach hotel in Diani, beach hotels invariably use septic tank-soak pit systems for sewage disposal. However, often the hotels discharge wastewater into the inshore lagoons, thus increasing pressure on the corals. It is also normal to construct seawalls to protect tourist facilities. This however, alters the wave dynamics and results in beach erosion, which tends to increase water turbidity and stress on the coral reefs.

Bad agricultural activities along the major river basins and in the catchment areas e.g. R. Tana and R. Sabaki have enhanced soil erosion, leading to high loads of suspended solids in the river water discharging into the sea and resulting in siltation and shadowing of corals. An example is the increased turbidity experienced by the coral gardens in the Malindi Marine Park and Reserve due to high silt loads discharged in the Malindi Bay by the R. Sabaki in the northern coast.

#### 4.3.2 Root Causes

The social changes that affect the modification of habitats include population pressure, poverty and inequality, low level of education, and beliefs and values. Demographic changes depicted by a national population growth rate of 2.9% p.a. and in-migration have increased demand for solar salt with consequent increase in solar salt production. Increased production of solar salt has caused destruction of the mangrove habitat at Ngomeni-Gongoni area, north of Malindi. Demographic changes have also resulted in increased need for means of livelihood and demand for aquaculture products and mangrove wood. They have also increased generation and disposal of wastes that impact negatively on the mangrove environment especially in Mombasa and Lamu where the municipal dumping sites are located in mangrove areas. Besides, increased population growth has increased the demand for petroleum oil and has raised the risk of accidents occurring. The increase in population and the desire to diversify the economy has also led to estuarine land being put to other uses e.g. the construction of a hotel in Funzi Bay that has encroached into an estuarine environment. The desire of the population to be self-sufficient in food requirements means increased irrigation, reducing the freshwater flow into the estuaries. Coral reefs and seagrass beds are under pressure from population increase especially along the coastal districts because of the increasing demand for their resources. The total population in the coastal districts increased from 1.8 million to 2.4 million between 1989 and 1999, an average growth rate of 3.1% p.a. (Republic of Kenya, 2000).

Poverty and inequality has resulted in over-dependence on mangrove resources since people are increasingly harvesting and selling mangrove wood to provide for their daily needs. Increasing poverty and lack of alternative means of livelihood has left most coastal communities with no viable options but to join the artisanal fisheries sector, often resorting to the use of destructive (or the “most effective”) gear, composed of beach seines, spear guns and small mesh-size nets, which further increase pressure on the coral reef and seagrass habitats.

The beliefs and values of the local populations and those of the immigrants have tended to conflict, where the immigrant population do not seem to value the ecosystem functions of the habitats, going instead for short term gains, by over-exploiting the resources at the expense of long term gains, e.g. the value placed on mangroves as a source of building materials and fuel wood for immediate gains rather than its ecosystem functions as a critical habitat. For the fisher folk, fishing is their traditional occupation and the preferred economic activity, coupled with the belief that marine resources are inexhaustible has resulted in increased fishing effort and added pressure on the inshore habitats.

Similarly, low levels of education and awareness, has resulted in uninformed actions, leading to the destruction of the ecologically sensitive coral and seagrass areas, for instance the use of destructive fishing gear, such as beach seines, small mesh-size nets and dynamite.

The institutional drivers that exert pressure on the issue include institutional governance, little government commitment and limited civil society empowerment. Institutional governance exerts pressure on mangrove and/or estuary resources due to lack of foresight on potential environmental problems associated with development, lack of appreciation of the critical ecological functions of mangrove ecosystem, lack of valuation data for mangrove ecosystems to guide decision making and enforcement of policies. The apathy that has developed among the law enforcers and non-implementation of regulations has caused destruction of mangrove estuaries, loss of productivity and biodiversity, contamination of surface water resources and emergence of community based groups to guard against unsustainable utilisation of mangrove resources. Institutional constraints affecting coral reefs and seagrass include issues of governance, i.e. lack of data and limited capability to monitor and

understand the extent of the problem, little government commitment or desire to control over-harvesting of resources, and the low awareness of the ecological importance and participation of the civil society in management of the resources.

Other root causes are macro-economic policies, micro-economic policies and little private sector commitment to environmental concerns. The current industrialisation policy and liberalisation of the Kenyan economy provide incentives to investors with consequent expansion of solar salt production in the mangrove areas. Currently there are a number of firms engaged in solar salt production at Ngomeni-Gongoni area, while initially only the government was involved in production of solar salt. Expansion in solar salt production, now extending to Lamu District, has resulted in increased cleared land. In addition, macro-economic policies have not adequately addressed the distribution of the national income. Out of a total national population of approximately 26 million, 11 million lived below the poverty line while 3 million were unemployed in 1997 (GOK, 1997). Because of widespread poverty, there is over-dependence on mangrove resources for livelihood. The private sector on the other hand concentrates on short-term profit maximisation. The lifting of the ban on export of mangrove products is responsible for the interference with mangrove estuaries. This is compounded by the increased number of people engaged in mangrove harvesting as the sole means of livelihood. The prevailing macro-economic policies whereby export promotion of prawns, sea-cucumber and other high value products, is emphasized to meet the high international market demand exacerbate over-exploitation of the resources at the disadvantage of the poor artisanal fishers. The macro-economic policies have failed to generate alternative employment opportunities resulting in increasing recruitment of artisanal fishermen and hence over-fishing and declining catch per capita. The outcome has been increased fishing effort (and pressure on the coral reefs) to meet the demand for the local market. There is also over-exploitation of other coral reef resources e.g. shells and ornamental fish for the tourist market.

Micro-economic policies have resulted in the emergence of community based organizations (CBOs) as instruments for sustainable development. These CBOs are involved in micro-enterprise programs, carrying out a variety of small-scale family or village based businesses that deal with locally available products, such as mangrove fuel-wood and mangrove-oyster. However, some of these activities exert pressure on the mangrove resources, for example, over-harvesting of mangroves for fuel-wood and destruction of mangroves during oyster harvesting.

### **4.3.3 Responses**

#### **4.3.3.1 Environmental Management and Sectoral Policy**

Existing environmental legislations that address problems associated with modification of ecosystems are found in Acts of parliament that deal with land use changes, forestry, fisheries regulations, tourism, major project decision making, spills and solid waste management, and water pollution management.

Problems associated with land use changes are addressed by the Land Planning Act Cap.303 and Physical Planning Act No. 6 (1996) of the Laws of Kenya. The Land Planning Act sets out land planning regulations and gives the local authorities power to plan their own developments. The Physical Planning Act is relevant to the management of mangrove, estuarine, seagrass and coral reef environments, as it recognises certain areas as special planning areas and controls the use of land. In addition, the Town Planning Act, Cap. 134, Agriculture Act, Cap. 318, and Environmental Management and Coordination Act (2000) of the Laws of Kenya, are relevant to the protection of estuaries. The Town Planning Act and the Physical Planning Act empower local authorities to plan and provide facilities and services to urban centres. Urbanization increases the demand and results in over-exploitation of inshore habitats, e.g. over-fishing at Diani, Shimoni and Mombasa.

The Agricultural Act provides for the development of agriculture and soil conservation with the aim of ensuring food security in the country. However poor agricultural practices especially in the large river

basins e.g. R. Tana, enhance soil erosion, the transportation of high loads of suspended sediments downriver into the sea and result in siltation in estuaries, adjacent beaches, seagrass areas, mangroves and coral reefs.

The Environmental Management and Coordination Act is designed to alleviate pressure on the environment through good environmental management and safeguards against any type of pollution.

The Fisheries (Fish Industry) Act, Cap 378 of the Laws of Kenya is designed to manage and promote sustainable exploitation of fisheries while minimizing environmental damage. However, fishing methods applied often prove to be destructive, e.g. trawling for prawns in seagrass beds, beach seining, and use of spear guns and dynamite in coral reefs. According to regulations commercial trawlers are allowed to operate beyond 5 nautical miles from the shore, but most often are found in inshore areas, resulting in conflict with the artisanal fishers.

The legislation providing for regulating the tourism sector includes the Tourist Industry Act, Cap 385, Tourism Industry Licensing Act, Tourist Development Cooperation Act, Cap 382 and Wildlife Conservation and Management Act, Cap, 376 of the Laws of Kenya. Tourist activities on coral reefs, which include reef walking, boat anchoring, collection of shells and ornamental fish, cause destruction of corals, impacting on community structure, productivity and biodiversity. The Acts however make provision for alleviating pressure on the coral reef ecosystem by regulating tourism for sustainable development and conservation of the resource base.

Forestry policies are found in the Forest Act, Cap. 385 of the Laws of Kenya. The Forest Act provides regulations for the management and utilization of forest resources including mangroves. Difficulties in regulating and monitoring harvesting of mangroves (and terrestrial forests) have resulted in over-exploitation of the resources.

The regulations governing major project decision making, with reference to solar-salt manufacturing and commercial prawn farming are addressed by the Environmental Management and Coordination Act (2000) and the Physical Planning Act No 6 (1996). Both Acts are comprehensive and relevant to the management and protection of the mangroves

Policies that deal with the management of spills and solid waste and other forms of water pollution are found in the Merchant Shipping Act Cap. 389, the Water Act, Cap. 372, Public Health Act Cap. 242, Environmental Management and Coordination Act, (2000) and the Territorial Waters Act, Cap. 371 of the Laws of Kenya. The Merchant Shipping Act safeguards the marine environment against oil pollution and damage. The act provides regulations for liabilities and compensation, oil pollution and damage, compulsory insurance, international safety management, and oil pollution preparedness response and cooperation. The Water Act safeguards water sources against pollution, the Public Health Act provides for waste management safeguarding against any form of pollution while the Territorial Waters Act prohibits the discharge of oil from ships thereby protecting the environment.

Most of the Acts, especially the Environmental Management and Coordination Act and Physical Planning Act address the concerns of some international agreements, in particular the Convention for the Protection, Management and Development of the Marine and Coastal environment of the Eastern Africa region (Nairobi Convention 1985) and the Convention on Biological Diversity (1992).

However, the effectiveness of the policies and/or tools in protecting the environment is compromised by inconsistencies in some of the laws developed, inadequate implementation of the policies or tools, gaps in the monitoring or availability of data, and ineffective enforcement of the policies or laws. Inconsistencies in the laws have been brought about by lack of integrated policy making, conflicting or overlapping jurisdiction and fragmentation of the laws on a sectoral basis. Inadequate implementation of the policies has been caused by lack of implementing authority, conflicting or overlapping jurisdiction with other policies, inadequate intersectoral cooperation, inconsistency in application of the law, abuse of influence (e.g. use of undue influence in change of land use), and lack of or

inadequate resources (staff and equipment), scientific and technical capacity (staff and training). Gaps in the monitoring data is attributed to lack of policy for systematic data collection on relevant issues, inadequate data collection on relevant issues, and lack of or inadequate resources, scientific and technical capacity, lack of sectoral cooperation, and poor awareness of problems (by both the community and implementing agency) on problems and solutions associated with habitat degradation. Ineffective enforcement of the law is also constrained by the lack of or inadequate monitoring data, as well as lack of enforcement authority and inconsistencies in application of the law.

In view of the constraints associated with the policies and tools, the effectiveness in environmental protection, as assessed on a scale of 0 - +4 (with 0 = not effective, +1 = least effective, +2 = fairly effective, +3 = effective, +4 = most effective), ranges between 1 and 2. Thus, the management policies assessed to be fairly effective (scored +2) are major project decision making, and spills and solid waste. Whereas, land use changes, forestry, fisheries regulations and water pollution management policies are assessed as being least effective (scored +1).

#### 4.3.3.2 Community Responses

There are a number of small-scale community based aquaculture initiatives that promote sustainable utilization of mangrove resources. These initiatives are executed by different community groups, such as *Mtwapa Community Group* in Mombasa which is involved in small-scale prawn and crab culture with the support of KMFRI and an NGO called *KWETU, Tsunza Conservation and Development Programme*, a community group in Kwale-Mombasa which is involved in small-scale culture of mud crab, bee-keeping and mangrove rehabilitation and conservation with support from KMFRI and the Swedish Society for the Conservation of Nature, *Miritini Community Group* in Mombasa which is involved in small-scale prawn culture and bee-keeping with the support of Aga Khan Foundation, and the *Pambazuko Women Group* in Mombasa. The pond construction for the small-scale prawn culture initiative is environmentally friendly because it is associated with minimum or no mangrove destruction. The mud crab culture involves the use of cages and does not interfere with the natural habitat. However, inadequate financial support to the community groups, limited scientific and technical support, limited awareness of problems and solutions associated with the mangrove environment, and poverty and lack of alternative means of livelihood among most of the coastal communities, are major constraints to the performance of these groups.

A number of community based mangrove conservation groups have emerged with the primary aim of rehabilitating mangrove areas that are degraded mainly by over-harvesting. Such groups include *Viriko-Vimoyoni* and *Jipe Moyo* mangrove conservation groups at Mida Creek, *Tsunza Community Conservation Group* in Mombasa, *Kipini Community Conservation Group* (Ungwana Bay), and community participation in mangrove rehabilitation at Gazi Bay. As they go about their activities, these conservation groups are constrained by poverty and lack of alternative means of livelihood among the local communities with consequent over-dependence on mangrove resources. Other constraints include inadequate financial support, limited scientific and technical support and episodic natural events leading to mangrove degradation, for example heavy siltation in mangrove areas during the *El Nino* rains.

Growing community awareness of the environmental problems associated with unsustainable utilization of the marine resources has resulted in the formation of community based beach management committees at Diani, Gazi, Shimoni and Vanga in the southern coast. The beach management committees are a co-management initiative coordinated by the Fisheries Department to promote community resource management and conservative. The committees draw their members from the local fishing community and depend on membership fees for their financial requirements. The aims of the community groups include environmental conservation by controlling the use of destructive fishing gear by artisanal fishers. This initiative helps to control the destruction of coral reefs and seagrass beds, conserve the productivity and biodiversity of the habitats and promote sustainable utilization of the resources. Constraints facing the community for effective addressing of the issue include, poverty which compels the artisanal fishers to use the “most effective” gears with

little regard to the environment, the over-dependence on artisanal fisheries due to lack of alternative employment opportunities, limited financial and logistical support to the community groups and the intrusion of foreign fishermen who often have no scruples in using destructive fishing methods.

#### **4.3.3.3 Market Responses**

Expansion of solar salt production in mangrove swamps in Ngomeni-Gongoni area, northern coast, was initially carried out by one Government owned firm. So far there are at least three firms involved, as the market has been liberalized. The firms/investors are attracted into the industry by the high demand for salt in the domestic and regional market and the low production cost. In fact most of the salt requirements in the economy are met by solar salt. The increased demand for salt implies increased salt production with consequent clearing of mangrove swamps. The poor awareness by the industry on problems and solutions associated with modification of the mangrove ecosystem, by constructing expansive ponds, and industrialisation policy that emphasizes job creation at the expense of the environment are major constraints in this area.

Growth in the number and size of firms dealing in and/or utilizing petroleum products in Mombasa has resulted from increased demand for fuel oil that poses an increasing threat of mangrove destruction due to oil spills. In addition, liberalization of the oil (petroleum) industry has resulted in increased importation and handling of crude oil and its products. Consequently, there are increased incidences of spills during off-loading and bunkering operations in the Mombasa harbour. The Mombasa port currently does not have receptacles for waste ballast water and equipment for handling major spills is lacking.

Commercial prawn farming at Ngomeni is another initiative that involved clearing of mangrove areas (approximately 50 ha) to create space for the construction of ponds. The destruction of mangroves here is associated with poor awareness on problems and solutions associated with loss and/or modification of the mangrove ecosystem.

Commercial logging and mangrove harvesting involves clearing of mangrove forests to meet the increasing market demand. Lack of a policy on monitoring of logging and mangrove harvesting, and inadequate resources by the regulatory authority have resulted in destruction of mangrove habitats.

There is a new tax policy on imported timber that is aimed at easing pressure on local forest resources. The policy spells out a tax waiver to make imported timber cheap and available in the market.

Low cost housing development in coastal urban areas by private developers has resulted from a high demand for affordable housing. Mangrove poles are the principal building material in most coastal urban centres for temporary and semi-permanent housing structures. Consequently there is relentless pressure on the mangrove resources. The popularity of mangrove wood among consumers is a disincentive to conservation.

Use of mangrove wood in industrial applications exerts pressure on mangrove ecosystems. Mangrove wood is a preferred source of fuel especially in the brick and calcium manufacturing in Mombasa. Besides, capital-intensive investments in tourist facilities involve the use of mangrove wood. Most of the tourist hotels and other recreational facilities have been constructed by using mangrove wood.

The development of “fuel efficient stoves” alleviate pressure on the mangrove and estuarine ecosystems as these improved stoves consume less fuel (charcoal from mangrove wood) with a consequent reduction on the volume of mangroves harvested. This initiative also furthers the interests of the Nairobi Convention (1985), Convention on Biological Diversity (1992) and the Ramsar Convention. However, widespread poverty among the coastal communities constrains the acquisition and use of fuel-efficient stoves.



The initiative of private sector participation in urban waste management as practised in Mombasa, Diani and Malindi has the potential to reduce high loads of suspended solids, nutrients and other contaminants entering the sea through storm water runoff. Domestic solid waste and sewage is collected and disposed off at dumpsites, often located in mangrove areas (e.g. Mombasa and Lamu). The solid waste dumped in mangrove areas smothers the mangroves and contaminates the marine environment with potential pollutants through leaching. Some tourist beach hotels namely Severin and Bamburi Beach in Mombasa and Travellers Beach at Tiwi near Diani in the southern coast have developed their own sewage treatment facilities. However, a number of beach hotels discharge wastewater in inshore lagoons, which is a potential problem for coral reefs and seagrass beds. Constraints against the promotion of private sector participation in urban waste management initiatives include the lack of innovative ways of waste management to make it attractive to investors and the poor awareness by private firms on problems associated with waste disposal in the marine environment.

Prawn trawling in the Malindi and Ungwana Bays is by its nature destructive and destroys the seagrass habitat and adversely impact on productivity and biodiversity. Intensified artisanal fisheries activities along the entire coast, with the exception of marine protected areas (MPAs), and the use of destructive fishing gear, such as beach seining, use of small mesh-size nets and dynamiting, has resulted in over-fishing and degradation of coral reefs and seagrass beds, and adversely impacted on productivity and biodiversity (McClanahan & Muthiga, 1987). Efforts at alleviating pressure on the seagrass resources are however constrained by the overwhelming motive of profit maximization by trawler operators. Whereas, poverty and over-dependence on coral reef and seagrass fisheries resources by the community, and the lack of proper storage or preservation facilities (cold house), tends to leave the artisanal fishers with little choice but to dispose their catch at low prices and resort to increasing the fishing effort to improve their earnings, thereby exerting more pressure on the habitats. The entry of small-scale fish processors has improved the market for artisanal and semi-industrial fishers, which has resulted in increased fishing effort and hence pressure on the inshore/nearshore habitats. This initiative is also driven by the desire to maximize profits and the export market.

The objectives behind the formation of Fishermen's Cooperative Societies are to provide storage facilities, marketing services and credit facilities, which would empower the fishermen to optimise their catches. However, over 80% of the Fishermen's Cooperative Societies have collapsed and the remaining, have to a large extent, failed to meet their goals, because of poor management skills and inadequate Government support, such as training opportunities and technical advice.

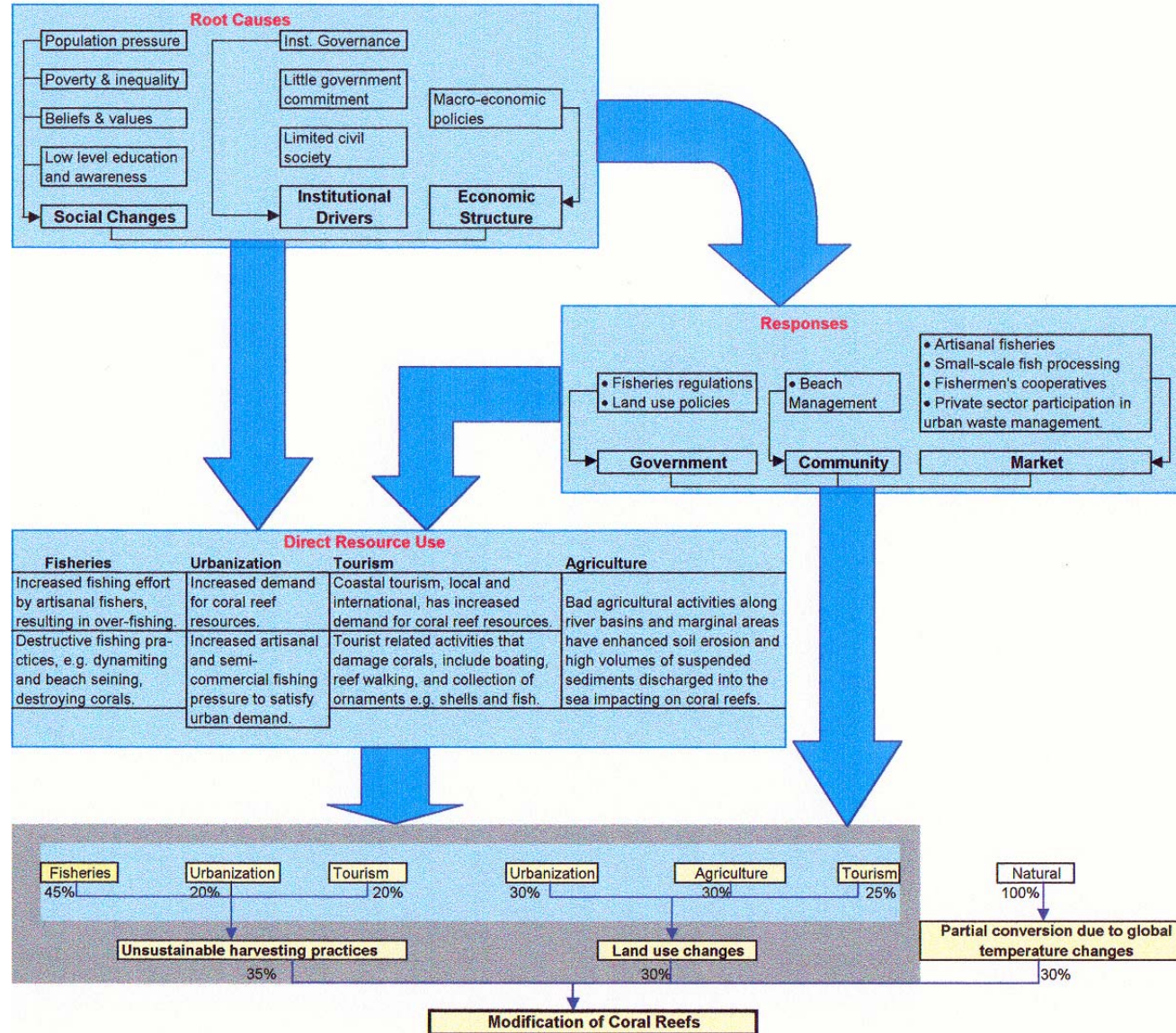
#### **4.3.4 Transboundarity Elements**

The mangroves of Mida creek (Malindi/Watamu Marine Park and Biosphere Reserve) and the adjacent coral reefs play important ecological functions and to date Mida creek has been recognized as a WWF Ecoregion of sub-regional importance. In addition, the mangroves of Lamu-Kiunga extend into Somalia. A lot of mangroves harvested at Lamu-Kiunga are exported to the Middle East.

The population of Billfish of Mida creek is of global significance. A number of endangered migratory species such as the Green Turtles, Hawksbill Turtles, Loggerhead Turtle and the Dugong are found in the seagrass meadows in Ungwana Bay. Conservation of these species is essential, and due to the migratory nature of these species, there is need for transnational efforts to their conservation.

The Pemba fishermen from Pemba Island in Tanzania actually fish in the coral reefs and seagrass meadows in Kenya. They often use destructive fishing methods such as dynamite, beach seines and drift nets, resulting in conflicts with the local fishermen.

It is also important to note that the River Uмба that flows from Tanzania discharges nutrients and suspended sediments into the sea at Vanga in the southern coast of Kenya.



**Figure 2. Causal Chain for Issue 13: Modification of Ecosystems or Ecotones Including Community Structure and/or Species Composition (Modification of Mangroves)**

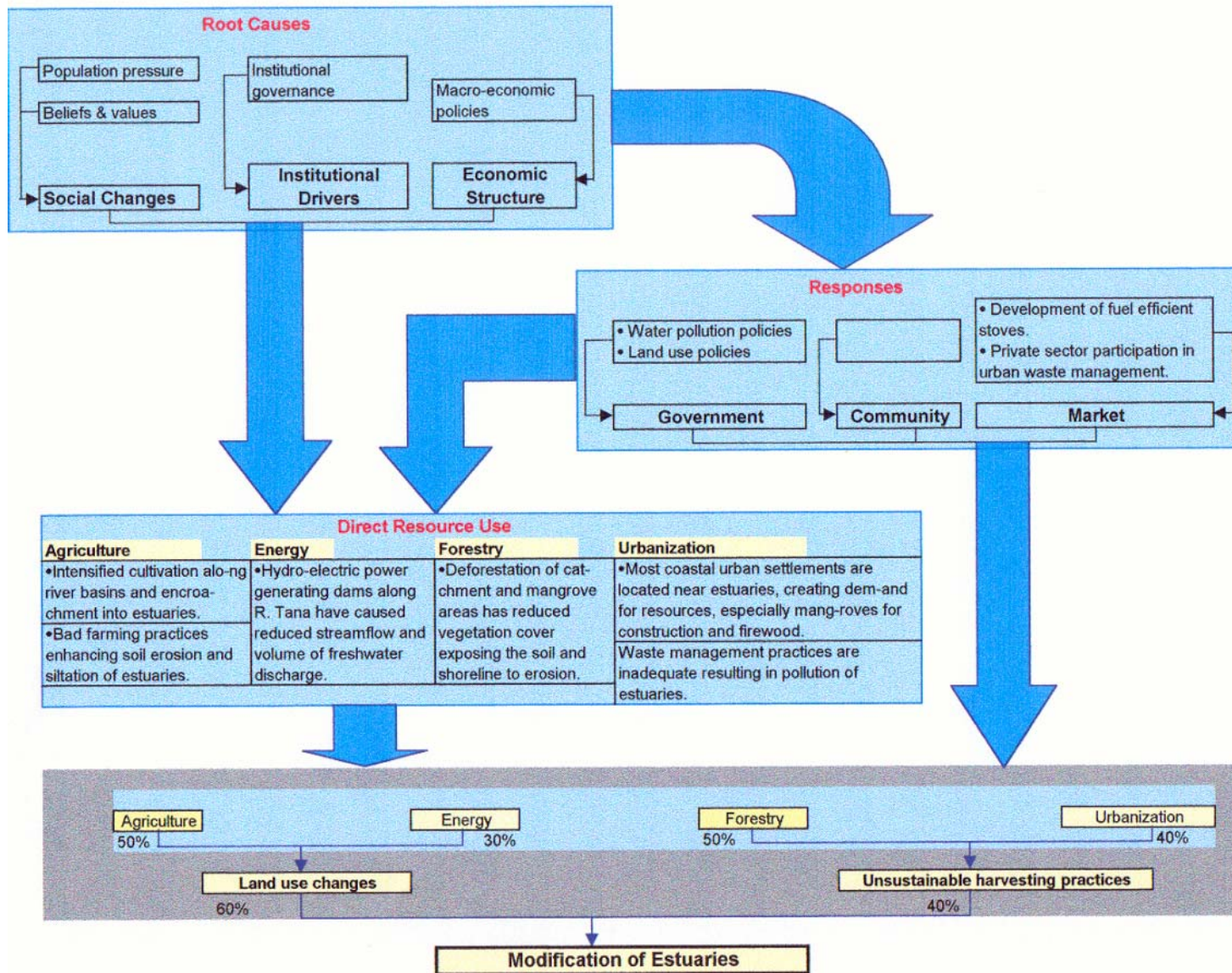


Figure 3. Causal Chain for Issue 13: Modification of Ecosystems or Ecotones Including Community Structure and/or Species Composition (Modification of Estuaries)

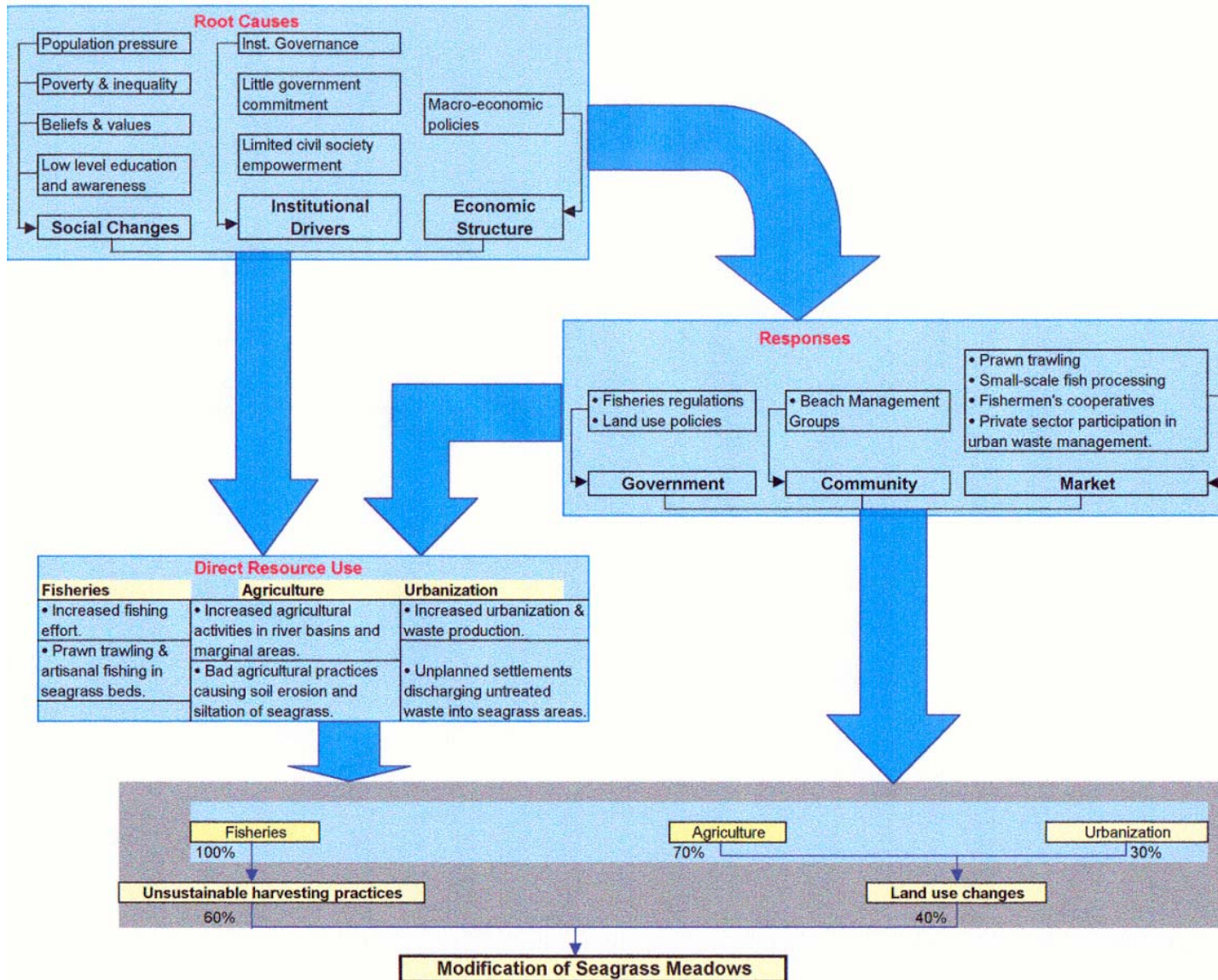


Figure 4. Causal Chain for Issue 13: Modification of Ecosystems or Ecotones Including Community Structure and/or Species Composition (Modification of Seagrass Meadows)

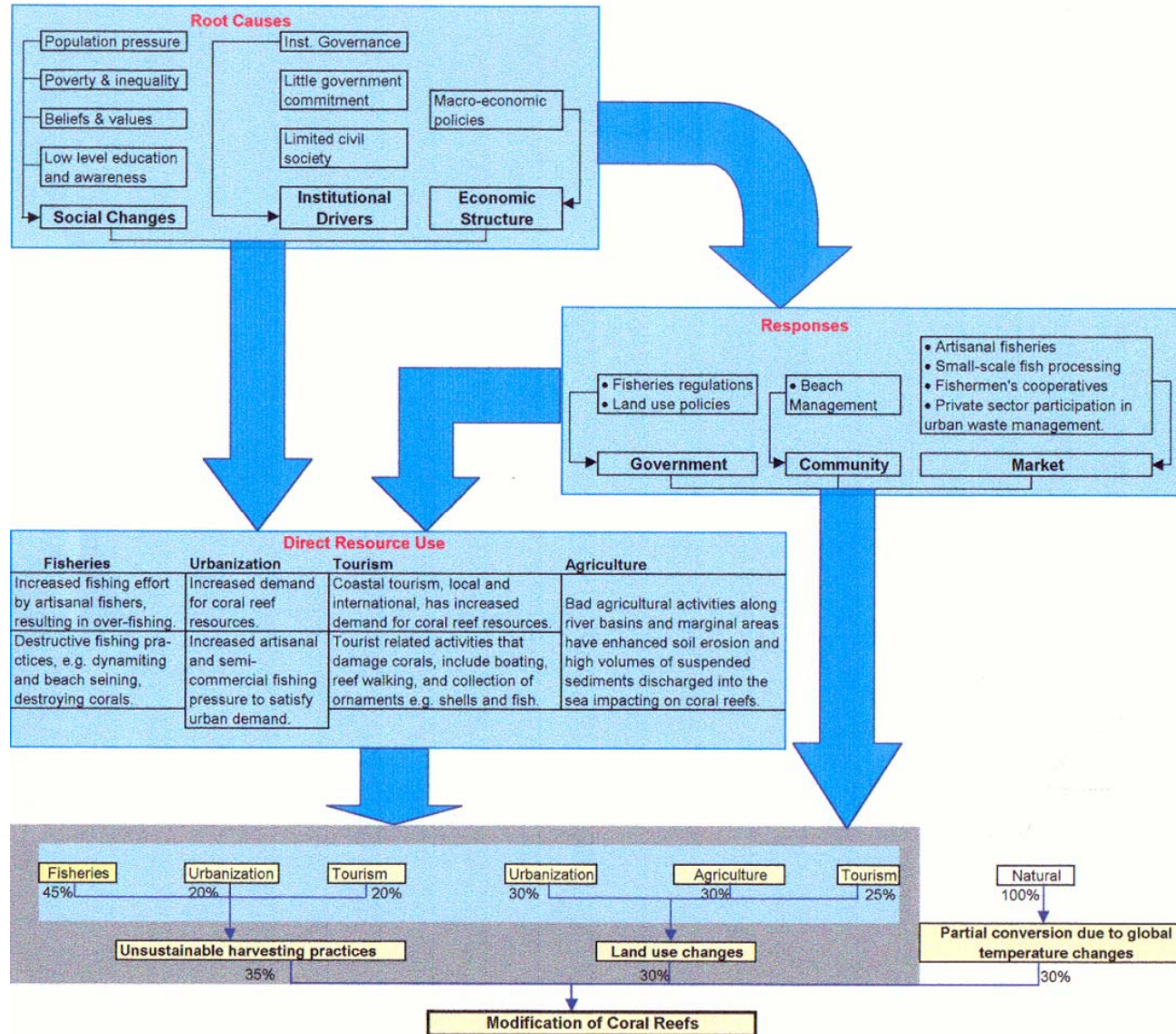


Figure 5. Causal Chain for Issue 13: Modification of Ecosystems or Ecotones Including Community Structure and/or Species Composition (Modification of Coral Reefs)

## 4.4 Issue 14: Over-Exploitation of Fisheries and Other Living Resources

### 4.4.1 Immediate Causes and Sectoral Pressures

The immediate causes of over-exploitation include changes within the sector (increased fishing effort) which accounts for approximately 35%, decreased habitat/nursery ground and level of recruitment that accounts for about 35% and shift in fish population distribution that accounts for 30% of the pressure (see Figure 6). Changes within the sector exert pressure through intensive artisanal fishing practices in the inshore areas, semi-industrial fishing, so is the commercial prawn trawling in the Malindi and Ungwana Bays. The primary economic sector is fisheries (100%). There is a trend towards the use of inappropriate fishing gears with adverse consequences in the artisanal fisheries. The commercial prawn trawling involves excessive by catch and discards and has caused a decline in some fish species that are highly valued in the artisanal fishery. In addition, prawn fishing has been identified as a threat to endangered species, namely the Green turtles and Hawksbill turtles.

Decreased habitat/nursery ground and level of recruitment is evident in increased destruction of mangroves, coral reefs and seagrass beds. Most pressure is exerted by urbanization (30%), agriculture (20%) and forestry (20%). Urbanization has resulted in increased demand for mangrove, coral and seagrass resources. Consequently, this has resulted in decreased mangrove cover at Gazi and Mombasa, degradation of coral reefs in the southern coast especially at Diani, with the resultant change in community structure and productivity. Shifts in fish population distribution have resulted in ecological imbalance in the over-fished areas. This is evident in the Diani reefs where increased fishing effort caused over-exploitation of coral reef fisheries resulting in changes in community structure e.g. decreased predator population caused increased sea urchin population (McClanahan, 1995). Natural factors such as the inclement weather due to the *EL Nino* phenomena have also adversely affected mangrove and coral reef habitats.

### 4.4.2 Root Causes

The root causes of over-exploitation include social changes, institutional drivers and economic structures. These are further broken down as population pressure (demographic changes), poverty and inequality, low level of education, little government commitment, institutional governance, limited civil society empowerment, macro economic policies and little private sector commitment.

Population pressure is caused by natural population increase and has resulted in increased demand for fish and other marine resources. Poverty and inequality have caused increased fishing effort as more people are getting into artisanal fisheries and tend to spend longer hours fishing as stocks dwindle. In addition, poverty has led to over-dependence on marine resources since there is increased need for means of livelihood.

Low level of education causes uninformed decisions by the fishermen. The use of indiscriminate and destructive fishing gears is becoming common. There is a high frequency of conflicts occurring between the informed fishermen who advocate sustainable fishing practices and the less informed fishermen who often use destructive fishing gears.

Inadequate budgetary allocation to the Fisheries Department by the Government makes it difficult for the department to effectively monitor resource exploitation and enforce regulations. Low economic returns from fishing have resulted in increased fishing intensity, over-exploitation and changes in community structure. Institutional bottlenecks have led to inadequate implementation of policies governing resource management in unprotected areas hence resulting in over-exploitation. Limited civil society empowerment has not favoured the promotion of community conservation groups and creation of awareness on environmental problems associated with over-exploitation of fisheries and habitat degradation.

Macro-economic policies that emphasize export promotion have encouraged commercial prawn trawling with excessive by-catch and discards and habitat destruction. Approximately 98% of all prawns landed by trawlers annually are exported (Fisheries Department, 2001). In addition there is little private sector commitment to environmental concerns. Commercial prawn trawlers are not keen at using turtle excluder devices (TEDs). Besides, they pay little attention to reducing the quantity of by-catch and discards. This has resulted in user conflicts between the artisanal fishermen, who feel that their traditional heritage is endangered, and the profit motivated prawn trawlers.

### **4.4.3 Responses**

#### **4.4.3.1 Environmental Management and Sectoral Policy**

Environmental legislations that address problems associated with over-exploitation of fisheries and other living resources are found in the Acts that deal directly with fisheries management. Such Acts include Fish Industry Act Cap. 378, the Government Fish Protection Act of the Laws of Kenya. The Fish Industry Act manages fishing activities at both artisanal and commercial levels. Relevant international agreements include the FAO code of conduct for responsible fisheries. The code of conduct addresses threats to biodiversity from fishing practices and is to be applied with due regard to the Biodiversity Convention (1992).

The Government Fisheries Protection Act provides for control on gathering particular species such as pearls, pearl shells, oysters, cowries, crustaceans and corals. This Act is in line with the Convention on International Trade on Endangered Species of Wild Fauna and Flora (CITES), Convention on Biological Diversity (1992), and the Nairobi Convention (1985).

Land use policies that are linked to over-exploitation of fisheries and other living resources are covered by various legislations namely, Land Planning Act Cap. 303, Town Planning Act Cap. 134, Physical Planning Act No.6 of 1996, Agriculture Act Cap. 318, Environmental Management and Coordination Act (2000) and the Forest Act Cap. 385 of the Laws of Kenya. The Land Planning Act sets land planning regulations and gives local authorities the mandate to plan development within their areas, while the Town Planning Act governs all development in urban centres including coastal urban settlements. Urbanization has resulted in increased demand for marine resources and the consequent over-exploitation in an effort to satisfy the market demand.

The Physical Planning Act and the Environmental Management and Coordination Act are more comprehensive. The Physical Planning Act provides for declaration of certain areas as special planning areas. It recognizes ecologically sensitive areas and provides for their preservation. The Environmental Management and Coordination Act provides for an integrated approach towards environmental management. However, this Act has not yet been effectively enforced as the regulatory authority is in the formative stage.

The Forest Act provides for establishment, control and regulation of forest resources. However, poverty and high population growth constrains enforcement of the Act since there is increased encroachment into marginal lands as people desperately search for agricultural land. High demand for fuel-wood and construction material also makes enforcement of the Act difficult. All these Acts are linked to the UNCED (1992) and the Nairobi Convention (1985).

Implementation of the Acts are further constrained by inconsistency in implementation of policies, e.g. legally the prawn trawlers should operate outside 5 nautical miles from the shoreline, but in reality they trawl inside the limit. The policies also suffer from gaps in monitoring or availability of data due to inadequate technical capacity in terms of staff and training, lack of resources and lack of intersectoral cooperation. The Acts are not enforced effectively due to lack of monitoring data, inadequate penalties to offenders, lack of transparency and inadequate resources allocated to the enforcement authority.

Taking into consideration the constraints affecting both the fisheries regulations and land use policies and tools, the management policies are least effective (scored +1).

#### 4.4.3.2 Community Responses

There are a number of community initiatives that address over-exploitation. Such community responses include community based beach management committees at Diani, Gazi, Shimoni and Vanga in the southern coast of Mombasa. These are local community initiatives meant to undertake surveillance and control the use of destructive fishing methods to promote sustainable exploitation of the artisanal fisheries. However, the initiatives are constrained by poverty among the artisanal fishermen. Poverty exerts pressure on fishermen to use what they perceive to be the most effective gears without regard to the environment. The apparent lack of alternative means of livelihood among majority of coastal communities tends to create over-dependence on artisanal fisheries. In addition, there are user conflicts arising from intrusion by foreign fishermen from Pemba in Tanzania who often use destructive fishing methods. This intrusion by foreign fishermen is a trans-boundary problem and is indicative of the extent of over-exploitation.

There are a number of community based mangrove conservation groups that have been formed along the coast of Kenya. Such groups include “*Viriko-Vimoyoni*” community conservation group at Mida creek in the Malindi-Watamu National Marine Park and Biosphere Reserve, *Tsunza* community mangrove conservation group in Mombasa, *Kipini* community conservation group at Tana River delta in Ungwana Bay. In the southern coast, there is community participation in mangrove rehabilitation at Gazi Bay. All these groups work on the rehabilitation of mangrove areas that are degraded mainly by over-harvesting. The groups in Mombasa and Gazi get technical support from KMFRI. Some NGOs provide them limited financial support. However, their efforts are constrained by poverty and lack of alternative means of livelihood among majority of the coastal communities that results in over-dependence on marine resources. Also, the financial resources available are inadequate, making it difficult for them to build a critical scientific and technical capacity.

#### 4.4.3.3 Market Responses

A number of market responses contribute to over-exploitation. They include intensification of prawn trawling at Malindi Bay and Ungwana Bay and artisanal fishing along the entire coast. Bottom prawn trawling causes destruction of seagrass beds, and excessive by-catch and discards that translate into over-exploitation, with consequent negative impacts on productivity and biodiversity. Artisanal fishing is tending towards the use of indiscriminate fishing gears that also impact adversely on the fisheries. Intensification of prawn trawling is driven by the profit maximization motive with little or no regard to environmental concerns. Artisanal fishing is driven by poverty and lack of alternative means of livelihood among coastal communities. Over-exploitation within the artisanal fisheries is further worsened by lack of cold storage facilities with consequent low returns during glut leading to increased fishing effort.

In response to socio-economic problems within the fisheries sector, fishermen’s cooperative societies were established to undertake fish marketing and provide fish storage and credit facilities to members. However, over 80% of these cooperative societies have failed to meet their desired goals. This failure together with poor and fluctuating fish prices have resulted in over-fishing with consequent destruction of fishing grounds. The cooperatives were constrained by low levels of education and lack of management skills by the society officials as well as inadequate Government support in terms of training.

Expansion in small-scale fish processing industry increases market for fish from the artisanal and semi-industrial fishermen. Consequently, there is increased fishing effort. The small-scale fish processing industry is driven by the profit maximization motive with little or no regard to environmental concerns. They are also influenced by export promotion and industrialisation policies.



Commercial logging and harvesting of mangroves along the entire coast involves clearing of terrestrial and mangrove forests to satisfy the increasing market demand. The agency charged with the responsibility of regulating logging and mangrove harvesting is currently constrained by inadequate resources to conduct the monitoring and enforcement of regulations.

#### **4.4.4 Transboundary Elements**

The case of the Pemba fishermen who often use destructive fishing gears in the Kenyan fishing areas is a transboundary issue that needs to be addressed jointly. In fact the Kenyan reef fisheries is threatened with over-exploitation and the presence of these foreign fishermen is already causing conflicts with the local fishermen who feel that their traditional fishing grounds are threatened (also see sec. 4.3.4).

### **4.5 Issue 7: Suspended Solids**

#### **4.5.1 Immediate Causes and Sectoral Pressures**

Three immediate causes were identified (see Figure 7) as the main technical causes putting pressure on the issue namely:

- i) soil and sediment erosion attributed with 35%;
- ii) land use changes attributed with 30%; and
- iii) runoff and storm waters through point and diffuse sources attributed with 30% of the pressure.

Significant sectoral pressure on soil and sediment erosion was attributed to the agriculture sector at 40%, forestry at 30% and natural causes at 30%. Bad farming practises along major river basins and banks and marginal lands have enhanced soil erosion and high loads of suspended sediments in the rivers discharging into the sea e.g. the high volumes of sediments discharged at the R. Tana Delta and R. Sabaki mouth. Illegal logging in the water catchment areas in the Mt. Kenya forest has also contributed to increased suspended sediments down the major rivers, R. Tana and R. Sabaki. Over-harvesting of mangroves has resulted in the deforestation of considerable areas of mangrove swamps resulting in shoreline erosion and increasing water turbidity, e.g. about 615 ha of mangrove cleared at Gazi exposed a section of the shoreline to severe erosion.

Sectoral pressure on changes in land use was mostly attributed to the agricultural sector at 80% and urbanization at 20%. Extensive agricultural activities including livestock grazing along the major river basins on marginal lands and steep slopes has enhanced soil erosion and increased suspended sediment loads in the rivers which discharge into the sea. The development of unplanned urban settlements most often in marginal lands has caused loss of vegetation cover resulting in soil erosion and increased levels of suspended matter, microbial pollution and excessive nutrients from domestic wastewater. Of the coastal urban centres only Mombasa has a sewage treatment facility serving a small proportion of the population, not exceeding 15%. Increased urbanization also results in high volumes of surface runoff during precipitation and high loads of suspended solids discharging into the sea.

#### **4.5.2 Root Causes**

The social changes that increase pressure on the immediate and technical causes and indirectly on the issue include population increase in the country and along the coastal districts. This has caused the increased demand for agricultural land leading to encroachment into forest and marginal lands. Poverty and low level of education of the community, in addition to a low appreciation of the ecological functions of forests, has also contributed to bad farming practices and the unsustainable harvesting of forest products. Declining cultural values among the coastal communities have encouraged encroachment into cultural and/or sacred coastal forest sites. In-migration into the coastal

urban centres has resulted in the development of unplanned settlements most often in marginal areas lacking essential services and amenities.

The macro-economic policies in the country tend to favour the development of certain key cash crops for the international market while neglecting others. Thus, areas not favoured may experience bad farming practises and lead to land degradation. Little private sector commitment to environmental issues, and in their quest for more profits, in a high demand market, has resulted in unsustainable harvesting of wood products.

The institutional drivers associated with the resource use changes and issue include matters of governance in which there is inadequate provision of technical support to small-scale farmers and abuse of influence (e.g. in excision of forests to create agricultural land), insufficient international assistance such that farmers continue to apply obsolete technology, and limited civil society empowerment to make the community assertive against activities or policies that are detrimental to forests.

### **4.5.3 Responses**

#### **4.5.3.1 Environmental Management and Sectoral Policies**

The soil conservation policy is covered by the Agriculture Act, Cap 318 and the Forest Act, Cap 385 of the Laws of Kenya. The effectiveness of the laws in environmental management is hampered by inadequate resources in terms of staff, equipment and finance for implementation of the Forest Act, inadequate scientific and technical capacity, inadequate data collection on relevant issues, weak deterrence in law enforcement (e.g. low fines) and inconsistency in application of the law.

The legislation concerned with land use changes policies include the Land Planning Act, Cap 303, Town Planning Act, Cap 134, Physical Planning Act No. 6 of 1996, Environmental Management and Coordination Act (2000) and the Agriculture Act, Cap 318 of the Laws of Kenya. The laws have been rendered less effective because of conflicting or overlapping jurisdiction (e.g. Town Planning and Land Planning Acts), lack of human, technical and financial capacity, abuse of influence in implementation of the policy or law, inadequate intersectoral cooperation (e.g. land use conflicts between crop farming and pastoralism), inadequate data collection and inconsistency in application of the law.

Urban policy is governed by the Land Planning Act, Cap 303, Town Planning Act, Cap 134, Physical Planning Act No. 6 of 1996, Environmental Management and Coordination Act (2000) and the Public Health Act of the Laws of Kenya. Effectiveness in protection of the environment is lessened by conflicting and overlapping jurisdiction, lack of resources (staff and equipment) especially for the implementation and enforcement of the Public Health Act, and lack of scientific and technical capacity.

The constraints associated with the three environmental management policies make them least effective (scored +1) in protecting the environment.

Sectoral policies that indirectly increase pressure on the issue include agriculture, forestry and urbanization. Agricultural activities are subject to the Agriculture Act whose goal is to promote the sector to ensure food security in the country. However, poor agricultural practices along major river basins and on steep slopes enhance soil erosion resulting in the transportation of high loads of suspended sediments downriver which discharge into the sea causing siltation in estuaries, adjacent beaches, mangroves and shadowing and/or siltation of coral reefs and seagrass beds. However, the Act provides for soil conservation strategies, which tend to alleviate pressure on marine resources and the issue.

The Forest Act provides for the management and utilization of forest resources, including coastal forests. However, deforestation in catchment areas, either through encroachment or illegal logging or unsustainable harvesting, enhances soil erosion which results in the transport of high loads of suspended sediments downriver and into the sea. Mangrove deforestation has caused shoreline erosion and high water turbidity at Gazi Bay south of Mombasa.

Urbanization is governed by the Town Planning Act and the Physical Planning Act. The former Act provides for urban development and the provision of amenities and services to the urban dwellers. However, increased clearing of vegetation cover exposes the soil surface to storm water runoff and erosion. The construction of seawalls for the protection of tourist facilities has resulted in changes in wave dynamics leading to erosion of the beach and increased loads of suspended solids.

The Public Health Act empowers the local authorities to take measures to maintain a clean environment in the urban centres. However, most coastal urban centres either have inadequate or non-existent sewage treatment facilities and sewerage systems. The result is high volumes of untreated urban runoff, industrial and domestic wastewater contaminated with suspended solids, nutrients and other pollutants discharging into adjacent marine habitats e.g. Mombasa and Lamu.

#### **4.5.3.2 Community Responses**

There are a number of community conservation groups that are involved in the rehabilitation of mangrove areas degraded mainly by over-harvesting, namely, *Viriko-Vimoyoni* and *Jipe-Moyo* groups at Mida creek (Malindi), *Tsunza* group (Kwale-Mombasa), Kipini group (Ungwana Bay) and Gazi group (Kwale). The community groups work with technical support from the KMFRI and financial support from NGOs. Mangrove reforestation efforts by the community groups aim at the restoration of degraded habitats, thereby stabilizing the shoreline and minimizing erosion, with consequent reduction in the levels of suspended sediments discharged into the marine habitats. Constraints against the community initiatives in further addressing the issue, include poverty and the lack of alternative employment opportunities which tend to create over-dependence on the mangrove resources, inadequate financial support, limited scientific and technical support and the episodic events causing mangrove degradation e.g. heavy siltation in mangrove areas resulting from exceptionally heavy precipitation during the *El Nino* weather phenomenon in 1997/98.

The Green Belt Movement is one of the well-known NGOs engaged in the rehabilitation and conservation of forests. Their mission is to sensitise the community and the Government on the importance of conserving forests in catchment areas. Consequently, they contribute towards alleviating soil erosion and siltation in the marine environment. Constraints limiting their efforts at further addressing the issue include little political support and the apparent lack of consistency in their conservation policies.

#### **4.5.3.3 Market Responses**

The development of fuel-efficient charcoal stoves was aimed at alleviating pressure on forest resources, both inland and coastal. The fuel-efficient stoves consume relatively lower volumes of charcoal and thus reduce the quantity of wood required for charcoal production. This translates into reduced pressure on forest resources in catchment areas and mangroves, thereby minimizing soil and sediment erosion and levels of suspended solids discharged into the marine environment. However, poverty among the community acts as a constraint in the acquisition and use of the fuel-efficient stoves.

Private sector participation in waste management was initiated in Mombasa, Diani and to a lesser extent, Malindi, especially in garbage and sewage sludge collection and disposal, which is normally dumped at designated sites, often in mangrove areas e.g. Lamu and Mombasa. The increased efficiency in waste management has the effect of reducing the loads of suspended solids, nutrients and other contaminants entering the sea through runoff. Some tourist hotels have established their own

sewage treatment facilities. However, a number of beach hotels discharge wastewater in inshore water areas which is a potential problem to sensitive marine habitats. Constraints towards further addressing of the issue include the lack of innovative ways for waste management to make it attractive to investors, and poor awareness by private firms on problems associated with waste disposal in the marine environment.

#### **4.5.4 Transboundary Elements**

The River Umba that flows from Tanzanian highlands transports nutrients and suspended sediments that discharge into the sea at Vanga in the southern coast. In addition, there are two major rivers in Kenya, the R. Tana and R. Sabaki that discharge water and nutrients into the sea but the extent of impacts is yet to be determined.

### **4.6 Commonalities or Overlaps**

#### **4.6.1 Immediate Causes and Sectoral Pressures**

The habitats addressed under the issue of modification of ecosystems or ecotones, including community structure and/or species composition, namely mangroves estuaries, seagrass and coral reefs are essentially inshore and are ecologically closely interlinked. Along the Kenyan coast, mangroves cover all estuaries, with the exception of the Sabaki river mouth. The seagrass beds occur in the sandy or muddy areas in the lagoons between the shoreline and the fringing coral reef. Among other functions mangrove estuaries serve as breeding and nursery grounds for a variety of fishes that spend part or all their lives in either seagrass or coral reefs. It is thus not unexpected that issues affecting one of the habitats subsequently affect the other.

There are two immediate causes that are common for the modification of the four habitats, namely land use changes and unsustainable harvesting practices. Land use changes is also one of the immediate causes for the suspended solids issue (Issue 7).

The most prevalent sectoral pressure is urbanization, which affects not only the modification of the four habitats but also suspended solids. Urbanization also contributes to over-exploitation of fisheries and other living resources (Issue 14) through a different immediate cause (not land use changes or unsustainable harvesting practices). The agriculture sector contributes to the modification of estuaries, seagrass beds and coral reefs, as well as over-exploitation of fisheries and suspended solids.

To sum-up land use changes and unsustainable harvesting practices are the most common immediate causes for modification of the four habitats and suspended solids. The most common sectoral pressure contributing to the immediate causes, in descending order are urbanization, agriculture, fisheries and forestry.

#### **4.6.2 Root Causes**

There are commonalities in the root causes of modification of ecosystems, over-exploitation and suspended solids. The common root causes include population pressure, poverty and inequality, beliefs and values, low level of education, institutional governance, little government commitment, limited civil society empowerment, macro-economic policies and little private sector commitment to environmental concerns.

Population pressure is one of the fundamental threats to coastal and marine resources and has impacted adversely on all the four habitats under modification of ecosystems, over-exploitation and suspended solids. Poverty and inequality among the coastal communities has impacted heavily on modification of mangrove, seagrass and coral reef habitats, over-exploitation and suspended solids. The changing beliefs and values held by the local people also exert pressure on the marine resources.

The effects of low level of education are felt on the modification of estuaries, over-exploitation and suspended solids. Pressure due to institutional bottlenecks or governance has been felt on all the environmental issues under analysis, namely modification of ecosystems, over-exploitation and suspended solids. Little government commitment is to blame for modification of seagrass meadows, coral reefs and over-exploitation of fisheries and other living resources.

The civil society has yet to be fully empowered to undertake management and conservation of marine resources to help ease pressure on the resources. In addition, macro-economic policies that promote industrialization, employment creation and foreign exchange earnings, result in modification of ecosystems, over-exploitation and suspended solids.

Finally, little private sector commitment to environmental concerns is responsible for degradation of mangrove habitat, over-exploitation and suspended solids.

### **4.6.3 Responses**

#### **4.6.3.1 Environmental Management and Sectoral Policy**

The predominant policies and/or tools designed to address problems associated with the modification of all the four habitats, and over-exploitation of fisheries and other living resources and suspended solids are land use changes policies. Fisheries regulations are common in addressing problems associated with modification of mangroves, seagrass beds, coral reefs and over-exploitation of fisheries and other living resources.

There are several legislations enacted to address land use changes. These include the Land Planning Act, Physical Planning Act (1996), Town Planning Act, Environmental Management and Coordination Act (2000), Agriculture Act, Forest Act and Land Adjudication Act. It is noted that with the exception of the Physical Planning Act and the Environmental Management and Coordination Act, which is yet to be fully implemented, most of the legislation is sectoral and this is one of the reasons that affect effectiveness of the laws. Thus, constraints that lessen the effectiveness of the legislation in protecting the environment, include inconsistency in the law developed depicted by conflicting or overlapping jurisdiction and deficiency in the policy planning. Implementation of the policies is constrained by lack of enforcement authority, lack of intersectoral cooperation, inconsistencies in implementation of policies (resulting in land use conflicts), abuse of influence (e.g. use of undue influence to change land use), and lack of or inadequate resources, human technical and financial capacity. The existence of gaps in the monitoring or availability of data is attributed to the lack of policy for systematic data collection on relevant issues, inadequate intersectoral cooperation, inadequate data collection, and the lack of or inadequate resources, scientific and technical capacity. The ineffective enforcement of the land use policies is attributed to the lack of enforcement authority, inconsistency in application of the law, lack of available monitoring data and inadequate penalties or deterrence.

The fisheries sector is addressed by the fisheries regulations, which are governed by the Fisheries Industry Act, Cap 378, and Government Fisheries Protection Act of the Laws of Kenya. However effectiveness of the legislation in protecting the environment is affected by, deficiency in the law in which inadequate penalties and incentives are provided for. Inadequacy in implementation of the policies is attributed to inconsistency in the implementation of policies and the lack of adequate resources, scientific and technical capacity. The occurrence of gaps in the monitoring or availability of data is attributed to the lack of or inadequate resources, scientific and technical capacity, and poor community awareness of environmental problems associated with degradation of marine habitats and over-exploitation of resources. Ineffective enforcement of fisheries regulations policies is attributed to lack of or inadequate resources and technical capacity, lack of or inadequate available monitoring data and inadequate penalties to offenders.

#### **4.6.3.2 Community Responses**

The community based initiatives that are commonly associated with the issues are the community mangrove conservation groups and community beach management groups. The mangrove conservation groups are associated with the modification of mangrove ecosystems, over-exploitation of fisheries and other living resources and suspended solids. The beach management groups are associated with the modification of seagrass beds, coral reef ecosystems and over-exploitation of fisheries and other living resources.

The mangrove initiative includes conservation groups based at Mida creek (Malindi), Mombasa, Kipini (Ungwana Bay) and Gazi Bay, all benefiting with technical support from KMFRI and financial support from NGOs. The beach, management initiatives include conservation groups based at Diani, Gazi, Shimoni and Vanga in the southern coast. Constraints that affect the groups include inadequate financial support, limited scientific and technical support, limited awareness on problems and solutions associated with the mangrove environment, poverty and lack of alternative means of livelihood, and inadequate government support, both financial and technical.

#### **4.6.3.3 Market Responses**

Six market responses overlap across the different issues. These responses include private sector participation in urban waste management, development of “fuel efficient stoves”, intensification of commercial prawn trawling and artisanal fishing, fishermen’s cooperative societies, expansion in small-scale fish processing industry, and commercial logging and mangrove harvesting.

Participation of the private sector in urban waste management is increasing especially in Mombasa and Diani. However, the activities of the private sector are constrained by lack of innovative ways of waste management that could make it more attractive to investors. This market initiative impacts on both modification of ecosystems (all habitats) and suspended solids.

The development of “fuel efficient stoves” helps to alleviate pressure on mangroves and estuarine ecosystems, and terrestrial forest. It is relevant to modification of ecosystems and suspended solids - as it alleviates deforestation that causes soil erosion upstream and siltation in the estuaries. However, the widespread poverty among the coastal communities hinder the acquisition and use of the “fuel-efficient stoves”

Bottom prawn trawling in the Malindi and Ungwana bays is destructive. It involves excessive by-catch and discards that translates into over-fishing and destruction of seagrass beds. This activity therefore brings out the overlap between different GIWA issues namely modification of seagrass meadows, over-exploitation of fisheries and living resources, destructive fishing practices and excessive by-catch and discards. Conversely, artisanal fishing is tending towards the use of indiscriminate fishing gears that result in over-fishing. Generally, this initiative is linked to modification of seagrass meadows and coral reefs, and over-exploitation of fisheries and other living resources.

The plight of fishermen’s cooperative societies and expansion in the small-scale fish processing industry has affected modification of seagrass beds and coral reefs, and over exploitation.

Commercial logging and harvesting of mangroves along the entire coast has resulted in modification of mangrove habitats, over-exploitation and increased suspended solids.

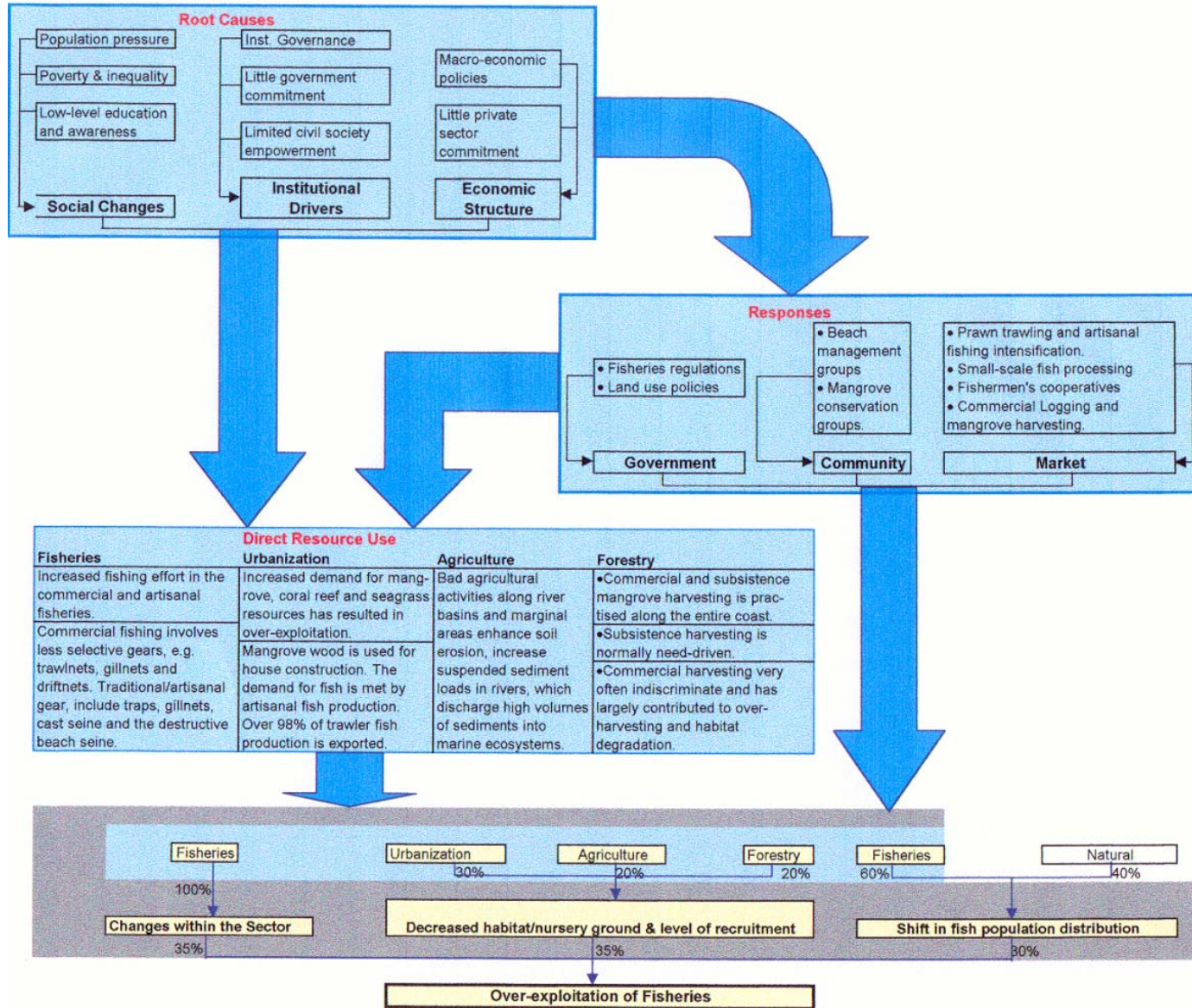


Figure 6. Causal Chain for Issue 14: Over-Exploitation of Fisheries and Other Living Resources

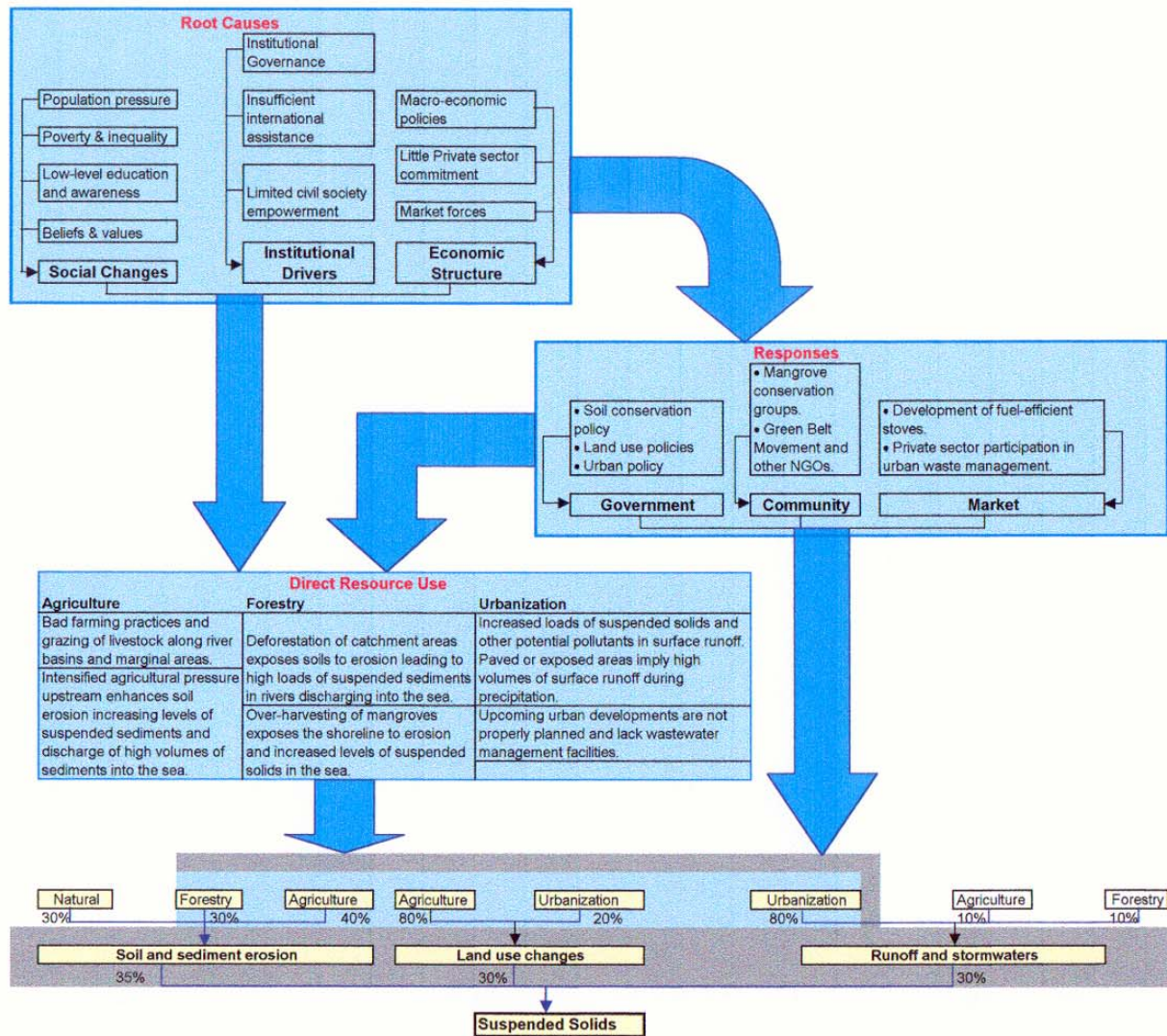


Figure 7. Causal Chain for Issue 7: Suspended Solids



## CHAPTER 5

### 5. Gaps and Weaknesses

Weaknesses in the overall output of the problem analysis process are overwhelmingly attributed to knowledge gaps in terms of monitoring data of impacts and comprehensive information on the ecosystems. Information gaps are also evident in the immediate causes, sectoral pressures, root causes and responses associated with the priority issues. Thus inadequate research information is a constraint towards evolving concrete recommendations of appropriate interventions on the issues. Too often inadequate quantitative data had to be supplemented with qualitative information, proxy indicators and expert knowledge to reach acceptable inferences. It is envisaged that the recommendations will provide for a mechanism for monitoring and evaluation to facilitate refocusing the interventions as appropriate.

Highlighted below are specific cases of information and data gaps encountered that need addressing.

#### 5.1 Impact Indicators

- there is a lack of data on some environmental impact indicators. For example, long-term monitoring/spatial data is lacking. Only one time assessment data is available in most cases. The quality of data cannot be determined since the existing assessments data were collected using different methods by different people at different times. Factors such as sampling frequencies could not be ascertained. Some of the assessment data could have been collected over very short periods of time;
- data from geological studies are available but the units of measurement used do not tally with the units prescribed in the GIWA impact indicator checklist. This means that conversion has to be done and conversion may distort what the author had in mind. Once conversion of units is conducted, it becomes difficult to cite the source as a reference;
- valuation data is lacking and where some little data is available, the form in which it is presented makes it difficult to fit in the GIWA data and extension tables; and
- much of the socio-economics information available is qualitative in nature, giving qualitative descriptions of impact measures.

#### 5.2 Dynamics of Estuarine Environments

Estuaries are normally transitional environments. In such dynamic environments are to be found species that must be tolerant to the changes in salinity that occur and adapt to them. Variations in fresh water discharges are therefore expected to impact on the fish diversity. However, there is lack of information of modelled stocks or species that would give an indication of the impacts on the diversity.

#### 5.3 Migratory Species

Comprehensive information on the bird life along the coastal and estuarine resorts is slowly emerging and at best patchy. The Sabaki estuary, for example, has one of the highest bird populations along the Kenyan coastal area both in terms of species arrival and wintering of migratory species. However historical data is inadequate to help follow on the changes in the species arrivals, wintering and nesting.

## 5.4 Immediate Causes

- under partial conversion due to pollution (spills and solid waste), data is very scarce. Only a few studies have been conducted in specific sites. This means that the level and effect of pollution to the issues, although important, cannot be determined. The same applies to runoff and storm waters from point and diffuse sources. Geographical coverage of the available data is also limited;
- there is lack of comprehensive scientific information and data, which covers most aspects of the marine ecosystems, e.g. comprehensive data on level of recruitment and shift in fish population distribution within the Somali Coastal Current, is lacking;
- there is inadequate information on the state of the critical seagrass habitat, particularly, with reference to impacts of resource use; and
- generally, the lack of or inadequate research and monitoring data and/or information on the impacts associated with the issues is a constraint in assessing the contribution of the immediate causes to the issues.

## 5.5 Sectoral Pressures

Most sectors involved in direct resource use have in place a policy for collecting monitoring data, whereby trends in resource exploitation may be followed. However, partly due to lack of or inadequate resources (human and financial) the data generated is at best crude estimates of the true situation, e.g. fish catch statistics from the Fisheries Department, and mangrove harvesting data from the Forestry Department.

The energy sector has definitely had an impact on river flow and sediment discharge into the estuaries. However, there is lack of historical and monitoring data on sediment discharge, with regard to River Tana where the dams for generation of electricity are located.

Comprehensive data on terrestrial activities is not readily available and where some data exists, it is mainly sectoral and not easily accessible, e.g. the energy sector where the impact of damming of rivers on suspended solids is not easily available.

The inability to address natural causes even where their contribution is dominant has led to information gaps, e.g. the massive coral bleaching due to rise in water temperatures and the widespread siltation of mangrove areas as a result of heavy precipitation and excessive suspended sediment transport due to the *El Nino* weather phenomena.

## 5.6 Root Causes

There are information gaps on international assistance and contribution of NGOs to resolving marine environmental issues. This information is either not accessible or available.

## 5.7 Responses

### 5.7.1 Environmental Management and Sectoral Policies

- there is lack of published assessment information on the effectiveness of the marine environmental management policies, because there is no policy on systematic data collection on relevant issues, inadequate scientific and technical capacity, lack of resources and intersectoral cooperation;
- there is lack of capacity (technical and financial) to address causes that are global in nature. This has resulted in information gaps on natural causes of marine environmental issues; and

- there are gaps resulting from lack of effective policing and enforcement by implementing agencies.

### **5.7.2 Community Responses**

- there are information gaps on community participation in the management of the marine and coastal environment. Traditional resource conservation initiatives such as the use of taboos, which are meant to save endangered species from extinction, have not been fully studied and documented;
- information on the sustainability or otherwise of the traditional exploitation of threatened and/or endangered species is yet to be revealed; and
- environmental impacts of small-scale prawn farming initiatives have not been ascertained.

### **5.7.3 Market Responses**

- environmental problems associated with solar salt production in mangrove areas and adjacent resources have not been assessed, e.g. the impact on groundwater; and
- the carrying capacity of the coastal urban settlements and the adjacent water bodies (estuaries) receiving urban waste has not been assessed.

## CHAPTER 6

### 6. Recommendations

#### 6.1 Issue 13: Modification of Ecosystems or Ecotones, including Community Structure and/or Species Composition

##### 6.1.1 Modification of Mangrove Ecosystems

###### 6.1.1.1 Impacts

Mangroves cover an area of 53,000 ha with the largest stands located in Lamu, Vanga and Funzi bay. Mangroves occur in estuaries and creeks with freshwater input. With the exception of the R. Sabaki mouth all estuaries are covered with mangroves.

- mangrove over-harvesting in Mida and Lamu has resulted in change in the community structure of regenerating stands, e.g. regenerating mangroves are dominated by inferior species (of low commercial and utility value);
- clearing of mangroves at Gazi (approximately 615 ha) caused shoreline instability resulting in erosion;
- a relatively low fish diversity was reported for Tudor mangrove creek in Mombasa as compared to Gazi creek, which was attributed to human activities including pollution input from domestic and industrial sources; and
- clearing of mangroves (over 5000 ha) in the Ngomeni swamps for solar salt production has the potential of causing loss of productivity of the creek and a decline in recruitment for the Malindi/Ungwana Bay fisheries.

###### 6.1.1.2 Causes

There are three immediate causes that were identified as the main contributors to the issue, namely land use changes (30%), unsustainable harvesting practices - of mangrove (30%) and partial conversion of the habitat due to pollution (spills and solid waste) (30%). Sectoral pressures that contribute to land use changes include industry and fisheries, with the former dominating. Unsustainable harvesting practices have forestry and urbanization as the dominant sectoral pressures. The sectoral pressures contributing to partial conversion due to pollution are transport, industry and urbanization.

The fisheries activity contributing to land use changes is aquaculture, both commercial prawn farming and small-scale farming. However, it is realised that the only extensive commercial prawn culture concern (about 50 ha) developed at Ngomeni was abandoned. While the small-scale aquaculture initiatives are potentially harmful, they are presently a minor contributor to land use changes. Thus in addressing land use changes, the industry sector (expansion of solar salt manufacturing) should be targeted.

The unsustainable harvesting of mangroves exerts direct pressure on the habitat and the forestry sector is responsible. Urbanization on the other hand creates demand for mangrove products. It is reckoned, therefore, interventions on unsustainable harvesting practices should concentrate on the forestry sector.

The three sectors contributing to partial conversion due to pollution act more or less independent of each other and intervention should include all of them.

### 6.1.1.3 Recommendations

#### ***Scenario 1: Intervention to reduce pressure of land use changes on the mangrove habitat.***

Immediate cause: Land use changes.

Sectoral pressure: Industry (solar-salt production).

#### **Intervention:**

- environmental impact study of existing salt manufacturing industries;
- environmental impact assessment of new industries (expanding to Lamu) for decision making and environmental management;
- mitigating measures; and
- root causes to be addressed include macro-economic policies (i.e. that favour solar-salt production).

#### ***Scenario 2: Intervention to alleviate pressure on mangroves due to over-harvesting***

Immediate cause: Unsustainable harvesting practices (of mangroves)

Sectoral pressure: Forestry.

#### **Intervention:**

- promotion of sustainable harvesting and utilization of mangroves;
- community participation in conservation efforts to be promoted and strengthened; and
- root causes to be addressed include poverty and inequality, beliefs and values, institutional governance (e.g. effectiveness of forestry management policies) and macro-economic policies.

#### ***Scenario 3: Assessment of impact of partial conversion of habitat due to pollution, resulting from spills and solid waste disposal, on the mangrove ecosystem.***

Immediate cause: Partial conversion of habitat due to pollution (spills and solid waste).

Sectoral pressure: Transport, industry and urbanization.

#### **Intervention:**

- assess level and extent of pollution in harbour creek (particularly Mombasa) due to oil spills and solid waste disposal;
- assess impact of pollution on mangrove ecosystem and on the local community.
- measures to mitigate against pollution; and
- root causes to be addressed include population pressure and institutional governance (that influence effectiveness of spills and solid waste management policies).

## 6.1.2 Modification of Estuaries

### 6.1.2.1 Impacts

Estuaries generally occur in sheltered areas and receive freshwater and sediments input from in-flowing rivers, the Tana and Sabaki Rivers being the largest. However, estuarine conditions in the Mida creek with no direct river input, are maintained by under ground seepage. Most estuaries are

covered with mangrove with the exception of the Sabaki mouth. The discharge of high volumes of suspended sediments into the sea by especially the major rivers, Tana and Sabaki, resulting in siltation of the estuary and adjacent habitats has had the following impacts:

- the absence of mangroves in the Sabaki estuary;
- shadowing and siltation of corals in the Malindi National Marine Park and Reserve, south of the Sabaki mouth (McClanahan & Obura 1995);
- reduction of species diversity of seagrass in the Malindi Bay (Wakibia 1996); and
- beach accretion in Malindi resulting in loss of beach frontage for tourist hotels and loss of aesthetic value rendering the beaches less attractive for the development of tourism.

### 6.1.2.2 Causes

Two immediate causes were identified namely, land use changes (60%) and unsustainable harvesting practices (40%). The sectors that exert pressure on land use changes are agriculture and energy (electricity production). The corresponding sectoral pressures for the latter immediate cause, are forestry and urbanization. The contribution of the energy sector is through the effect of hydroelectric power generation dams on the Tana River water flow. With no dam development along the Tana foreseen in the near future the contribution of the sector is not expected to increase. Therefore possible interventions at addressing land use changes on the issue should concentrate on the agriculture sector.

The unsustainable harvesting of mangroves is the more significant cause of modification of mangrove estuaries because it exerts direct pressure on the habitat (and resources). Thus, whereas urbanization creates a demand on mangroves (and other forest resources), forestry is responsible for the exploitation of the resources. Therefore, possible intervention should target the forestry sector for sustainable utilization of forest products.

#### Recommendations:

*Scenario 1:* Intervention to alleviate pressure on estuaries due to excessive siltation.

Immediate cause: Land use changes

Sectoral pressure: Agriculture

#### Intervention:

- promotion of good agricultural practices along river basins and marginal areas; and
- root causes to be addressed include population pressure and low level of education.

Immediate cause: Unsustainable harvesting of mangroves and other forest products.

Sectoral pressure: Forestry

#### Intervention:

- promotion of sustainable harvesting and utilization of mangroves; and
- root causes to be addressed include population pressure, low level of education, institutional governance and macro-economic policies.

### 6.1.3 Modification of Seagrass Meadows

### 6.1.3.1 Impacts

Trawling activities in the Malindi Bay and Ungwana Bay have had significant negative impacts on the seagrass meadows and on the threatened and/or endangered species, which use this habitat. The endangered/threatened species include the Green Turtle, Hawksbill Turtle, Loggerhead Turtle and the Dugong. Dead turtles have been sighted in the Ungwana Bay whose deaths have been attributed to incidental catches by trawlers. Modification of the fishing grounds due to trawling has led to loss of income to artisanal fishermen with consequent resource use conflicts between the artisanal fishermen and trawler operators. Issues of inter and intra-generational equity and survival of the artisanal fishermen have become critical.

### 6.1.3.2 Causes

The priority immediate causes are land use changes/land development attributed with 30% and unsustainable harvesting practices attributed with 70% of the pressure. Unsustainable harvesting practices are therefore the predominant cause of modification of seagrass ecosystems. Priority root causes include population pressure, poverty and inequality, beliefs and values, institutional governance/bottlenecks, limited civil society empowerment and macro-economic policies.

#### ***Recommendations:***

***Scenario 1:*** Intervention to alleviate pressure on seagrass resources due to over-fishing.

➤ Immediate cause: Unsustainable harvesting practices

Sectoral pressure: Fisheries

Intervention:

- promote sustainable exploitation of fisheries resources by regulating trawling activities;
- search for and promote alternative employment opportunities for the local fishing community, e.g. empowerment of community based self-help groups; and
- underlying root causes to be addressed include poverty and inequality, low-levels of education and awareness, institutional governance and macro-economic policies (that influence the effectiveness of Fisheries regulations).

### 6.1.4 Modification of Coral Reef Ecosystems

#### 6.1.5 Impacts

Kenyan coral reefs have experienced degradation due to over-fishing and bleaching resulting in changes in community structure and coral death. Decline in productivity and biodiversity of coral reefs have resulted in loss of income to artisanal fishermen who depend on the coral reef. Similarly, degraded coral reefs result in loss of aesthetic value, loss of employment and revenue from tourism. Degradation of coral reefs also adversely affect marine species, including migratory species that spend part of their life cycles in the coral reef habitat.

#### 6.1.6 Causes

Priority immediate causes of modification of coral reef ecosystems are land use changes attributed with 30%, unsustainable harvesting practices attributed with 35%, and partial conversion as a result of global temperature changes, attributed with 30% of the pressure. Priority root causes include population pressure, poverty and inequality, beliefs and values, institutional governance/bottlenecks,

limited civil society empowerment and macro-economic policies. The priority causes are compounded by lack of alternative means of livelihood to the fishing communities.

**Recommendations:**

**Scenario 1:** Intervention to alleviate pressure on coral reefs due to unsustainable harvesting practices.

Immediate cause: Unsustainable harvesting practices.

Sectoral pressures: Fisheries and tourism.

**Intervention:**

- promotion of sustainable fishing practices in the coral reef habitats, e.g. controlling the use of destructive fishing gear;
- controlling destructive tourist activities in coral reef areas;
- empowerment of fisheries management and conservation groups to promote co-management initiatives;
- transboundary fishing activities and conflicts are to be addressed;
- research study to establish viable alternative economic activities for the fisher folk to alleviate pressure on coral reef resources; and
- root causes to be addressed include poverty and inequality, institutional governance and macro-economic policies.

**6.1.7 Scenario 2: Intervention to alleviate pressure on coral reef ecosystems due to land use changes.**

➤ Immediate cause: Land use changes

Sectoral pressures: Agriculture and urbanization

Intervention:

- promotion of good agricultural practices along river basins and catchment areas to mitigate against soil erosion;
- promotion of appropriate urban waste management practices;
- industries and tourist beach hotels in Mombasa, Diani, Malindi and Lamu to be sensitised to treat their waste before disposal into the marine environment; and
- root causes to be addressed include poverty and inequality, low level of awareness of environmental issues, government commitment and macro-economic policies.

**6.2 Issue 14: Over-Exploitation of Fisheries and Other Living Resources**

**6.2.1 Impacts**

Over-fishing in coral reef habitats has been shown to cause reef degradation and adversely affect the productivity and diversity. Similarly, trawling for shallow water prawns in the Malindi Bay and Ungwana Bay has resulted in destruction of the seagrass habitat, and impacted on productivity and fish diversity, with resultant conflicts between artisanal fishermen and trawler operators. Excessive by-catch and its disposal is another important area of concern. Furthermore, threatened/endangered species such as Green Turtles, Hawksbill Turtle, Loggerhead Turtle and the Dugongs that frequent the seagrass meadows at Ungwana Bay are at risk from prawn trawlers.



## 6.2.2 Causes

From the causal chain analysis of the issue, the priority immediate causes are changes within the sector (increased fishing effort) that accounts for about 35%, decreased habitat/nursery ground and level of recruitment that accounts for approximately 35%, and shift in fish population distribution that accounts for 30% of the pressure. Priority root causes are poverty and inequality, population pressure, low level of education, institutional governance, limited civil society empowerment, macro-economic policies and little private sector commitment to environmental concerns. The dominant economic sector is fisheries. Interventions should concentrate on unsustainable harvesting practices, especially the prawn trawling at Malindi Bay and Ungwana Bay and artisanal fisheries at the Diani reefs, Shimoni, Vanga and Mombasa inshore waters areas.

### **Scenario 1: Intervention to alleviate the impacts of over-fishing in the Malindi and Ungwana Bays.**

Immediate cause: Changes within the sector.

Sectoral pressure: Fisheries.

#### **Intervention:**

- research study to establish the impact of bottom trawling in the Malindi and Ungwana Bays on the community structure and socio-economic well-being of the fishing community;
- strengthen fisheries regulations and empower implementing institutions to enforce laws (e.g. laws regulating trawling activities); and
- root causes to be addressed include lack of commitment of the private sector to environmental issues associated with their activities and macro-economic policies that promote export of prawns.

### **Scenario 2: Intervention to alleviate impacts of the use of destructive fishing gear in the southern coast of Kenya.**

Immediate cause: Decreased habitat / nursery ground and level of recruitment.

Sectoral pressures: Urbanization and agriculture.

#### **Intervention:**

- raise awareness on environmental problems associated with unsustainable fishing practices;
- empower community conservation groups to help control habitat degradation;
- strengthen fisheries regulations and empower implementing institutions to effectively enforce the law; and
- root causes to be addressed include low level of education and awareness, poverty and inequality and macro-economic policies.

## 6.3 Issue 7: Suspended Solids

### 6.3.1 Impacts

The main sources of suspended solids input into the marine environment include the major rivers Tana and Sabaki, which discharge large volumes of suspended sediment, and surface runoff. High loads of suspended solids have adversely impacted on the estuary and seagrass in the Malindi Bay and the coral reef system in the Malindi Marine Park and Reserve, specifically, shadowing and siltation of the coral system in the Malindi Marine Park and Reserve with consequent loss of the aesthetic value of the habitat making it less attractive to tourists.

- decline in biodiversity in coral and seagrass ecosystems in the Malindi Bay, e.g. the disappearance of seagrass species;
- potential negative impact on fisheries productivity in the inshore habitats, which translates in loss of earnings from fishing and tourism; and
- siltation and beach accretion in the Malindi Bay have resulted in the loss of beach frontage for beach hotel establishments and loss of tourism revenues and closure of most of the beach hotels.

### 6.3.2 Causes

Three immediate causes were identified, namely soil and sediment erosion (35%), land use changes (30%), and runoff and storm waters (30%). The sectoral pressures that contribute to soil and sediment erosion include agriculture, forestry and natural causes. While Agriculture and urbanization were the main sectors contributing to land use changes, urbanization was identified as the principal contributor to runoff and storm waters, with minor contributions from agriculture and forestry.

It is evident that the contribution of agricultural activities to soil and sediment erosion and land use changes is a common factor. The contribution of forestry is perceived to be more significant because of the direct link to resource use (unsustainable exploitation of forest resources) practices, which encourage soil erosion, as compared to urbanization, which exerts indirect pressure by creating a demand for the resources. On the other hand, storm water and runoff from urban areas, with little or no vegetation cover, paved streets and poor facilities for wastewater management contribute most significantly to suspended solids from the urban coastal towns e.g. Mombasa, Malindi and Lamu. Therefore possible intervention to alleviate impacts of the issue should concentrate on the agriculture and forestry sectors for soil and sediment erosion and land use changes, and urbanization for runoff and storm water.

#### ***Scenario 1: Intervention to reduce suspended solids due to soil and sediment erosion, and land use changes.***

Immediate cause: Soil and sediment erosion, and land use changes.

Sectoral pressure: Agriculture and forestry.

#### **Intervention:**

- promotion of good agricultural practices along river basins, and marginal areas;
- promotion of sustainable harvesting of forests, both terrestrial and mangroves; and
- root causes that need to be addressed include poverty and inequality, low level of education, beliefs and values, institutional governance, insufficient international assistance and macro-economic policies.

#### ***Scenario 2: Suspended solids from storm water runoff.***

Immediate cause: runoff and storm water

Sectoral pressure: urbanization

#### **Intervention:**

- review effectiveness of town planning policies (e.g. as regards provision of essential services by local authorities); and
- root causes that need to be addressed include poverty and inequality, institutional governance and market forces (e.g. private sector participation in wastewater management).

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Samoilys, M.A. *Abundance and species richness of coral reef fish on the Kenyan coast: the effects of protective management and fishing.* Proceedings of the sixth international coral reef symposium, Australia, Vol.2, 1988.

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## Annex I

### Identification Sheet: Hot Spot, Sensitive Areas and/or Overriding Issue (Agenda item 6)

#### Hot Spot

1. **Title:** Mombasa inshore water areas (Hot Spot # 1).
2. **Region (Administrative) and Location:** Mombasa District.
3. **Surface Area/Definition:** 65 km<sup>2</sup>
5. **Transboundary Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**  
Local.
6. **Relevant [GIWA] Issue(s)<sup>1</sup>:**  
  
Pollution - microbiological, eutrophication, chemical suspended solids, solid waste and spills; over-exploitation of fisheries and mangrove resources.
7. **Context of the Site:**
  - 7a. **Main Human Activity(ies) Related to the Site:**  
  
Urban and commercial activities, tourism, artisanal fisheries and mangrove harvesting.
  - 7b. **Natural Conditions/Phenomenon Related to the Site:**  
  
Low lying coastal plain. Mangrove, coral and seagrass ecosystems with high productivity and biodiversity.
8. **Nature of Threats and Extent of Threats (Human and Natural):**  
  
Pollution of the marine environment and ground water resources. Declining fish catches and diversity, resulting in loss of livelihood for the community.
9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**  
  
Point sources - sewage outfalls, harbour, storm water drains and solid waste dumpsite; non-point sources - pit latrines and soak-pits; diffuse - surface or municipal runoff.

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<sup>1</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionuclides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

### 11. List of Available Data Sets:

Munga, D., Yobe, A.C., Owili, M.O. and S.M. Mwanguni. *An assessment of land-based sources of marine pollution along the Kenyan coast*. Report to the World Health Organization. Brazzaville, 1993, 60 pp.

Mwanguni S.M. *The cost and benefits associated with addressing the sewage problem affecting the coastal marine and associated freshwater environment with special focus on the town of Mombasa on the Kenyan coast*. A contribution to the implementation in East Africa of the UNEP/GPA Strategic Action Plan on Sewage, 2000, 51 pp.

Mwanguni, S. and D. Munga. *Land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environments along the Kenyan coast*. Report to the WHO, 1997, 56 pp.

UNEP. *Eastern Africa atlas of coastal resources 1: Kenya*, 1998, 119 pp.

#### Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Hot Spot

1. **Title:** Lamu inshore water areas (Hot Spot # 2).
2. **Region (Administrative) and Location:** Lamu District, North Coast.
3. **Surface Area/Definition:** 30 km<sup>-2</sup>.
5. **Transboundary Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**  
Local.
6. **Relevant [GIWA] Issue(s)<sup>2</sup>:**

Pollution - microbiological, suspended solids and solid waste. Modification of ecosystems or ecotones, including community structure and/or species composition.

7. **Context of the site:**

7a. **Main Human Activity(ies) Related to the Site:**

Domestic activities and keeping draft animals.

7b. **Natural Conditions/Phenomenon Related to the Site:**

Highly productive mangrove ecosystem with high biodiversity.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Pollution of the marine inshore waters and destruction of the mangrove habitat.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

Point sources - solid waste dumpsites; Non point sources - pit latrines; Diffuse source - municipal or storm water runoff.

10. Value of the site:	Local	National	Regional/global
Environmental significance	√		
Socio-economic significance	√	√	

<sup>2</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionuclides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

## 11. List of Available Data Sets:

Munga, D., Yobe, A.C., Owili, M.O. and S.M. Mwanguni. *An assessment of land-based sources of marine pollution along the Kenyan coast*. Report to the World Health Organization. Brazzaville, 1993, 60 pp.

Mwanguni, S. and D. Munga. *Land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environments along the Kenyan coast*. Report to the WHO, 1997, 56 pp.

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### Notes:

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We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.



## Hot Spot

1. **Title:** Unsustainable exploitation of fisheries in Ungwana Bay (Hot Spot # 3).
2. **Region (Administrative) and Location:** Ungwana Bay, North Kenya Banks.
3. **Surface Area/Definition:** 10,700 km<sup>2</sup>, Trawling grounds.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Interacts with the Tana River Delta, a source of nutrients and nursery grounds for species that feed in the bay.

6. **Relevant [GIWA] Issue(s)<sup>3</sup>:**

Pollution form suspended solids. Over-exploitation of fisheries resources, excessive by catch and discards and destructive fishing practices. Loss and modification of seagrass habitat, including community structure and/or species composition.

7. **Context of the site:**

**7a. Main Human Activity(ies) Related to the Site:**

Trawling primarily for shrimp.

**7b. Natural Conditions/Phenomenon Related to the Site:**

Seagrass meadows with high productivity and biodiversity.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Destruction of marine habitat, diminishing catches and biodiversity and killing of endangered turtle species. Loss of livelihood for local community.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

Point Source - river sediment discharge.

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

<sup>3</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO2 source/sink function. See attached [table 1](#).

## 11. List of Available Data Sets:

Sanders M.J., Gichere S.G. and R.M. Nzioka. *Report of Kenya marine fisheries sub-sector study*. Draft Report. FAO, 1990, 44 pp.

UNEP. *Eastern Africa atlas of coastal resources 1: Kenya*, 1998, 119 pp.

Wamukoya G.M., Mirangi J.M. and W.K. Ottichillo. Report on the marine aerial survey of marine mammals, sea turtles, sharks & rays. *KWS technical series report No. 1*, 1996, 22 pp.

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### Notes:

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We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Hot Spot

1. **Title:** Malindi Bay (Hot Spot # 4).
2. **Region (Administrative) and Location:** Malindi District, North Coast.
3. **Surface Area/Definition:** 450 km<sup>-2</sup>.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Habitats for turtles and other fish species.

6. **Relevant [GIWA] Issue(s)<sup>4</sup>:**

Pollution - microbiological, eutrophication, suspended solids and solid waste; modification of seagrass habitats, including community structure and/or species composition, and over-exploitation of inshore/nearshore fishery resources.

7. **Context of the Site:**

**7a. Main Human Activity(ies) Related to the Site:**

Urban and commercial activities, tourism, artisanal fisheries and trawling for shrimp.

**7b. Natural Conditions/Phenomenon Related to the Site:**

Estuarine bay receiving freshwater and substantial inputs of sediment from the Sabaki River.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Pollution of the marine environment, declining fish catches and diversity, resulting in loss of livelihood for the community.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

Point sources - storm-water drains, solid waste dumpsite; non-point sources - pit latrines and soak-pits; diffuse - surface or municipal runoff.

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	

<sup>4</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO2 source/sink function. See attached [table 1](#).

## 11. List of Available Data Sets:

Munga, D., Yobe, A.C., Owili, M.O. and S.M. Mwanguni. *An assessment of land-based sources of marine pollution along the Kenyan coast*. Report to the World Health Organization. Brazzaville, 1993. 60 pp.

Mwanguni, S. and D. Munga. *Land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environments along the Kenyan coast*. Report to the WHO, 1997, 56 pp.

UNEP. *Eastern Africa atlas of coastal resources 1: Kenya*, 1998, 119 pp.

Wamukoya G.M., Mirangi J.M. and W.K. Ottichillo. Report on the marine aerial survey of marine mammals, sea turtles, sharks & rays. *KWS technical series report No. 1*, 1996, 22 pp.

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### Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

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We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Hot Spot

1. **Title:** Diani inshore water areas (Hot Spot # 5).
2. **Region (Administrative) and Location:** Diani Location, South Coast.
3. **Surface Area/Definition:** 20 km<sup>-2</sup>.
5. **Transboundary Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**  
Local.
6. **Relevant [GIWA] Issue(s)<sup>5</sup>:**

Pollution – microbiological, suspended solids, solid waste. Loss and modification of coral reef ecosystem, including community structure and/or species composition.

7. **Context of the Site:**

7a. **Main Human Activity(ies) Related to the Site:**

Tourist and domestic activities, and artisanal fisheries.

7b. **Natural Conditions/Phenomenon Related to the Site:**

Coral reef and lagoon, and sandy beach.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Pollution of the marine inshore waters and beach litter (plastics), and destruction of the coral habitat.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

Point sources - solid waste dumpsites; non-point sources - soak-pits; diffuse sources - surface runoff.

10. Value of the site:	Local	National	Regional/global
Environmental significance	√		
Socio-economic significance	√	√	

<sup>5</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionuclides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

## 11. List of Available Data Sets:

McClanahan T.R. and N.A. Muthiga. Patterns of predation on a sea urchin, *Echinometra mathaei* (de Blainville), on Kenyan coral reefs. *J. exp. mar. biol. ecol.*, 126, 1989, pp. 77-94.

McClanahan T.R. and N.A. Muthiga. Changes in Kenyan coral reef community structure and function due to exploitation. *Hydrobiologia*, 166, 1988, pp. 269-276.

Munga, D., Yobe, A.C., Owili, M.O. and S.M. Mwanguni. *An assessment of land-based sources of marine pollution along the Kenyan coast*. Report to the World Health Organization. Brazzaville, 1993, 60 pp.

Mwanguni, S. and D. Munga. *Land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environments along the Kenyan coast*. Report to the WHO, 1997, 56 pp.

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### Notes:

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We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Sensitive Area

1. **Title:** Vanga Creek (Sensitive Area # 1).
2. **Region (Administrative) and Location:** Vanga Location – South Coast.
3. **Surface Area/Definition:** 10 km<sup>-2</sup>.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Fisheries. River Uмба originates in Tanzania and discharges into the sea near Vanga village.

6. **Relevant [GIWA] Issue(s)<sup>6</sup>:**

Destructive fishing practices, loss of ecosystem - coral reef, modification of ecosystems, and microbiological pollution.

7. **Context of the Site:**

**7a. Main Human Activity(ies) Related to the Site:**

Artisanal fisheries, exploitation of mangrove resources and subsistence farming.

**7b. Natural Conditions/Phenomenon Related to the Site:**

Highly productive mangrove ecosystem with a high biodiversity.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Loss of livelihood for the community; loss of productivity and biodiversity; declining fish catches, pollution of inshore waters and ground water; siltation; damage caused by periodical flooding of River Uмба.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

<sup>6</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionuclides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

## 11. List of Available Data Sets:

Government of Kenya. *Kwale district development plan 1997 - 2001*. Nairobi, 1997.

Munga, D., Yobe, A.C., Owili, M.O. and S.M. Mwanguni. *An assessment of land-based sources of marine pollution along the Kenyan coast*. Report to the World Health Organization. Brazzaville, 1993, 60 pp.

Mwanguni, S. and D. Munga. *Land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environments along the Kenyan coast*. Report to the WHO, 1997, 56 pp.

Radull J., Ochwiro J. and B. Nyonje. *Socio-economic aspects of mangrove systems and alternatives to traditional mangrove-area land use in the south coast of Kenya*. KMFRI-KWS, Mombasa, 1997.

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### Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.



## Sensitive Area

1. **Title:** Wasini Channel (Sensitive Area # 2).
2. **Region (Administrative) and Location:** Shimoni, Msambweni Division - South Coast.
3. **Surface Area/Definition:** 20 km<sup>-2</sup>.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

It is common for artisanal fishermen from Pemba, Tanzania, fish and/or land their catches at Shimoni.

6. **Relevant [GIWA] Issue(s)<sup>7</sup>:**

Loss and modification of coral ecosystem, including community structure and/or species composition. Over-exploitation of fishery resources and destructive fishing practices.

7. **Context of the Site:**

**7a. Main Human Activity(ies) Related to the Site:**

Artisanal fisheries, tourism and water transport.

**7b. Natural Conditions/Phenomenon Related to the Site:**

Coral ecosystem, a deep channel with fast long shore currents.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Loss of livelihood for the community; loss of productivity and biodiversity; over fishing, declining fish catches, coral destruction due to tourist activities. Extent: within and beyond the channel.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

<sup>7</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

## **11. List of Available Data Sets:**

GOK. *The study of national tourism master plan in the Republic of Kenya*. Vol. 1-4, 1995.

KWS. *Management plan, Kisite-Mpunguti Marine National Park and Reserve*. First Draft November 1999.

UNEP. *Eastern Africa atlas of coastal resources 1: Kenya*, 1998, 119 pp.

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The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Sensitive Area

1. **Title:** Gazi Bay (Sensitive Area # 3).
2. **Region (Administrative) and Location:** Gazi, Msambweni Division – South Coast.
3. **Surface Area/Definition:** 10 km-2 mangrove creek.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Artisanal fishing involves both local and those from Pemba, Tanzania.

6. **Relevant [GIWA] Issue(s):**

Loss and modification of coral and mangrove ecosystems, including community structure and/or species composition. Over-exploitation of mangrove resources and destructive fishing practices.

7. **Context of the Site:**

**7a. Main Human Activity(ies) Related to the Site:**

Artisanal fisheries and mangrove harvesting.

**7b. Natural Conditions/Phenomenon Related to the Site:**

Highly productive mangrove, coral and seagrass ecosystems with high biodiversity.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Coastal erosion, loss of biodiversity and declining catches. Loss of livelihood for the local community.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

11. **List of Available Data Sets:**

Ministry of Environment and Natural Resources. *The Kenya national environment plan*. Nairobi, 1994, 203 pp.

### Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular

attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Sensitive Area

1. **Title:** Ngomeni mangrove swamps (Sensitive Area # 4).
2. **Region (Administrative) and Location:** Ngomeni, Malindi District - North Coast.
3. **Surface Area/Definition:** 50 km<sup>-2</sup> cleared mangrove areas.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Fisheries affected because of loss and modification of the mangrove ecosystem.

6. **Relevant [GIWA] Issue(s)<sup>8</sup>:**

Loss and modification of the mangrove and seagrass ecosystems, including community structure and/or species composition.

7. **Context of the Site:**

**7a. Main Human Activity(ies) Related to the Site:**

Artisanal fisheries and solar salt manufacturing.

**7b. Natural Conditions/Phenomenon Related to the Site:**

Highly productive mangrove and seagrass ecosystems, with high biodiversity.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Loss of biodiversity and declining catches. Exposure of shoreline to erosion. Loss of livelihood for the local community.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

11. **List of Available Data Sets:**

UNEP. Eastern Africa atlas of coastal resources 1: Kenya, 1998, 119 pp.

<sup>8</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO2 source/sink function. See attached [table 1](#).

Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Sensitive Area

1. **Title:** Malindi/Watamu Marine National Park and Reserve (Sensitive Area # 5).
2. **Region (Administrative) and Location:** Malindi District – North Coast.
3. **Surface Area/Definition:** 200 km<sup>2</sup>.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Marine organisms that are frequently observed in the area include turtle species.

6. **Relevant [GIWA] Issue(s)<sup>9</sup>:**

Pollution: microbiological and suspended solids. Modification of mangrove ecosystem, including community structure and/or species composition. Over-exploitation (of mangrove resources).

7. **Context of the site:**

### 7a. Main Human Activity(ies) Related to the Site:

Urbanisation, tourism, artisanal fishing and mangrove harvesting.

### 7b. Natural Conditions/Phenomenon Related to the Site:

Highly productive coral reef and mangrove ecosystems, with high biodiversity, including sandy beaches and cliffs.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Coral reef and mangrove degradation, siltation and declining water quality.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

<sup>9</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO2 source/sink function. See attached [table 1](#).

## 11. List of Available Data Sets:

KWS. *Biodiversity of Mida Creek: final technical report*. Eds. G.K. Mwatha, E. Fondo, J.N. Uku & J.U. Kitheka. Kenya Marine and Fisheries Research Institute, Mombasa, 1998, 197 pp.

UNEP. *Eastern Africa atlas of coastal resources 1: Kenya*, 1998, 119 pp.

Wamukoya G.M., Mirangi J.M. and W.K. Ottichillo. Report on the marine aerial survey of marine mammals, sea turtles, sharks and rays. *KWS technical series report No. 1*, 1996, 22 pp.

### Notes:

Individual hot spots and/or sensitive areas would be described are per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.



## Overriding Issue

1. **Title:** Unsustainable exploitation of inshore fisheries (Overriding Issue # 4).
2. **Region (Administrative) and Location:** Kenyan Inshore Waters.
3. **Surface Area/Definition:** 2,000 km<sup>2</sup> Unprotected Inshore Water Areas.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Interference with juveniles of fish and other marine species.

6. **Relevant [GIWA] Issue(s)<sup>10</sup>:**

Modification of inshore ecosystems, including community structure and/or species composition. Over-exploitation and destructive fishing practices.

7. **Context of the Site:**

**7a. Main Human Activity(ies) Related to the Site:**

Artisanal fishing.

**7b. Natural Conditions/Phenomenon Related to the Site:**

Coral reefs, lagoons, mangrove estuaries, with high productivity and biodiversity.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Declining catches and biodiversity. Loss of livelihood and protein food source for local community. Extent: widely spread.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

<sup>10</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

11. List of Available Data Sets:

McClanahan T.R. and N.A. Muthiga. Patterns of predation on a sea urchin, *Echinometra mathaei* (de Blainville), on Kenyan coral reefs. *J. exp. mar. biol. ecol.*, 126, 1989, pp. 77-94.

McClanahan T.R. and N.A. Muthiga. Changes in Kenyan coral reef community structure and function due to exploitation. *Hydrobiologia*, 166, 1988, pp. 269-276.

Sanders M.J., Gichere S.G. and R.M. Nzioka. *Report of Kenya marine fisheries sub-sector study*. Draft Report. FAO, 1990. 44 pp.

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Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Overriding Issue

1. **Title:** Coral reef degradation (Overriding Issue # 2).
2. **Region (Administrative) and Location:** Kenyan Inshore Waters.
3. **Surface Area/Definition:** 500 km<sup>-2</sup>.
5. **Transboundarity elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Interference with habitats for fish and other marine species. Exposure of shoreline to high wave energy which may cause shoreline changes.

6. **Relevant [GIWA] Issue(s)<sup>11</sup>:**

Pollution: suspended solids and chemical. Loss and modification of coral ecosystem, including community structure and/or species composition. Over-exploitation of coral resources and destructive fishing practices.

7. **Context of the Site:**

**7a. Main Human Activity(ies) Related to the Site:**

Artisanal fisheries and tourism.

**7b. Natural Conditions/Phenomenon Related to the Site:**

High productivity and biodiversity.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Shoreline exposure leading to erosion, loss of productivity and biodiversity, loss of aesthetic value, and loss of livelihood for the local community. Extent: widely spread.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

<sup>11</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

## 11. List of Available Data Sets:

McClanahan T.R. and N.A. Muthiga. Patterns of predation on a sea urchin, *Echinometra mathaei* (de Blainville), on Kenyan coral reefs. *J. exp. mar. biol. ecol.*, 126, 1989, pp. 77-94.

McClanahan T.R. and N.A. Muthiga. Changes in Kenyan coral reef community structure and function due to exploitation. *Hydrobiologia*, 166, 1988, pp. 269-276.

UNEP. *Eastern Africa atlas of coastal resources 1: Kenya*, 1998, 119 pp.

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### Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

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We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Overriding Issue

1. **Title:** Degradation of Seagrass Meadows (Overriding Issue # 3).
2. **Region (Administrative) and Location:** Kenyan Inshore Waters.
3. **Surface Area/Definition:** Lagoons.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Interference with habitats for fish and other marine species, including dugongs and turtles.

6. **Relevant [GIWA] Issue(s)<sup>12</sup>:**

Modification of seagrass ecosystem, including community structure and/or species composition. Over-exploitation of seagrass resources and destructive fishing practices.

7. **Context of the Site:**

### 7a. Main Human Activity(ies) Related to the Site:

Artisanal fishing and trawling.

### 7b. Natural Conditions/Phenomenon Related to the Site:

High productivity and biodiversity sandy and muddy areas.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Sedimentation and high turbidity. Extent: in the vicinity of outfalls and river mouths or deltas.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

11. **List of Available Data Sets:**

UNEP. *Eastern Africa atlas of coastal resources 1: Kenya*, 1998, 119 pp.

<sup>12</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO2 source/sink function. See attached [table 1](#).

Notes:

Individual hot spots and/or sensitive areas would be described are per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

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## Overriding Issue

1. **Title:** Unsustainable Exploitation of Mangrove Resources (Overriding Issue # 1).
2. **Region (Administrative) and Location:** Kenyan Coastal Area.
3. **Surface Area/Definition:** 530 km<sup>-2</sup>.
5. **Transboundarity Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**

Interference with nursery grounds and recruitment of fish, crustacea and other marine species. Mangrove clearing may cause shoreline changes, and loss of vegetation that may have implications on CO<sub>2</sub> sink function and global warming.

6. **Relevant [GIWA] Issue(s)<sup>13</sup>:**

Over-exploitation (of mangrove resources). Loss and modification of mangrove ecosystem, including community structure and/or species composition.

7. **Context of the Site:**

### 7a. Main Human Activity(ies) Related to the Site:

Artisanal fishing, mangrove harvesting, aquaculture, bee keeping and solar salt manufacturing.

### 7b. Natural Conditions/Phenomenon Related to the Site:

High productivity and biodiversity.

8. **Nature of Threats and Extent of Threats (Human and Natural):**

Shoreline exposure leading to erosion, loss of productivity and biodiversity, loss of aesthetic value, exposure of the marine environment to pollution from land-based sources and loss of livelihood for the local community.

9. **If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):**

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

<sup>13</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionucleides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

## 11. List of Available Data Sets:

Bosire J.O. *Management along the Kenyan coast*. A resource management review paper presented during the 9<sup>th</sup> South African Marine Science Symposium (SAMSS), University of Cape Town, South Africa, 1996.

Hirsch D. and Mauser A. *The economic values of mangroves: 2 case studies: Mida Creek and Funzi Bay*. University of Amsterdam, 1992, 20 pp.

Kairo J.G. *Some human induced stresses on the mangrove ecosystems of Kenya*. A report prepared for the Mangrove Mapping Team, Forest Department, Nairobi, 1992.

Obade P.T. *Anthropogenically induced changes in a Kenyan mangrove ecosystem explained by application of remote sensing and Geographic Information Systems (GIS)*. M.Sc. thesis. Free University of Brussels (VUB), 2000.

Ruwa R.K. and P.Polk. Short communication: additional information on mangrove distribution in Kenya: some observations and remarks. *Kenya j. sci. series B*, 7(2), 1986, pp. 41-45.

UNEP. *Eastern Africa atlas of coastal resources 1: Kenya*, 1998, 119 pp.

### Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

We recommend that the GIWA issues be used as much as possible. Other issues can be proposed, but care must be taken to ensure that these are not either impacts or causes of a GIWA issue.

We advise that up to 3 issues be identified per site. And we advise that no more than 3 overriding issues be identified.

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## Overriding Issue

1. **Title:** Coastal Erosion (Overriding Issue # 5).
2. **Region (Administrative) and Location:** Kenyan Coastal Area.
3. **Surface Area/Definition:** 600 km Coastline.
5. **Transboundary Elements - Please identify whether and in what ways the site extends to other country(ies)/region and whether and in what ways adjacent areas influence the site:**
6. **Relevant [GIWA] Issue(s)<sup>14</sup>:**

Loss and modification of ecosystems, especially mangroves and sandy beaches, including community structure and/or species composition. Changes in hydrological cycle and sea level change.

### 7. Context of the Site:

#### 7a. Main Human Activity(ies) Related to the Site:

Changed land-use - human settlements, tourist hotel developments and mangrove harvesting.

#### 7b. Natural Conditions/Phenomenon Related to the Site:

Coral reefs, lagoons, mangrove estuaries, sandy beaches, dunes and cliffs.

### 8. Nature of Threats and Extent of Threats (Human and Natural):

Loss of investments and income. Loss of biodiversity.

### 9. If heavy incidence of pollution, list the type of source (point, non point, diffuse) and pre-identify the exact source(s):

10. Value of the site:	Local	National	Regional/global
Environmental significance	√	√	√
Socio-economic significance	√	√	√

### 11. List of Available Data Sets:

Kairu K. *Vulnerability of the Kenya shoreline to coastal instability*. A case study on coastal erosion. Paper presented at the UNESCO seminar, Mombasa, Kenya, 1997.

<sup>14</sup> GIWA issues are: reduction in stream flow of freshwater; pollution of existing supplied of freshwater; lowering watertables of freshwater; microbiological pollution; eutrophication (harmful algal blooms); chemical pollution; suspended solids pollution; solid wastes; thermal pollution; radionuclides pollution; spills pollution; loss of ecosystems of ecotones; modification of ecosystems or ecotones, including community structure and/or species composition; over-exploitation of fisheries resources; excessive bycatch and discards of fish stocks; destructive fishing practices; decreased viability of stock through pollution and disease; impact on biological and genetic diversity; changes in hydrological cycle; sea level change; increased radiation as a result of ozone depletion; changes in ocean CO<sub>2</sub> source/sink function. See attached [table 1](#).

Mwanje J.I. *Socio-economic impacts of coastal instability (erosion) in Kenya*. A case study. Paper presented at the UNESCO/KENYA national seminar, Mombasa, Kenya, 1997.

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Notes:

Individual hot spots and/or sensitive areas would be described as per the above headings, and on the basis of local and national knowledge of the sites and/or of existing studies and documents. It is important though to be able to substantiate the identification, and experts are asked to pay particular attention to quoting the reference documents as well as note the data sets available. Local and national consultation with experts and institutions is strongly encouraged, so is reference to existing strategies, plans, studies and assessments.

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The lists of hot spots and sensitive areas would need to be as exhaustive as possible at the start. The lists would be prioritised at the first national meeting of experts.

## Annex II

### Report of the First Kenya National Experts Meeting

Date of the meeting: 4th, 8th - 12th January 2001

Location: KMFRI, MOMBASA

Team Coordinator: Dr Johnson M. Kazungu

#### IDENTIFICATION OF HOT SPOTS, OF SENSITIVE AREAS, AND OF OVERRIDING ISSUES

Prior to the identification of hot spots, sensitive areas and overriding issues, the Kenya national team had an introduction meeting on 20th December 2000, where the national team coordinator, Dr J.M. Kazungu, introduced the GEF MSP Sub-Sahara Africa Project on Integrated Problem Analysis. During the introduction meeting, it was agreed that the identification exercise be started immediately with each expert carrying it out individually using the identification sheets (Annex 1 - WGRCA-I/4). The national team members gave themselves a timeframe of two weeks to carry out the exercise. The results of the identification exercise were later reported in the first national meeting that took place on 4th, 8th-12th January 2001.

During the meeting, the national experts extensively discussed the results that were presented. The team then prepared three lists of hot spots, sensitive areas and overriding issues. For both hot spots and overriding issues, the aspects of the transboundary of the sites were extensively discussed and the meeting came up with a list of five hot spots, and list of sensitive areas. The identified hot spots include Mombasa Inshore Water Areas, Malindi Bay, Ungwana Bay, Lamu Inshore Water Areas, Diani Beach. The identified sensitive areas include Malindi/Watamu Marine Park and Reserves, Wasini Channel, Ngomeni Mangrove Swamps, Gazi Bay, Vanga Creek. The overriding issues that were identified include over-exploitation of fisheries and other living resources, modification of ecosystems and destructive fishing practices.

#### **Outcome of the Identification Exercise:**

##### **Hot Spots:**

**Mombasa Inshore Water Areas:** This hot spot suffers from microbiological pollution, chemical pollution, eutrophication, suspended solids, solid wastes, spills, over-exploitation of fisheries and mangrove resources and destructive fishing practices. The port of Mombasa that serves almost the whole of East Africa is located here.

**Malindi Bay:** The site experiences suspended solids (especially silt deposition from River Sabaki), over-exploitation of fisheries resources (trawling and artisanal fishing) and modification of ecosystems. Malindi Bay has some endangered species such as the Green Turtles that need conservation. In terms of transboundary elements, wastage of juveniles in one jurisdiction may affect earnings in another jurisdiction.

**Ungwana Bay:** The site experiences destructive fishing practices, excessive by-catch and discards from trawling activities, suspended solids and modification of ecosystems. On transboundary aspects, a number of foreign owned trawlers fish in this bay and approximately 98% of what they catch is sold outside the country. The bay also has some of the endangered species that need conservation.

**Lamu Inshore Water Areas:** This site suffers from microbiological pollution, suspended solids and solid wastes.

**Diani Beach:** The area suffers from destructive fishing practices, over-exploitation of fisheries resources and modification of ecosystems (through combined impacts of the above plus construction of seawalls that accelerate coastal erosion in other adjacent areas. The site contains a rich biodiversity.

##### **Sensitive areas:**

**Malindi/Watamu Marine Park and Reserves:** The site experiences suspended solids that impact on the coral gardens, modification of ecosystems from over-harvesting of mangroves and trampling of

corals, and microbiological pollution from domestic sewage. The site has been declared a biosphere reserve.

**Wasini Channel:** The site experiences destructive fishing (especially by fishermen from a neighbouring country who use dynamite and beach seines), over-exploitation of fisheries resources and loss and modification of ecosystems.

**Ngomeni Mangrove Swamps:** The site suffers from loss and modification of ecosystems due to the presence of salt works that completely clear mangrove forests to create salt pans.

**Gazi Bay:** The site experiences over-exploitation of fisheries resources (fishermen from a neighbouring country operate alongside local fishermen), loss of ecosystems and modification of ecosystems (due to over-harvesting of mangroves and coastal erosion).

**Vanga Creek:** The site experiences destructive fishing practices, over-exploitation of fisheries resources, microbiological pollution and modification of ecosystems. The site is located at the boundary between Kenya and Tanzania and is traversed by a river that has its source in Tanzania.

#### **Overriding Issues:**

The following overriding issues were identified:

- Over-exploitation,
- Modification of ecosystems, and
- Destructive fishing practices.

These overriding issues are also experienced in almost all the countries in the West Indian Ocean region.

#### **Relevance of the GIWA List of Issues:**

The national team recognized the broadness of the GIWA list of issues. The list is well designed and accommodates most of the problems experienced in our region. It therefore provides a relevant guide to the choice of issues.

#### **Constraint:**

The national team recognized the need for a longer timeframe. It was noticed that the time spelt out in the initial programme is too tight. It was thought that the scoring exercise would take one day but it required about four days.

### **SCALING: PRIORITISATION OF HOT SPOTS AND SENSITIVE AREAS:**

The methodology for prioritising hot spots and sensitive areas is good as it provides a standardized method of rating sites. The ratings make it easy to compare sites on a regional or global scale hence rational decisions can be made.

#### **Key features of the summary list of prioritised hot spots and sensitive areas:**

Less than nine key issues (only seven different GIWA issues) have been recorded since some issues recur. The side of the prioritised hot spots shows the dominance of three issues across the three hot spots namely suspended solids, over-exploitation, and modification of ecosystems. The side of the prioritised sensitive areas shows the dominance of one issue across the three prioritised sites. The dominant issue being modification of ecosystems. As a whole, modification of ecosystems, over-exploitation and suspended solids emerge to be dominant. Coincidentally, modification of ecosystems and over-exploitation happen to be the main overriding issues here.

**From the summary table, the scoping exercise has come up with the following seven key issues: Microbiological pollution, suspended solids, loss of ecosystems or ecotones, modification of ecosystems or ecotones, over-exploitation, excessive by-catch and discards, and destructive fishing practices.**

### **SCOPING: PRIORITISATION OF ISSUES:**

The scoping methodology was noted to be useful in prioritising issues. The methodology is well presented and gives room for a detailed assessment of issues before a score is awarded. The reporting tables provide a good framework for arriving at issues with the highest scores that in turn happen to be the overriding issues.

Final outcome (summary table for the scoping exercise)

The seven key issues are presented in the table together with the corresponding average total score per issue. The average scores of the perceived future change have also been presented per issue. All average scores under the perceived future change are positive indicating the likelihood of impact worsening. The issues that have higher average scores also have higher average scores of perceived future change. The final score from each issue helps us rank the issues and from the final ranking of issues we are able to tell which issues to zero on to hence the three prioritised issues.



## Annex III

## Reporting Tables

**Table 1a. Reporting and Calculation Tables for Scoping Exercises for Hot Spots: Consequences of Environmental Problems upon the Environmental Context and the Socio-Economic Activities on the Selected Hot Spot**

IMPACTS TABLE		Country: Kenya			Date: 13 January 2001					
Major concern	Issue	Hot Spot 1: Mombasa			Hot Spot 2: Malindi Bay		Hot Spot 3: Ungwana Bay			
		Scores 0 - 3		Total for issue	Scores 0 - 3		Total for issue	Scores 0 - 3		Total for issue
		(a) Environmental	(b) Socio-economic	(a+b) max=6	(a) Environmental	(b) Socio-economic	(a+b) max=6	(a) Environmental	(b) Socio-economic	(a+b) max=6
I Freshwater shortage										
II: Pollution	Microbiological	1	2	3	0	2	2	0	1	1
	Suspended solids	2	1	3	3	1	4	2	1	3
III: Habitat and community modification	Modification of ecosystems or ecotones, including community structure and/or species composition	2	2	4	3	2	5	3	2	5
IV: Unsustainable exploitation of fisheries & other living resources.	Over-exploitation	3	2	5	3	2	5	3	2	5
	Excessive by catch and discards	0	1	1	3	2	5	3	2	5
V: Global change										
VI. Other										

*\*The habitats and communities suffering most significant damage will be reported on Table .*

**Table 1b. Reporting and Calculation Tables for Scoping Exercises for Sensitive Areas: Consequences of Environmental Problems upon the Environmental Context and the Socio-Economic Activities of the Selected Sensitive Areas**

IMPACTS TABLE		Country: Kenya			Date: 13 January 2001					
Major concern	Issue	Sensitive Area 1: Malindi/Watamu			Sensitive Area 2: Wasini Channel			Sensitive Area 3: Ngomeni Swamps		
		Scores 0 - 3		Total for issue	Scores 0 - 3		Total for issue	Scores 0 - 3		Total for issue
		(a) Environmental	(b) Socio-economic	(a+b) max=6	(a) Environmental	(b) Socio-economic	(a+b) max=6	(a) Environmental	(b) Socio-economic	(a+b) max=6
I Freshwater shortage										
II: Pollution	Microbiological	1	2	3	0	2	2	0	1	1
	Suspended solids	2	1	3	0	1	1	1	1	2
III: Habitat and community modification	Loss of ecosystems or ecotones	1	2	3	1	2	3	3	2	5
	Modification of ecosystems or ecotones, including community structure and/or species composition	2	2	4	2	2	4	3	2	5
IV: Unsustainable exploitation of fisheries & other living resources.	Over-exploitation	3	2	5	3	2	5	1	2	3
	Destructive fishing practices	1	2	3	3	2	5	1	2	3
V: Global change										
VI. Other										

*\*The habitats and communities suffering most significant damage will be reported on Table 2.*

Note: In Sensitive Area 1 the issue of over-exploitation refers to over-fishing and mangrove harvesting.



**Table 1c. Reporting and Calculation Tables for Scoping Exercises for Overriding Issues: Consequences of Environmental Problems upon the Environmental Context and the Socio-Economic Activities of the Country or National Ecosystem as a Whole**

IMPACTS TABLE		Country: Kenya		Date: 13 January 2001
Major concern	Issue	Scores 0 - 3		Total for issue
		(a) Environ- mental	(b) Socio- economic	(a+b)
		max=6		
I Freshwater shortage				
II: Pollution				
III: Habitat and community modification	Modification of ecosystems or ecotones, including community structure and/or species composition	3	3	6
IV: Unsustainable exploitation of fisheries & other living resources.	Over-exploitation	3	3	6
	Destructive fishing practices	2	3	5
V: Global change				
VI. Other				

*\*The habitats and communities suffering most significant damage will be reported on Table 2.*

**Table 3a. Reporting and Calculation Tables for the Scoping Exercises for Perception of Future Change in Impacts upon Issues Affecting Hot Spots**

FUTURE CHANGES TABLE		Country: Kenya	Date: 13 January 2001	
Major concern	Issue	Hot Spot 1: Mombasa	Hot Spot 2: Malindi Bay	Hot Spot 3: Ungwana Bay
		Scores -3 to 3	Scores -3 to 3	Scores -3 to 3
		Perceived future changes	Perceived future changes	Perceived future changes
I Freshwater shortage				
II: Pollution	Microbiological	3	2	0
	Suspended solids	2	3	2
III: Habitat and community modification	Modification of ecosystems or ecotones, including community structure and/or species composition	3	3	3
IV: Unsustainable exploitation of fisheries & other living resources.	Over-exploitation	3	3	3
	Excessive by catch and discards	0	2	3
V: Global change				
VI. Other				

**Table 3b. Reporting and Calculation Tables for the Scoping Exercises for Perception of Future Change in Impacts upon Issues Affecting Sensitive Areas**

FUTURE CHANGES TABLE		Country: Kenya	Date: 13 January 2001	
Major concern	Issue	Sensitive Area 1: Malindi/Watamu	Sensitive Area 2: Wasini Channel	Sensitive Area 3: Ngomeni Swamps
		Scores -3 to 3	Scores -3 to 3	Scores -3 to 3
		Perceived future changes	Perceived future changes	Perceived future changes
I Freshwater shortage				
II: Pollution	Microbiological	3	0	0
	Suspended solids	2	2	1
III: Habitat and community modification	Loss of ecosystems or ecotones	2	2	3
	Modification of ecosystems or ecotones, including community structure and/or species composition	3	2	3
IV: Unsustainable exploitation of fisheries & other living resources.	Over-exploitation	2	3	0
	Destructive fishing practices	1	2	0
V: Global change				
VI. Other				

**Table 3c. Reporting and Calculation Tables for the Scoping Exercises for Perception of Future Change in Impacts upon Overriding Issues**

<b>FUTURE CHANGES TABLE</b>		<b>Country: Kenya</b>	<b>Date: 13 January 2001</b>
<b>Major concern</b>	<b>Issue</b>	<b>Scores -3 to 3</b>	
		<b>Perceived future changes</b>	
I Freshwater shortage			
II: Pollution			
III: Habitat and community modification	Modification of ecosystems or ecotones, including community structure and/or species composition		3
IV: Unsustainable exploitation of fisheries & other living resources.	Over-exploitation		3
	Destructive fishing practices		3
V: Global change			
VI. Other			

### Aggregated Table for Hot Spots

	<i>Criteria</i>	<i>Hot -Spot</i>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
1	Size of affected area		2	2	5	3	2				
2	Affected population		15	9	6	9	9				
3	Extent to which the natural coastal and marine resources of the site support the livelihood of local communities (for instance, in the case of fisheries, tourism);		20	20	20	20	20				
4	Extent to which the natural coastal and marine resources of the site support the national development (for instance, in the case of fisheries, tourism);		10	4	4	6	6				
5	Extent to which the site is a government priority (refer to NEAP or other strategic environmental action programme)		12	6	9	12	12				
6	Extent to which the site is of regional and/or global significance and priority (see WWF ecoregions, IUCN categories, etc.).		6	4	6	8	6				
7	Degree of Degradation at the site (e.g. type of degradation))		9	6	15	12	12				
8	Extent of degradation on coastal and marine resources and systems		8	4	10	8	8				
	<b>TOTAL SCORE</b>		82	55	75	78	75				
	<b>NORMALISED SCORE</b>										
	Key issues relevant to the hot spots:	1-	II.4	II.4	III.13	II.7	III.13				
		2-	II.7	II.7	IV.14	III.13	IV.14				
		3-	IV.14	III.13	IV.15	IV.14	IV.16				

### Aggregated Table for Sensitive Areas

	<i>Criteria</i>	<i>Sensitive Area</i>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
1	Biodiversity value of the site		12	15	12	12	15				
2	Cultural value of the site		6	8	6	4	8				
3	Size of area at risk		4	4	4	4	6				
4	Population at risk (please define the population)		6	6	6	6	9				
5	Extent to which the natural coastal and marine resources of the site support the livelihood of local communities (for instance, in the case of fisheries, tourism);		20	20	20	20	20				
6	Extent to which the natural coastal and marine resources of the site support the national development (for instance, in the case of fisheries, tourism);		4	8	4	12	12				
7	Extent of involvement of communities in local management		2	6	4	4	8				
8	Extent to which the site is a government priority (refer to NEAP or other strategic environmental action programme)		12	12	9	9	15				
9	Extent to which the site is of regional and/or global significance and priority (see WWF ecoregions, IUCN categories, etc.).		6	10	4	4	10				
	<b>TOTAL SCORE</b>		72	89	69	75	103				
	<b>NORMALISED SCORE</b>										
	Key issues relevant to the sensitive area*	1- 2- 3-	II.4 III.13 IV.16	III.13 IV.14 IV.16	III.13 IV.14 IV.16	III.12 III.13	II.4 II.7 III.13				

**Annex IV****Socio-Economic Impact Exposure Tables****Socio-economic Impacts of Suspended Solids - Exposure Table**

Sub-region: \_\_\_\_\_ East African Coast Aquatic system: The Somali Current LME Country: Kenya  
 No. Name

Prepared by: Kenya Marine and Fisheries Research Institute

Organisation/Department

**Name**

<b>Impacts</b>	<b>Impact Measure</b>	<b>Amount</b>	<b>Value of Underlying Measure</b>	<b>Geographical Coverage</b>	<b>Source Publication</b>	<b>Source Organisation</b>
Tourism and recreation	Decrease in number of international and national tourist visits	"K"				
	Decrease in average time of visit (hours)	"K"				
	Decrease in time spent on water based activities (person days)	"K"				
Water supply/storage capacity	Decrease in volume of useable water (e.g. for drinking, agricultural purposes) (m <sup>3</sup> )	25,000m <sup>3</sup> per day 9,125,000m <sup>3</sup> p.a.	80,000m <sup>3</sup> produced per day earlier, but now only 55,000m <sup>3</sup> is produced per day	Malindi-Mombasa approx. 125km coastline		Water Department, Coast region
Fish & aquaculture sales	Decrease in fish catch (metric tons)	"K"				
	Average value of fish catch before decrease (state currency units per metric ton)	"K"				
	Decrease in harvest of non-fish species (metric tons)	"K"				
	Average value of harvest before decrease (currency units per metric ton)	"K"				
Property value	Decrease in average land price (currency units m <sup>-2</sup> )	"K"				
	Land area affected (km <sup>2</sup> )	"K"				

Impacts	Impact Measure	Amount	Value of Underlying Measure	Geographical Coverage	Source Publication	Source Organisation
	Fall in average residential and commercial building price (currency units m <sup>-2</sup> floor area)	"K"				
Aesthetic value	Number of complaints to authorities about visual disamenity	"K"				
Development opportunities	Number of future employment opportunities lost	"K"				
Human health (impacts attributable to diminution in water quality due to pollution)	Increase in morbidity rate (number of illnesses per 100,000 population)	"K"				
	Increase in average length of illness (days)	"K"				
	Increase in mortality rate (number of deaths per 100,000 population)	"K"				
Water treatment	Increase in costs to maintain quality (currency units)	66%	US\$219,000 i.e. difference between 1996 water treatment costs and 2000 water treatment costs	Malindi Bay – Mombasa approx. 125km coastline		Water Department, coast region
Physical protection measures	Increase in costs of construction of preventative structures (walls, barriers etc.) (currency units)	"K"				
Navigational clearance	Costs of maintaining navigational channels (currency units)	?				
Equipment damage	Increased costs in maintaining water related equipment (currency units)	"K"				



<b>Impacts</b>	<b>Impact Measure</b>	<b>Amount</b>	<b>Value of Underlying Measure</b>	<b>Geographical Coverage</b>	<b>Source Publication</b>	<b>Source Organisation</b>
Wildlife	Decrease in number of locally extant species	2	4 species 1972 2 species 1992	Mamburi, Malindi Bay	Wakibia, J.G. 1995. The potential human induced impacts on the Kenya seagrasses. UNESCO reports in Marine Science. No. 66	KMFRI
Proportion of impacts arising from economic activities outside the country in which the impact is suffered						
Other Impacts:	Specify appropriate measure:					
Other Impacts:	Specify appropriate measure:					
Other Impacts:	Specify appropriate measure:					
Other Impacts:	Specify appropriate measure:					

## Socio-Economic Impact Assessments

### 1. Suspended Solids

Suspended solids results in reduced tourism/recreational opportunities as it interferes with the aesthetic value of beaches, coral reefs and mangroves. The most affected sites are Malindi Bay; a selected hot spot and Malindi/Watamu Marine Park and Biosphere Reserve; a selected sensitive area. Tourism is a leading foreign exchange earner in the country and is employing thousands of coastal dwellers. The Malindi town which is located at Malindi Bay, is a town that developed purely from tourism. Currently some tourist hotels have lost their beach frontage with consequent loss of tourism business. This is further manifested in loss of employment to many hotel employees.

Kenya experiences increased costs of coastal protection from waves, storm surges, flooding from major river systems and erosion. Many sea walls have been erected at major tourist development centres to control shoreline erosion that has been threatening many coastal developments. This impact is most felt at Malindi Bay, Mombasa Inshore Water Areas and Diani all of which are hot spots and Malindi/Watamu Marine Park and Biosphere Reserve and Ngomeni Mangrove Swamps that are sensitive areas.

Suspended Solids has caused increase in water treatment costs with adverse impacts on the coastal dwellers. For example, the Baricho water supply plant in the Malindi Bay area was designed to produce 80,000m<sup>3</sup> per day from River Sabaki (Ministry of Water Development, 2001 pers. comm.). The plant could not continue functioning as planned due to high volumes of suspended solids that required high expenditures on coagulation. The water supply plant had to change her source of water intake from the River Sabaki itself to wells that are dug close to the river. The plant is currently producing only 55,000m<sup>3</sup> per day (i.e. a reduction of 25,000m<sup>3</sup>). The water department which is the government agency responsible for water resources development argues that coagulation has become too costly considering the high sediment loads carried by the river.

### Socio-economic impact assessments

Decrease in number of some locally extant seagrass species has been reported in Malindi Bay. It is documented that four (4) locally extant species were reported in 1972 at Mambrui in Malindi Bay but, in 1992 only two (2) species remained available (Wakibia, 1995). Coincidentally, the decrease has occurred at Malindi Bay which is a hot spot that is experiencing heavy siltation. Besides, the decrease is tremendous and worrying, considering that this change has occurred within a period of only twenty (20) years.

There is some dredging of the navigational channel at Mombasa inshore water areas to maintain the depth required for shipping activities. The costs of dredging has increased over time thereby impacting on the operational budget of the agency responsible for the management of harbours in the country. The costs of dredging shows the significance of the impacts of suspended solids on the Kenyan coastal waters.

### References

Ministry of Water Development. Coast province annual reports. Unpublished, 2001.

Wakibia, J.G. The potential human induced impacts on the Kenya seagrasses. UNESCO reports in *Marine science*, No. 66.

**Socio-economic Impacts of Habitat and Community Modification - Data Table  
for Issue/Impact Point(s) Reference(s) \_\_\_\_\_**

Sub-region: \_\_\_\_\_ East African Coast Aquatic system: The Somali Current LME  
No. Name

Country: Kenya Prepared by: Kenya Marine and Fisheries Research Institute  
Organisation/Department Name

1.	Responsible organization	IUCN	
2.	Publication reference (if study published)	Emerton, L. 1999. Economic Tools for the Management of Marine Protected Areas in Eastern Africa. IUCN, Nairobi, December 1999.  2. Emerton, L. 1998. Economic Tools for Valuing Wetlands in Eastern Africa. IUCN, Nairobi, December 1998.	
3.	Year study performed	1999 1998	
4.	Basis period or year	1998	
	Study coverage		
5.	Type of habitat and impact(s) covered by study	Coral Reefs:- Tourism, recreation and aesthetic values. Tana Delta Wetlands (Mangroves): (a). Land use, physical capital & human safety i.e. Increase in number of dwellings & business premises inundated by flood or storm surge, increase in costs of construction of defensive structures (walls, barriers, etc.), (b) Restoration & response to catastrophic events i.e. increase in costs of habitat protection or restoration, increase in costs of emergency service response to floods/surges	
6.	Study Type*		
7.	If Study Type IV or V in Box 6: Site(s)/activity valued	Within the <i>selected system</i>	In another system
	<b>Valuation of impact(s)</b>		
8.	Amount	US \$280,000 US\$4,583,333	
9.	Currency units	UNITED STATES DOLLARS	
10.	Currency year (if not as in Box 4 above)	1998	
11.	Measurement units (time, space)	12 months (one financial year)	
12.	Conversion factors	Sites = x2 Sites = x3	
13.	Method of valuation	Management costs using market prices to value the costs of managing Marine Protected Areas in Kenya. Proxy indicators, looking at the damage avoided to roads and bridges by the control of annual floods.	
14.	Basis of valuation	Analysis of the annual budgets of the KWS: staff, equipment, infrastructure and maintenance costs for three Marine National Parks. Wetlands and mangroves on the Tana Delta provide important flood and storm control functions, protecting coastal infrastructure and settlements. This function was valued looking at the damage avoided to roads and bridges by the control of annual floods.	
15.	Annual value of impact in study currency  b. Inflation rate to 1998 c. Study currency: PPP\$ rate for 1998 d. Annual value of impact in PPP\$	US\$560,000 US\$13,749,999.	
16.	Proportion of impact value arising	-	

	from environmental damage caused by economic activities outside <i>your country</i>	
17.	<p><b>If the study was based on forecasts (i.e. the basis period in Box 4 above was later than the year in which the study was performed per Box 3 above) what assumptions were used as to:</b></p> <p>Changes in levels of habitat loss or modification?</p> <p>Changes in impact values (e.g. increase in costs associated with restoration of natural habitats)?</p>	<p>(a). Increase in costs of rehabilitating degraded natural habitats and controlling further degradation The direct costs of marine protected areas can be calculated by identifying the labour, equipment, infrastructure, vehicles and other investment and recurrent expenditures required for their management. These can be valued at market prices</p> <p>(d). The annual budgets of the national agency responsible for park management gives a good reflection of concern given to changes in levels of coral reef modification</p> <p>2. Increase in costs associated with restoration of natural habitats; calculating the value of damage occurring as a result of the loss or irrevocable degradation of wetlands - for example the costs of destruction to houses, roads, bridges and farms caused by flooding - provides a way of valuing wetland services in terms of losses avoided and costs saved.</p>

\* To find Study Type see chart "Identification of Study Type" at Annex I to the guidance notes.  
Where the Study Type is III, IV or V: an Extension Table is required.

## Imp/Hab/EX \_\_\_\_

## Socio-economic Impacts of Habitat and Community Modification - Extension Table

## for Data Table Imp/Hab/DT \_\_\_\_

## SEE GUIDANCE NOTES:

## X1-X3

## X4-X6

		Study Type III	Study Type IV
1.	Study Type (per Data Table Box 6)		
2.	Annual value of impact(s) for <i>your country</i> (per Data Table Box 15d.)		
3.	Variable for allocating between aquatic systems, and units (e.g. area of habitat(s) threatened or lost at time of study, km <sup>2</sup> )		
4.	Value of allocation variable (Box 3) for <i>selected system</i>		
5.	Value of allocation variable in (Box 3) for the whole of <i>your country</i>		
6.	Proportion of whole country value attributable to <i>selected system</i> = Box 4 ÷ Box 5		
7.	Annual value of impact(s) attributable to <i>selected system</i> = Box 6 x Box 2		
8.	Annual value of impact(s) for site(s)/activities studied (per Data Table Box 15d.)		1. US\$560,000 2. US\$13,749,999.
9.	Unit of valuation for scaling up to all sites in the <i>selected system</i> (e.g. area of habitat(s) threatened or lost at time of study, km <sup>2</sup> )		1. There are 2 such sites hence we multiply by <u>2</u> to scale up. 2. There is another site similar to the Tana Delta.  There are also other smaller rivers that normally flood during the rainy season and display similar impacts whose impacts can be assigned a similar value. The function can therefore be partially valued by multiplying the Tana Delta value by <u>3</u> to scale up for the entire Kenyan coast.
10.	Annual value of impact(s) for site(s) studied per unit of valuation in Box 9		1. US\$280,000 2. US\$4,583,333
11.	Total unit of valuation in (Box 9) for all sites/activities in <i>your country</i> and the <i>selected system</i> (including site(s)/activities in Box 8)		1. =X2 2. =X3
12.	Annual value of impact(s) attributable to <i>selected system</i> = Box 10 x Box 11		1. US\$560,000. 2. US\$13,749,999

N.B. The numbering 1 and 2 in the data entry column represent the valuation study reports as reflected under references (row 2 column 3 of this data table).

## 2. Habitat and Community Modification

In Kenya, modification of ecosystems and/or ecotones is a very significant issue on socio-economic grounds. Continuous degradation of ecosystems and habitats leads to reduced capacity to meet basic human needs (food, fuel & shelter). An assessment of the cross-border fishing activities between Kenya and Tanzania that are sharing marine resources reveals that modification of ecosystems has led to reduced fish catches in both countries and hence a lost means of livelihood. The conflict between fishermen from the two countries is now being dealt with at the East African Community (EAC) level.

The most notable degraded habitats and/or ecosystems include mangroves, coral reefs, seagrass meadows and beaches. For generations these habitats and/or ecosystems have been supporting the means of livelihood to thousands of coastal dwellers in Kenya. Modification of ecosystems have resulted into the loss of their aesthetic value a characteristic on which tourism depends. The loss of aesthetic value and the degradation of the ecosystems has led to loss of income and foreign exchange from tourism. Regionally, modification has caused loss of existing and potential income from fishing and tourism. Conversely, modification of ecosystems has caused changes in employment opportunities for local communities as well as the resultant changes in the social structures. In areas where trawling is practised, modification of the fishing grounds has led to loss of existing income to artisanal fishermen thereby causing resource use conflicts between the artisanal fishermen and trawlers.

In selected hot spots, there is evidence of modification or loss of cultural heritage. At the Ngomeni mangrove swamps for example, a large stretch of mangroves has been cleared to give way for salt pans. At Gazi Bay, uncontrolled mangrove harvesting has led to loss of land due to erosion of the devegetated shoreline. Cultural heritage is therefore put in the balance. Once ecosystems are modified, the costs of restoration are too high and it takes too long to bring an ecosystem back to its original state. The survival of future generations may be compromised. However, despite these critical socio-economic impacts, no comprehensive valuation studies have been conducted in Kenya on the corresponding socio-economic impact measures. Using the limited information available, the Government of Kenya recognised the socio-economic and environmental significance of habitat and community modification and responded by establishing Marine Protected Areas to protect the critical habitats, conserve biodiversity and enhance inter and intra-generational equity. To date, the Kenya Government is spending approximately US\$560,000 per year towards Marine Park management.

According to a valuation study by Emerton (1999), the direct costs of conserving three of Kenya's Marine National Parks - Kisite, Malindi and Watamu were calculated by analysis of the annual budgets of the Kenya Wildlife Services, the national agency responsible for their management. In total, staff, equipment, infrastructure and maintenance costs for the three Marine National Parks were in the financial year 1994/95 equivalent to some US\$0.28 million at 1999 prices. When this figure is scaled up to cover all the Marine Parks and Reserves along the coast of Kenya, we obtain a total expenditure of approximately US\$560,000 in one year. This figure however, does not reflect the total economic value of the target coral reef and mangrove ecosystems in Kenya. These ecosystems support fisheries which is a major source of livelihood to many of the coastal dwellers. They also support tourism which is a significant employer and a leading foreign exchange earner in the country. However, besides the positive gains from tourism, it also impacts negatively on the coral reefs in Kenya through trawling, diving and snorkelling.

Recent surveys of the condition of the inner lagoon reef at Diani in the Kenyan south coast indicated a high level of degradation (McClanahan et al., in prep). Abundance and diversity of corals recorded were lower than in protected sites in Kenya or northern Tanzania (McClanahan & Mutere, 1994; McClanahan & Obura, 1995). Eight families of reef fish were censused during a recent study at Diani in the south coast of Kenya. The mean figure from five study sites for total wet-weight of fish from the eight families was 68 kg/ha. This is comparable to other unprotected reefs in Kenya (McClanahan & Obura, 1995) which were consistently below 100kg/ha between 1988 – 1993. Total wet-weight of the same fish families in 3 Kenyan marine parks were much higher, ranging between 800 kg/ha and 1500 kg/ha.

Currently, there is evidence that modification of coral reef and mangrove ecosystems in Kenya force fishermen and other coastal dwellers to experience reduced capacity to meet basic human needs (food, fuel...). Nationally, the objectives of achieving high and growing per capita incomes have not been fully met in the recent years. Between 1980 and 1989, the average growth rate of per capita income was only 0.4 percent per year and between 1990 and 1995, the rate was a negative 0.3 percent per year. Rapid and sustained per capita income growth has remained an elusive target (Republic of Kenya, 1997). The welfare of majority of the people has declined as evidenced by the increase in the

number of Kenyans living below the absolute poverty line. Kenyan coral reefs show signs of over-exploitation with increase in sea-urchin population and

decrease in perceived catch (Malleret-King, 2000). The high urchin densities, the absence of urchin predators and the medium term decline in hard substrate cover, indicate that the condition of the lagoon is a result of fishing pressure. The survival of the fishing communities is therefore put in the balance, unless sustainable resource utilisation practices are put in place. There is need for comprehensive valuation studies to generate data on this issue to guide resource management decisions.

Modification of the mangrove ecosystems of the Kenyan Coast results in damage to coastal infrastructure and settlements. A valuation study on the Tana Delta Wetlands (Ungwana - Bay) show that the wetlands and mangroves of Tana Delta provide significant flood and storm control functions, protecting coastal infrastructure and settlements. This function was partially valued by looking at the damage avoided to roads and bridges by the control of annual floods. The valuation study computed a total present value of Ksh.275 million (US\$4,583,333) in terms of re-establishment and maintenance expenditures avoided (Emerton, 1998). When scaled up to capture the functions of such ecosystems along the entire Kenyan coastline, a total present value of US\$13,749,999 is obtained for the flood and storm control function of the mangroves. If modification of mangroves and other coastal wetlands continue, this amount would be lost towards re-establishment and maintenance expenditures for protecting coastal infrastructures and settlements. This is by all standards quite a high value for a developing country and therefore mitigating measures are required to alleviate further degradation/modification.

At Mambrui in Malindi Bay, decrease in number of locally extant plant species has been reported. In 1972, four (4) locally extant seagrass species were documented but in 1992, only two (2) could be traced (Wakibia, 1995).

Habitat and community modification also causes loss of existing income and foreign exchange from fisheries. Prawn trawling in the Ungwana estuary has been going on since the 1970's. For the last one decade, trawlers have had an average annual landing of 334 and 640 tons of prawns and fish respectively. These catches are associated with about 70-80% by-catch in weight, which includes juveniles of commercial fish species and other marine organisms that include endangered species like sea turtles. Other problems associated with prawn trawling include benthic habitat destruction/modification and conflicts between the trawler operators and the artisanal fishermen. In the year 2000, artisanal fishermen from Malindi Bay and Ungwana Bay raised alarm over the impacts of trawlers on their catches. Issues of inter and intra-generational

equity and the survival of the artisanal fishermen are becoming critical causing conflicts in the use of common resources. However, the Government also needs foreign exchange which this sector generates through trawling. There is therefore need to conduct a comprehensive valuation study to generate formation and data for rational management of the fishery.

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**Socio-economic Impacts of Unsustainable Exploitation of Fisheries and Other Living Resources  
Exposure Table**

Sub-region: \_\_\_\_\_ East Africa Coast  
No. Name

Aquatic system: The Somali Current LME Country: Kenya

Prepared by: Kenya Marine and Fisheries Research Institute

Organisation/Department Name

Impacts	Impact Measure	Amount	Value of Underlying Measure	Geographical Coverage	Source Publication	Source Organisation
Protein for human and animal consumption	Decrease in local human consumption of fish protein (kg per capita)	31kg per capita	-1,588,000 kg -1,612,000kg	2000km <sup>2</sup>	-	- Fisheries Department, Kenya
	Decrease in local animal consumption of fish protein (metric tons)	"K"				
Employment earnings/ Employment	Decrease in aggregate earnings of those employed in fishing (currency units)	"K"				
	Decrease in total number of individuals employed full or part-time in fishing	"K"				
Food sources and livelihoods	Decrease in number of individuals obtaining more than 50% of their non-vegetable protein intake from fish	"K"				
	Decrease in number of households reliant for subsistence on fishing	"K"				
Economic returns	Decrease in aggregate fishery revenues from all stocks (currency)	US\$450,000	US\$742,857	600km coastline	-	Fisheries Department
	Increase in average fishery revenues from all stocks (currency units per metric ton)	"K"	-	-	-	-

Impacts	Impact Measure	Amount	Value of Underlying Measure	Geographical Coverage	Source Publication	Source Organisation
Management of stocks/ User conflict	Increase in individuals employed by government in monitoring and managing fisheries stocks or fishing activities	US\$560,000	MPAS direct management costs	850km <sup>2</sup>	1. Gilbane, L. (1995).... 2. Emerton, L. (1999). Economic Tools for the management of marine protected areas in Eastern Africa. Nairobi, December 1999.	Kenya Wildlife Services IUCN
	Increase in number court or local tribunal cases concerned with fishing rights	"K"				
	Increase in number of international disputes (involving protest by <i>your country</i> to another government) concerned with fishing rights	"K"				
Subsidy/ Employment support	Increase in financial transfers from government to fishing sector (currency units)	"K"				
Change in the value of stocks	Decrease in: biomass of all stocks, kg x average value per kg) (currency units)	"K"				
Increasing capacity/ technology	Increase in aggregate capital costs (investment in vessels and equipment) of fishing sector (currency units)	"K"				
	Increase in private and public research and development expenditure for commercial fishing equipment (currency units)	"K"				
Human health <sup>15</sup>	Increase in morbidity rate (number of illnesses per 100,000 pop.)	216	3,888 persons malnourished	600km coastline	Republic of Kenya. 1998. Statistical Abstract - 1998. Nairobi, Kenya.	Central Bureau of Statistics

<sup>15</sup> Impacts attributable to consumption of contaminated fish or other species.

Impacts	Impact Measure	Amount	Value of Underlying Measure	Geographical Coverage	Source Publication	Source Organisation
	Increase in average length of illness (days)	"K"				
	Increase in mortality rate (number of deaths per 100,000 pop.)	"K"				
Protected species	Number of protected species individuals killed in the course of fishing activities, by species	64 Dugongs killed between 1973 and 1980; - >13 Green turtles in one survey in 1996	13 Green turtles were found dead during one survey, plus many dead turtles along the Tana delta beaches where turtle nesting was absent	600km coastline	Wamukoya, G.M, J.M. Mirangi, and W.K. Ottichillo. 1996. Marine aerial survey of marine mammals, sea turtles, sharks & rays. KWS Technical Series Report No.1	Kenya Wildlife Service
Commercial species	Number of formerly commercially viable stocks not currently targeted in fishing activities	"K"				
Biodiversity	Decrease in number of locally extant water dwelling species and seabird species	"K"				
Proportion of impacts arising from economic activities outside the country in which the impact is suffered						
Other Impacts:	Specify appropriate measure: Inappropriate fishing gears (beach seines, drift nets, ...)	Many		2000km <sup>2</sup>		Fisheries Department, Kenya Marine and Fisheries Research Institute.

### **3. Over-exploitation of Fisheries and Other Living Resources**

Over-exploitation of fisheries and other living resources causes reduced economic returns to many coastal dwellers in Kenya. This is further manifested in loss of protein for human consumption. Fisheries and mangroves are important livelihood sources for many of the coastal communities along the coast of Kenya. Traditionally, the coastal communities depended on fisheries and mangrove exploitation. At the moment, the Kenyan reef fishery show signs of over-exploitation (i.e. decrease in the perceived catch, increase in sea urchin population (Samoilys, 1988; Wells and Sheppard, 1988; McClanahan and Obura, 1995; Watson, 1996; Glaesel, 1997; Muthiga, 1998; Fisheries Department-catch statistics, 2000). Besides, it is documented that 70% of a Kenyan coastal fishing community depends on the coral reef fishery for 80% of its income (Malleret-King, 2000).

From the exposure table, it is evident that fish catch has been declining over years. For example, between 1998 and 1999, fish catch declined by a total of 1,612,000kg while the fishing effort remained high especially in the artisanal sector. There is decline in aggregate marine fishery revenues amounting to US\$450,000. Between 1998 and 1999, the decline in fishery revenue was higher i.e. US\$742,857. This corresponds with decline in fish catch during that period. Decrease in fish catch results in the subsequent decrease in local human consumption of fish protein. It is estimated that the average decrease in local human consumption of fish amounts to 31kg per capita. This explains the reported cases of malnutrition in the coast of Kenya since many households depend solely on fishing both as a source of protein and for their means of livelihood. 3,888 malnourished persons were reported in 1998 (Republic of Kenya, 1998). This represents an increase in morbidity rate i.e. 216 persons per 100,000 population in the Coast of Kenya.

#### **Socio-economic impact assessments**

Recent reports have documented evidence of rapid decline of sea turtles and marine mammal populations in Kenya's waters (Jarman, 1966; Watson, 1973; Pertet & Thorsell, 1980; Kendall, 1986; Olendo, 1993). Records show that there has been a drastic decline in dugong population over years from 67 animals in 1973 (Watson, 1973) to a record of only 3 animals in 1980 (Pertet and Thorsell, 1980). This implies that 64 Dugongs could have been killed between 1973 and 1980. This has been attributed to intensive hunting primarily for their meat and oil. Over-exploitation and incidental catches appear to be the main factors threatening dugong population in Kenya. Dugong meat and other products have numerous uses that have remained the driving force behind their being hunted. Accidental drowning in trawling nets and set nets by the ever increasing commercial and artisanal fishermen poses the greatest threat to the survival of the dugong population in Kenya particularly in Ungwana Bay. It has been reported that mortalities from accidental drowning is significant but it is very difficult to obtain precise figures.

Besides, during one survey 13 green turtles were found dead in various stages of decomposition or as shell remnants and many other turtles were dead along the beaches. Some of the dead turtles were intact indicating that they were not slaughtered for food, but could have drowned in trawl nets before washing ashore. This implies that the deaths could be as a result of human predation on nesting females or the fishing activities in the outlying areas as incidental catches in trawler nets as this is an area with high trawling activity. Since turtles are endangered species, such over-exploitation/indiscriminate killing may result into their extinction. There is need for a study to determine the viability of traditional approaches to conserving such endangered species.

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## **Annex V**

### **Report of the Third National Meeting**

Date of the meeting: **8<sup>th</sup> May 2001**

**Location:** Kenya Marine and Fisheries Research Institute, Mombasa

#### **Agenda**

The Kenyan third National Meeting was based on the following agenda:

1. Background to GEF – MSP Integrated Problem Analysis project
2. Introduction to Causal Chain Analysis & formation of discussion groups
3. Analysis of the immediate and root causes of the prioritised environmental issues, the associated sectoral pressures and responses
4. Recommendations

#### **Participation**

The third national meeting drew participants from different national institutions that are concerned with the management of the coastal and marine environment. These institutions include the National Environment Secretariat, the National Museums of Kenya, the Fisheries Department, Coast Development Authority, and Kenya Marine and Fisheries Research Institute. The other institutions that sent their apologies include Kenya Wildlife Services and Moi University's Centre for Environmental Research. The list of participants is appended as annex 1 of this report.

#### **Organisation of the Meeting**

The meeting began with an introduction to the GEF – MSP Sub-Saharan Africa Project, Integrated Problem Analysis and the Causal Chain Analysis Methodology. The national experts presented the work that had been done before the national meeting. After the highlights on what had been accomplished, the participants were divided into two groups with one group set to discuss immediate causes, sectoral pressures, root causes and responses associated with modification of mangrove habitats and estuaries, and suspended solids. The other group discussed modification of seagrass beds and coral reef habitats, and over-exploitation of fisheries and other living resources. After the group discussions, the participants re-assembled for a plenary where the results of the discussions were presented and discussed.

#### **Recommendations of the Meeting**

In view of the time constraints, the meeting came up with the following recommendations:

- the national team of experts to compile the report taking into consideration the issues raised in the national meeting; and
- the draft causal chain and meeting report to be circulated to all participants by e-mail for them to edit and add information where necessary.

#### **Constraints**

The following constraints have exerted pressure during the execution of this phase:

- time was inadequate and the participants felt that the meeting needed a minimum of two days to discuss the issues exhaustively;
- lack of monitoring data made it difficult to qualify the contribution of some immediate causes, sectoral pressures, root causes and responses; and
- financial constraints made it difficult to organize another meeting for the participants to come together again and discuss the final report as they had wished.



## Annex VI

### Kenyan Third National Meeting of GEF MSP Sub-Saharan Africa Project - Integrated Problem Analysis, “Development and Protection of Coastal and Marine Environment in Sub-Saharan Africa”

18<sup>TH</sup> MAY 2001, KMFRI - MOMBASA

#### LIST OF PARTICIPANTS

1. Mr Michael M. Nguli, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [mnguli@recoscix.org](mailto:mnguli@recoscix.org)
2. Dr Helida Oyieke, National Museums of Kenya, P.O. Box 40658, Nairobi, Kenya. Tel. 254-2-742161/4, 732131/4, 742445, Fax: 254-2-741424, E-mail: [Biodive@tt.gn.apc.org](mailto:Biodive@tt.gn.apc.org), [Biod@arcc.or.ke](mailto:Biod@arcc.or.ke)
3. Mr Patrick Gwada, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [pgwada@recoscix.org](mailto:pgwada@recoscix.org)
4. Mr Gerald Mwatha, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [gmwatha@recoscix.org](mailto:gmwatha@recoscix.org)
5. Mr Ali Mohamed, National Environment Secretariat, P.O. Box 67839, Nairobi, Kenya. Tel. 254-2-243088,243839, 247795.
6. Ms. Jacqueline Uku, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [juku@recoscix.org](mailto:juku@recoscix.org)
7. Ms. Gladys Moragwa, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [gokemwa@recoscix.org](mailto:gokemwa@recoscix.org)
8. Ms. Esther Fondo, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [efondo@recoscix.org](mailto:efondo@recoscix.org)
9. Ms. Pamela Abuodha, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [pabuodha@recoscix.org](mailto:pabuodha@recoscix.org)
10. Mr Harrison Ong’anda, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [honganda@recoscix.org](mailto:honganda@recoscix.org)
11. Ms. Elizabeth Mueni- Fisheries Department – Coast Region, P.O. Box 90423, Mombasa, Kenya. Tel. 254-11-315904, E-mail: [emueni@hotmail.com](mailto:emueni@hotmail.com)
12. Mr Shaban Mwachireya, Kenya Marine and Fisheries Research Institute, P.O. Box 81651, Mombasa, Kenya. Tel. 254-11-475152/4, Fax: 254-11-475157, E-mail: [akubuni@recoscix.org](mailto:akubuni@recoscix.org)
13. Mr Saeed M. Mwaguni – National Expert (Environment)
14. Mr Jacob Ochiewo – National Expert (Socio-economics)
15. Mr Daniel Munga - National Expert (Pollution).