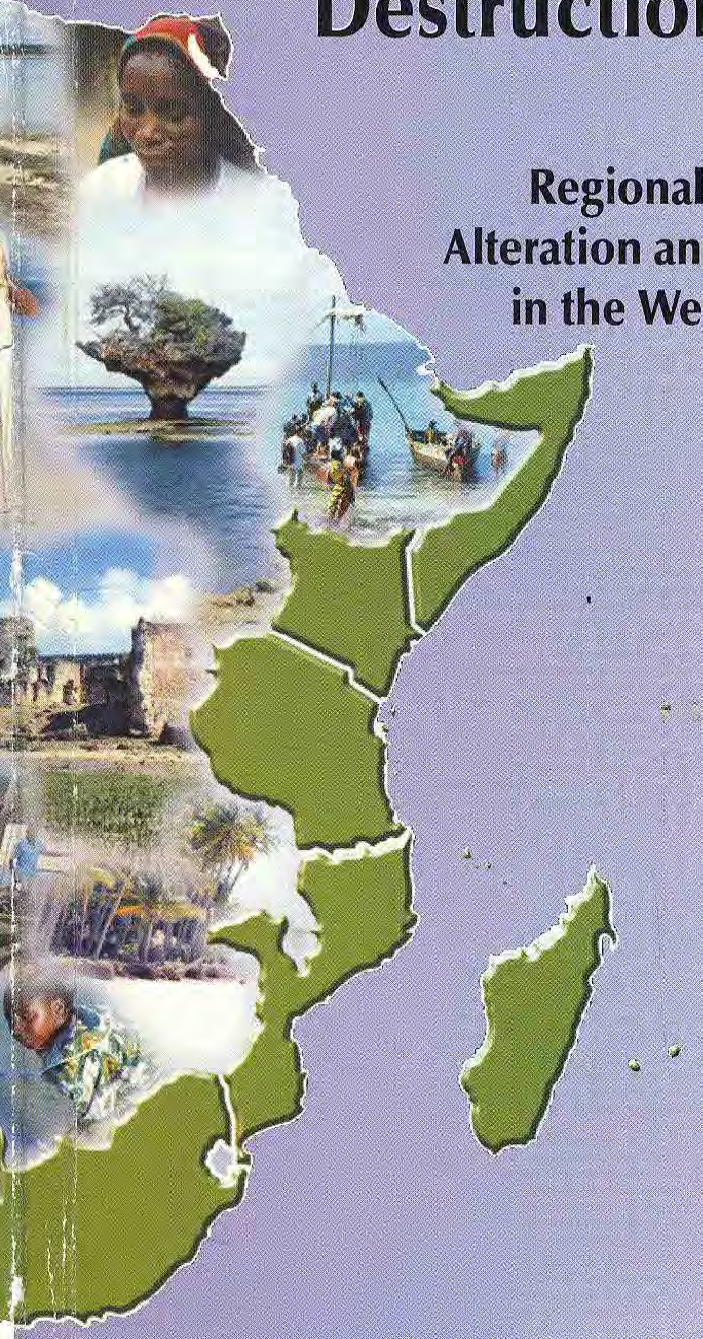
THE NAIROBI CONVENTION

Physical Alteration and Destruction of Habitats (PADH)

Regional Overview of the Physical Alteration and Habitat Destruction (PADH) in the Western Indian Ocean region



GPA Global Programme of Action for the Protection of the Marine Environment from Land-based Activities

Physical Alteration and Destruction of Habitats

WIOMSA Western Indian Ocean Marine Science Association

UNEP

GPA

WIOMSA

Nairobi Convention *UNEP/GPA Coordination Office*

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By

WESTERN INDIAN OCEAN MARINE SCIENCE ASSOCIATION (WIOMSA)

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List of Abbreviations and Acronyms

AFC	African Fishing Company
ANGAP	National Association for the Management of Protected Areas
EAF	Eastern Africa
EIA	Environmental Impact Assessment
EMCA	Environmental Management and Coordination Act (Kenya)
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
GEF	Global Environment Facility
GESAMP	The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GIWA	Global International Water Assessment Programme
GNP	Gross National Product
GOK	Government Of Kenya
GOM	Government Of Mauritius
GPA	Global Programme of Action for the protection of the Marine Environment from Land-Based Activities
IDD	International Direct Dialing
IUCN	The World Conservation Union (International Union for Conservation of Nature)
LBA	Land Based Activities
MICOA	Ministry for the Coordination of Environmental Affairs (Mozambique)
MMP	Mangrove Management Project
MSP	Medium Sized Project
NEMA	National Environment Management Authority (Kenya)
NES	National Environment Secretariat (Kenya)
ONE	National Office for Environment (Madagascar)
PADH	Physical Alteration and Habitat Destruction
SEACAM	Secretariat for Eastern African Coastal Area Management
TCMP	Tanzania Coastal Management Partnership
TCPA	Town and Country Planning Act
TShs	Tanzanian Shillings
UNEP	United Nations Environment Programme
WIO	Western Indian Ocean
WIOMSA	Western Indian Ocean Marine Science Association
WRM	World Rainforest Movement
WTO	World Tourism Organisation
WWF	World Wildlife Fund

1 BACKGROUND

The United Nations Environment Programme as the Secretariat of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) established the GPA Coordination Office in The Hague, The Netherlands after the adoption of the GPA in Washington D.C. in 1995. The role of the GPA office, in close partnership with relevant organizations, is to: coordinate promote and facilitate implementation of the tasks and activities contained in the Global Programme of Action that was adopted by 108 Governments, and the European Commission. The GPA promotes and facilitates implementation of priority activities at the national, regional and sub-regional level through, the UNEP Regional Seas Programme; and plays a catalytic role with other organizations and institutions in implementation of the GPA at the international level.

The GPA has been mandated to provide guidance and develop activities to address nine source categories of land-based sources of marine degradation. These are: wastewater/sewage; Nutrients; Persistent Organic Pollutants; Radioactive substances; Heavy metals; Sediment mobilization; Litter; Oils (Hydrocarbons); and Physical Alteration and Habitat destruction (PADH).

Physical alteration and habitat destruction is considered as the strongest reflection of the increasing population and economic activities in the coastal zone. PADH is also referred as "Habitat and Community Modification" by the Global International Water Assessment (GIWA) Programme or "Destruction and Alteration of Habitats" in other processes.

Based on its nature and effects of PADH can broadly be categorized into hinterland and coastal foreshore development (GESAMP, 2001). The effects of hinterland development involve mainly the modification of river basins by human activities resulting into changes, in terms of scale and periodicity of water, suspended sediments and nutrient fluxes. According to the GESAMP, 2001, activities contributing to the physical alteration in the coastal foreshore include: beach development and sustenance; tourist development; the dredging of nvigational channels; construction of industrial plants and infrastructure; and reclamation.

The Physical Alteration and Habitat Destruction as defined by GPA focuses on sediment mobilization effects by the four economic sectors that potentially pose a threat to such habitats. Those sectors include: tourism; ports and harbors; aquaculture; and mining (sand and aggregate extraction).

The overall PADH Project aims at supporting the efforts of stakeholders in protecting coastal and marine habitats against physical alteration and destruction. Through the project, appropriate checklists and guidance will be developed for each of the priority sectors. The project will also document and disseminate information on case studies and examples illustrating environmental, social and economic benefits of taking positive actions. Furthermore, regional stakeholder meetings will be held in South Asian, Caribbean and East African regions to develop regional and sector specific checklists as well as initiating actions such as pilot projects

2 INTRODUCTION

As a follow-up and in response to the outcome of the First Intergovernmental Review meeting of the GPA held in 2001 in Montreal, Canada, the GPA Co-ordination Office started implementation of the Physical Alteration and Destruction of Habitat (PADH) project in Eastern African region.

The first activity was the organization of the "Regional Meeting for Physical Alteration and Destruction of Habitats (PADH)" held in Nairobi, Kenya from 17-18 July 2002. The meeting was organized by UNEP/GPA in collaboration with the Secretariat of the Nairobi Convention and brought together participants from Government and non-governmental organizations, research and academic institutions, as well as private sector. The participants came from the following countries: Kenya, United Republic of Tanzania, Comoros, Mauritius, Seychelles, Madagascar, Somalia, South Africa and Mozambique. The Meeting received presentation on Physical Alteration and Destruction of Habitats in the Eastern African Region and priority issues of concern in region regarding Physical Alteration and Destruction of Habitats, were identified.

The meeting identified nine areas of concern, which included: tourism, mariculture/aquaculture, ports, mining, salt works, agriculture, urbanization and land reclamation. These were grouped into three main priority areas namely:

a) **Coastal tourism** - which include issues related to land use planning such as urbanization, siting of hotels and eco-architecture and location of tourist facilities
b) **Mangrove Destruction,** due salt works aquaculture, agriculture and mangrove harvesting
c) **Mining/ Sediment movement, Ports and Land reclamation and damming of rivers**

According to the reports prepared by the GEF-funded project on "the Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa" involving six Eastern African countries (Kenya, Mauritius, Mozambique, Seychelles, South Africa, and Tanzania) and five Western African countries (Gambia, Ghana, Ivory Coast, Nigeria, and Senegal), four issues clearly stand out, in terms of scoring. These are, in priority order:

i) Loss/modification of ecosystem (selected by all countries)
ii) Over-exploitation of resources (selected by 73% of the countries)
iii) Modification of stream flow (selected by 45% of the countries)
iv) Destructive fishing practices (selected by 27% of the countries)

Table below show the prioritization of issues by the countries of the WIO region.

Table 1: Priority issues selected by some of the WIO countries

	1	2	3
Kenya	Modification of ecosystems	Over-exploitation	Suspended solids
Mauritius	Loss/modification of ecosystem	Shoreline change	Over-exploitation
Mozambique	Modification and loss of ecosystem	Over-exploitation of fisheries resources	Destructive fishing practices
Seychelles	Modification of ecosystems	Sea level rise	Loss of ecosystem
South Africa	Over-exploitation	Modification of stream flow	Loss and modification of habitats
Tanzania	Loss/modification of ecosystem	Over-exploitation of resources	Destructive fishing practices

It is clear from the above Table that modification and loss of ecosystems is one of the main issues of concern for most of the countries. Important ecosystems/habitats are being modified and some cases completely destroyed. Mangroves are being transformed into agricultural lands and through coastal development. Unplanned and unregulated tourism, unrestricted and uncontrolled aquaculture, and mining for sand and aggregate extraction, building of ports and jetties as well as construction of coastal defences, are also contributing to the physical destruction of important habitats/ecosystems.

These observations are in line with those of GESAMP, which concluded that Physical Alteration and Habitat Destruction is now considered as one of the most important single threat to the coastal and marine environment. Poor planning and accelerating social and economic development in coastal areas, are the main driving force for the physical alteration and habitat destruction. These problems are further exacerbated by the failure to consider the economic value of environment when planning and implementing activities in the coastal and marine environment.

The physical alteration and destruction of habitats is not purely an ecological issue but also, an economic as well as social issue. Major economic sectors, particularly fisheries and tourism are directly dependent on this biological resource. Tourism is very important economic sector in terms of providing employment as well as its contribution to foreign exchange earnings for the countries such as Kenya, Mozambique, Mauritius and Seychelles. More importantly, the sustainability of the tourism industry itself depends on a healthy environment.

This regional overview report presents an assessment of:

- the importance of the three main priority areas for action (Coastal tourism; mangroves mining/sediment movement; ports and land reclamation and damming of rivers) on the social and economic well-being of the countries of the region
- national legislation (laws, regulations, decrees, standards, etc.) relevant to the three main priority areas to be addressed in the region as far as the Physical Alteration and Habitat Destruction, is concerned.
- areas that have been severely degraded due to coastal tourism; salt work; mariculture; clear cutting of coastal forests; and mining/ sediment movement, ports and land reclamation and damming of rivers

- ecosystem restoration initiatives in the WIO region, and carry out detailed case studies of selected projects/initiatives with special emphasis on the lessons learnt; challenges encountered; potential for replicability; and cost-effectiveness

The report describes the regional dimensions of the activities (Coastal tourism; mangroves mining/sediment movement; ports and land reclamation and damming of rivers) that are contributing to the physical alteration and destruction of habitats, and it examines their socio-economic and environmental implications. Some case studies highlighting specific issues of interest also examined. Specific recommendations to deal with the issues and problems identified in the report, are also proposed.

3 METHODOLOGY

This Regional Overview report on the PAHD in the WIO region is based on available primary and secondary sources of information as well as consultation with experts and members of the public and private sectors. More specifically, the report was prepared based on (Figure 1):

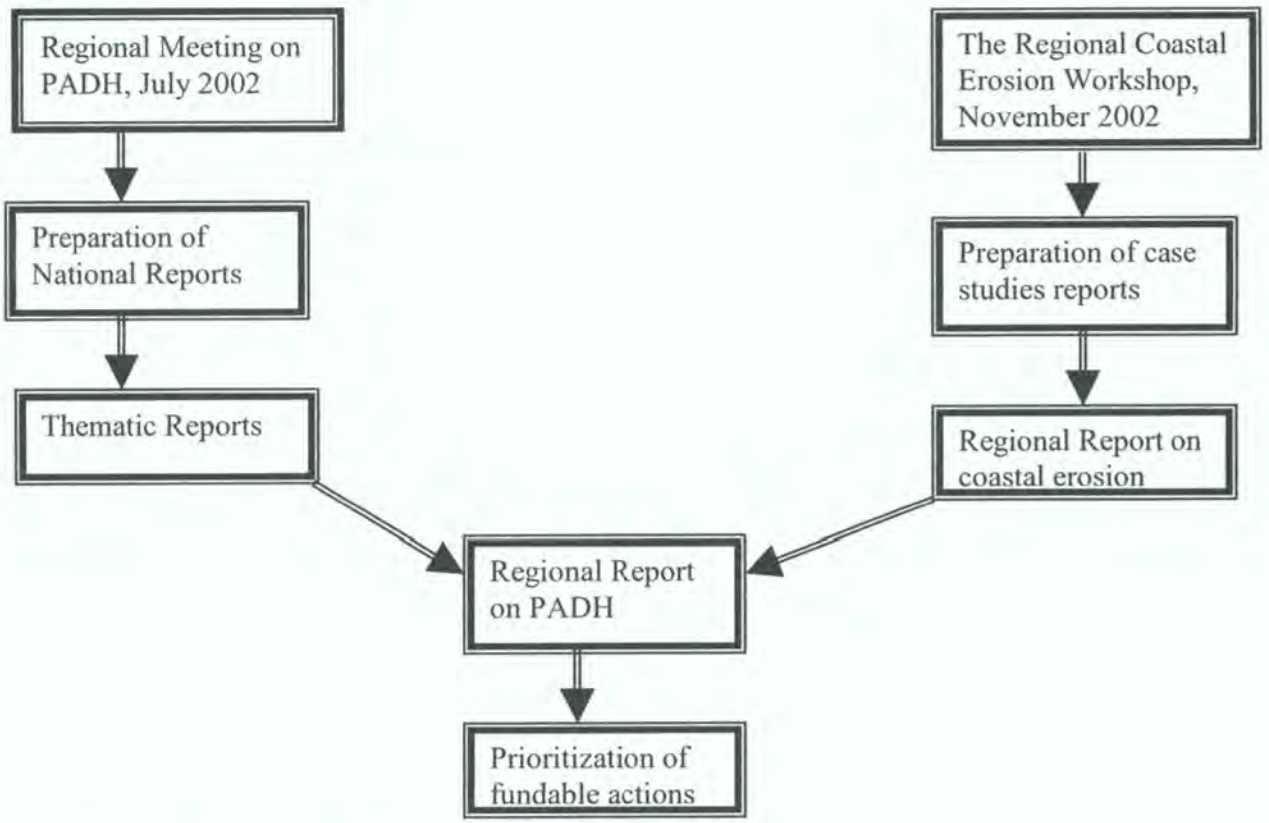

Figure 1 : The process of developing PADH Regional Report

a) National reports prepared by Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, and Tanzania

b) Thematic reports on the following themes: Analysis of legal and institutional frameworks related to PADH in the region; Review of the importance of the three main priority areas for action (Coastal tourism; mangroves mining/sediment movement; ports and land reclamation and damming of rivers) on the social and economic well-being of the countries of the region; Identification of areas that have been severely degraded due to coastal tourism; salt work; mariculture; clear cutting of coastal forests; and mining/ sediment movement, ports and land reclamation and damming of rivers) and Identification of ecosystem restoration

initiatives in the WIO region, with special emphasis on the lessons learnt; challenges encountered; potential for replicability; and cost-effectiveness

In additional, the regional report has drawn information from reports on coastal erosion compiled under a project supported by UNEP/GPA. These reports include:

a) Case studies reports for Bamburi-Shanzu and Malindi-Ungwana (Kenya); Morondava (Madagascar); Western Coast of Mauritius; Macaneta Peninsula (Mozambique); Anse Kerlan (Seychelles); and Kunduchi (Tanzania)
b) Regional Overview report in coastal erosion

Furthermore, the report is also based on the following, amongst others:

a) The Eastern African Coastal and Marine Environment Resource Database and Atlas (EAF/14) project implemented by UNEP and funded by the Government of Belgium. The Project has been implemented in Kenya, Comoros, Mozambique, Seychelles, and Tanzania.
b) National reports prepared in 2001 by Kenya, Mauritius, Mozambique, Seychelles and Tanzania, for the GEF MSP project "Development and Protection of marine and coastal environment of the Sub-Saharan Africa."
c) Reports and maps prepared under the Eastern African Marine Ecoregion Programme

In this report, it was decided to combine the "physical alteration" and "habitat destruction" since it is very difficult to separate and quantify the two. This difficulty is partly due to the insufficiency of detailed knowledge on processes and species composition in the ecosystem concerned. Also many of the human activities that lead to degradation cause both "physical alteration" and "habitat destruction", with varying degrees of impact.

The absence of consistent and systematic data of key parameters for most of the priority aspects as well as for all the countries concerned, prevented a detailed analysis of the problems facing the countries. Consequently, the report is more detailed in some aspects and countries than others.

4 REGIONAL OVERVIEW

The Western Indian Ocean (WIO) Region extends from Latitude 12^0 N to 30^0 N and Longitude 30^0 to 80^0 E. The region represents a large array of marine and coastal settings: small island states and large countries with extensive coastline and tropical and subtropical climates. The continental coastal states are Somalia, Kenya, Tanzania, Mozambique and South Africa and the island States are Mauritius, Comoros, Reunion - France, Seychelles, and Madagascar (Figure 2). These countries share not only common biological resources and climatic features but also many historical, cultural and economic ties. However, despite of these commonalities, these are at different stages of both political and economic development. These differences are reflected by the following examples:

i) Individual economic indicators from range from those with a per capita gross national product of over $ 7,000 per annum (Seychelles and Reunion), to those with less than $500 per capita (Comoros, Tanzania, and Madagascar).
ii) Economic growth rates have been uneven ranging from countries such as Mozambique which are growing well above global levels, but with many, with economic growth not keeping pace with population growth
iii) Factors as urbanisation pressures, poverty, structural adjustments problems and weak informal sector activities, are far more dominant in the mainland states, as compared to the island states, especially Mauritius and Seychelles.
iv) The island states (except Madagascar) due to their geographical size, are much more exposed as a whole to the marine environment, relative to the mainland states.
v) National institutions reflect comparable variations in strength and infrastructure as exemplified by the collapse of institutions and governance structure in Somalia and the evolution of a working government in Mozambique after several decades of strife.

Figure 2: Map of the WIO region

Some 40 million people inhabit the coastal areas of the region and so overall population density of the region is not remarkably high. However, while large areas are almost unpopulated, such as in Somalia, certain areas are indeed very densely populated with several hundred persons per square kilometer. Such densely populated areas include Mombasa, Kenya, Dar es Salaam, Tanzania, Maputo, Mozambique as well as on most of the islands.

Table 2: Socio-economic characteristics of the WIO countries

	Total population	% living within 100 km of the coast	Annual growth rate (%)	Coastline (km)	EEZ (km^2)
Comoros	571,900	100	2.5	340	228,400
Kenya	30,700,000	6	2.1	536	118,000
Madagascar	16,000,000	37	2.9	4,828	1,292,000
Mauritius	1,200,000	100	1	177	1,183,000
Mayotte	145,000	100	N/a	185	433,900
Mozambique	18,100,000	34	2.1	2,470	562,000
Reunion	728,000	100	N/a	208	598,300
Seychelles	82,416	100	1.4	491	1,374,000
Somalia	9,100,000	38	3.5	3,025	782,800
South Africa	43,200,000	-	1	2,881	1,016,700
Tanzania	34,500,000	25	2.2	1, 424	223,200

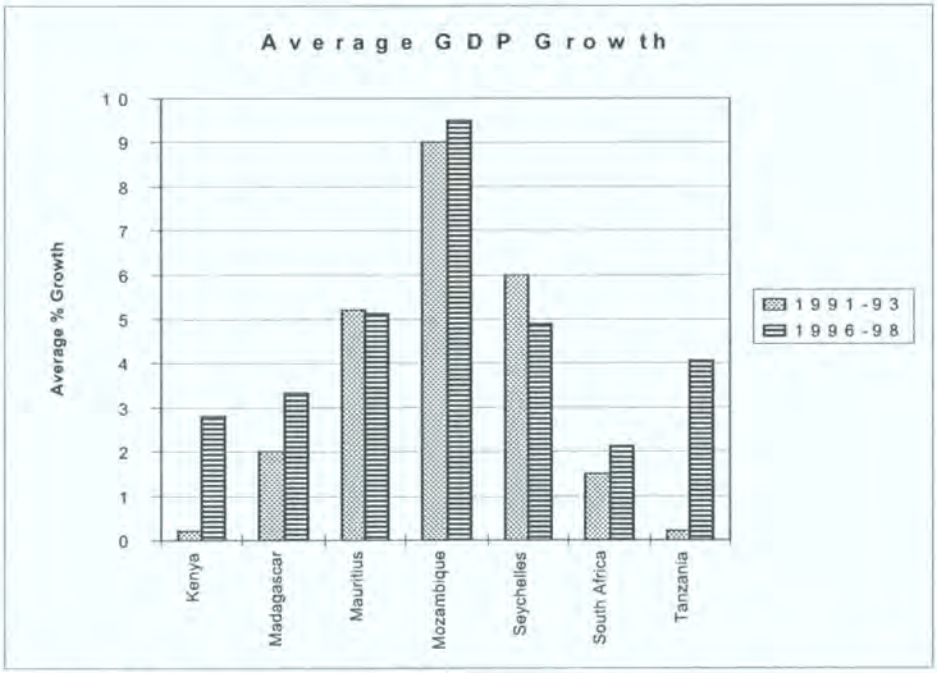

Figure 3: Gross Domestic Product Growth Rates

(*Source: http://www.newafrica.com/economy/graphs/gdp.htm (extracted from graph)*)

The coastal areas are centers of economic activities in the WIO region. It shelters internationally important ports and harbours: Mombasa, Kenya; Dar es Salaam, Tanzania; Beira and Maputo, Mozambique; and Durban and Richards Bay, South Africa. These ports handle most of the region's incoming and outward-bound ship-borne cargo.

The coast is also an important area for urbanization. In some countries significant percentage of the population live on the coast, for instance, 33% in South Africa, 41% in Mozambique and 28% in Tanzania. Major megacities are located close to the sea such as Mombasa, Maputo, or Dar es Salaam.

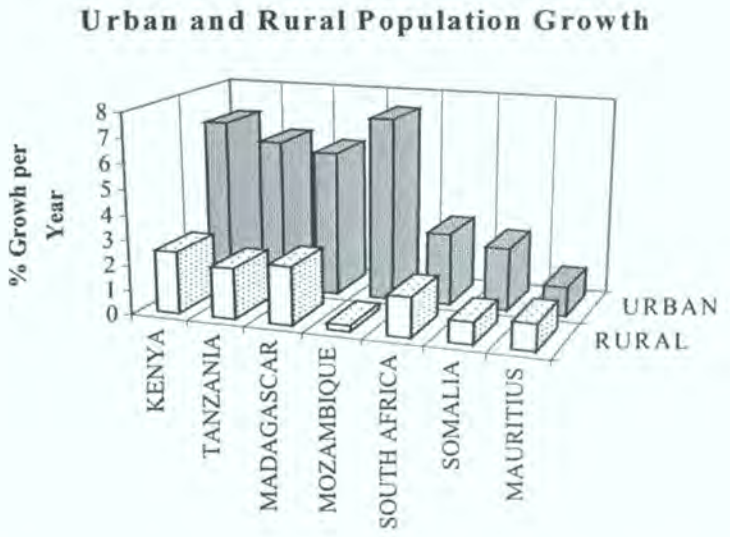

Figure 4: Relative Urban and Rural Population Growth 1990-95

(*Source: World Resources 1999-97, The Urban Environment (http://data.wri.org:1996/cgi-bin/charlotte)*)

During the last three decades, tourism industry played a significant role in the economic development of most of the countries of the WIO region. Tourism expansion has been actively pursued by national governments because of its positive effects on national income, the level of employment and diversification of the economic structure. Tourism is very important sector as a source of foreign exchange earnings for the countries of Kenya, Mauritius and Seychelles. In these countries, most of the tourism activities take place in coastal areas.

The WIO countries particularly the mainland countries are rich in mineral deposits. However most of the mining activities are activities are taking place in the inland rather than in the coastal areas. Nevertheless, coastal mining is significant in South Africa, Kenya, Mozambique and Tanzania (SEACAM, 2003). Other countries such as Comoros, Mauritius, Reunion and Seychelles, do not have significant mineral reserves or a formal mining sector (SEACAM, 2003).

Table 3: Sites of current and potential mineral exploitation and quarrying in coastal areas of Tanzania

(UNEP/DGIC/URT/UDSM, 2001)

Deposit	Location
Rock salt	Lindi
Limestone	Wazo Hill
Kaolin	Pugu Hills
Gravel	all coast
Sand	all coast
Limestone	all coast
Rutile	all coast
Solar/pan salt	Dar es Salaam /Bagamoyo /Tanga/Lindi/Mtwara
Calcite	Miono, Mkonge and Mandera (Coast)
Clay	Kisarawe
Dolomite	Mboga (Coast)
Amethyst	Tanga/Mtwara
Garnet	Tanga/Mtwara
Tourmaline, Kornerupine, Ruby, Chrisoberyl, Alexandrite, Sapphire, Turquoise	Tanga/Mtwara
Kyanite	Tanga/Mtwara
Gypsum	Tanga/Mtwara
Gold	Nachingwea
Feldspar	Tanga/Mtwara
Zircon	Tanga/Mtwara
Bauxite	Tanga/Mtwara
Graphite	Tanga/Mtwara
Rhodolite	Tanga/Mtwara
Marble	Tanga/Mtwara

Table 4: Sites of current and potential mineral exploitation and quarrying in coastal areas of Kenya, Madagascar and Mozambique

Country	Mineral	Location
Kenya	Coral limestone	Mombasa town, Bamburi-Kikambala, Tiwi
	Gypsum	Tana river and Roka
	Sand	Tiwi, Mazeras, Ngomeni
	Silica sand	Msambweni
	Shale	Nguu Tatu
	Iron ore	Jaribuni
	Pollozana	Kilifi
	Heavy mineral sands	Kwale, Vipingo, Sokoke, Mambrui and Sabaki
Madagascar	Ilmenite-bearing sands	Toalagnaro
Mozambique	Limestone	Salamanga, Buzi, Muanza and Nampula
	Heavy mineral sands	Chibuto

Given its geographic disposition, the WIO region is an area of considerable geographic, ecological and human diversity with highly productive coastal habitats and a rich biodiversity. The WIO region is considered a distinct subdivision of the tropic Indo- West Pacific, the world's largest marine biogeographic province (Sheppard, 1987; 2000). The region being at the edge of the Indo-Pacific province contributes to high level of biodiversity including more than 1500 species of fish, 200 species, of coral, 10 species of mangroves, 12 species of seagrass, 1000 species of marine algae, several hundred sponge species, 3,000 species of mollusks, 300 species of crabs, and 250 echinoderms (Richmond, 2001). The WIO region is a region of relatively high diversity in both corals (Veron, 1995) and reef fish (McAllister *et al.*, 1994), which is attributed to the occurrence of a large number of species endemic to the region or, to a lesser extent, to various parts of it such as Mauritius and Reunion. Furthermore, based on 52 tropical inshore fishes, it has been found that in term of endemism, the region accounts for 22% compared to, for example, the Red Sea (13%) and Eastern Indian Ocean (6%). Five of the world's seven turtles nest on beaches of the region and more than 20 cetacean species are found there.

Although the WIO region is still one of the least ecologically disturbed oceans relative to other region, it is in increasing jeopardy. In the recent past, coastal and marine environment have started showing signs of degradation, attributed to both natural factors (coral bleaching)(Lindén & Sporrong, 1999) and a variety of human activities, acting at different intensities and in various combinations. The rate of population and economic growth in the coastal zones of the region has resulted in increased pressure on the coastal and marine environment, as highlighted in the backgrounds documents prepared for the GEF MSP project "Development and Protection of marine and coastal environment of the Sub-Saharan Africa" and other publications. These pressures are reflected by:

- Magnitude of areas developed for hotels, housing and other development activities. In the last three decades, Bamburi – Shanzu area has seen very rapid development associated with tourism industry and housing (Figure 5a &b). In the 1980's, there were about 20 beach hotels in the area but currently there are 33 beach hotels (WIOMSA, 2003).
- Reduction in coral reef coverage. According to IUCN, (1987), most reefs throughout Tanga region, Tanzania at that time had only 20% live coral cover, while some areas had less than 10%. A more extensive survey in 1995 covering 58 reefs (Horrill *et al.*, 2000) showed that 12% of the reefs were completely destroyed, 12% in poor condition, 52% in moderate condition and 24% in good condition.
- Reduction in aerial extent of mangroves and seagrass beds. In Mozambique, the rate of mangrove loss over 18 years (between 1972 and 1990) was 3.6% of the total area of mangrove in 1972. Maputo Province shows the highest rate of deforestation with 15.2% lost of the mangrove area of 1972.
- Shoreline change. Shoreline change has affected several areas along the coast of the WIO region, causing significant social, economic and ecological impacts. These include: loss of beaches, arable and buildable land; damages to coastal property or infrastructure; and destruction of ecologically important ecosystems (WIOMSA, 2003)
- Reduction in resource availability. In some countries in the region, there is evidence indicating that the artisanal as well as the commercial fisheries have or are about to exceed the point of sustainability (Insull et al., 1995). For example, in recent years, the artisanal and industrial coastal fisheries in Tanzania have been

falling consistently. The artisanal fish landings has decreased from 54527 tons in 1990 to 32286 tons in 1994. According to Salm, (1998) sharks appear to be been over-fished in several areas, including parts of Somalia and Tanzania. Both shark and ray catches have declined significantly in Tanzania, particularly at Mafia and Songo Songo Islands. Furthermore, there is evidence that increased commercialization of octopus, sea cucumber and seashells harvest has resulted in declines of these species in a number of areas in Tanzania, Kenya and Mozambique (Salm, 1998 and WWF, 1997).

- Degradation of water quality due to the release of untreated sewage, industrial waste and agrochemicals into coastal and marine environment. Eutrophication associated with the release of inorganic nutrients (phosphate, nitrate and ammonia) into coastal waters from domestic sewage around Zanzibar has been identified as one of the main cause of the decreased cover of coral-reef-building algae (Bjork et al., 1995). Studies in the Maputo Bay, Mozambique have revealed that feacal coliforms, feacal streptococci and Escherichia coli were detected in marine water and shellfish tissues. Pathogens causing severe gastro-intestinal illness were also isolated from clams collected in different parts of the Bay (Fernandes and Hauengue, 1997).
- Increasing threats to many of the threatened, endangered and/or endemic species. Turtle populations have declined in the region probably due to loss of the nesting sites. Maziwi Island in Tanzania which was an important breeding site for the green, hawksbill and olive ridley turtles, submerged below the high spring tides in the early 1980's and is no longer suitable for nesting (Fay, 1992). In Kenya, 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).
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(a)

(b)

Figure 5 a and b: Aerial photograph of Lower Bamburi in 1964 and 2000, Scale: 1: 12,500.

5 GENERAL DESCRIPTION OF THE MAJOR ECOSYSTEMS

The coastal and marine environment of the Western Indian Ocean region contains diverse and valuable ecosystems, such as coral reefs, seagrass beds, mangroves and beaches. These ecosystems contribute significantly to the livelihood of coastal communities and the economy of the countries.

5.1 Mangroves

Mangrove ecosystems are rich in biodiversity and play a key ecological role in the coastal environment. Their extensive root systems stabilize sediments and protect coastline; they provide shelter for an array of marine animals, birds and the juveniles of commercially important fish and crustaceans as well as contributing organic matter to adjacent ecosystems.

Mangrovs grow in sheltered areas of brackish water, where freshwater mixes with seawater. These areas include estuaries, lagoons, bays, tidal creeks, and inlets. The main species found in the region are *Rhizophora mucronata, Ceriops tagal*, and *Bruguiera gymnorrhiza*. Other species include *Avicennia marina, Avicennia officionalis, Heritiera littolaris, Lumnitzera racemosa, Sonneratia alba, Xylocarpus granatum* and *Xylocarpus moluccensis*. Matthes and Kapetsky (1988) found out that the WIO region has a total of 654 species of algae, mollusks, crustaceans, echinoderms and fishes of economic importance which are associated with mangroves.

Mangrove forests occur along many stretches of the coast of east Africa, from southern Somalia to the KwaZulu-Natal coast of South Africa, and along the west coast of Madagascar. Small isolated forests are also found on the islands of Mauritius, Reunion and the Seychelles.

Table 5: Area coverage of mangroves and coral reefs by country

Country	Coral reef area (km^2)	Mangroves forest area (km^2)
Comoros	430	26
Kenya	630	530
Madagascar	2,230	3,403
Mauritius	870	< 1
Mayotte	570	10
Mozambique	1,860	925
Reunion	< 50	Na
Seychelles	1,690	29
Somalia	710	910
South Africa	< 50	11
Tanzania	3,580	1,155

5.2 Seagrass beds

Seagrass beds are important because of their interactions with other ecosystems in the marine environment, especially mangroves and coral reefs. Seagrasses form dense beds that cover large areas of coastal waters and perform a wide range of biological and physical functions. They provide breeding, nursery and feeding areas as well as shelter for many invertebrates and vertebrate species. The Green turtle *Chelonia mydas* and the dugong, *Dugong dugon* depend on seagrasses for food and other organisms such as certain species of sea urchins feed on the detritus produced by seagrasses. In Mozambique, the distribution of dugong and the green turtle are closely associated with that of seagrass beds. Moreover, seagrass roots bind sediments and slow the rate of water flow over the substrate, thus preventing erosion of the ocean sediments.

They are found in all countries of the WIO region, the most extensive beds are around the Bazaruto Archipelago in Mozambique. In Tanzania, seagrass beds are found in bays and the west side of Pemba, Unguja and Mafia Islands. In Kenya , seagrass are prominent in Mombasa, Diani and Malindi while, in Seychelles they are dominant in Platte, Coetivy and Aldabra.

5.3 Coral reefs

Coral reefs are shallow water ecosystems, which rank among the most biologically productive and diverse of all natural ecosystems. They support a diversity of marine organisms including fish, crustacea, molluscs, sponges, algae, and seagrass. Coral reefs are an important resource base for many coastal communities throughout the region. Then provide many benefits including food from reef fish, recreation for tourists and coastal protection.

In the Western Indian Ocean region, there are four types of coral reef formation. These include: the fringing reefs (occurring along the coast of Kenya, Tanzania, northern Mozambique and around many of the islands), barrier reefs (The Grande Recife of SW Madagascar and the Mahebourg Reef of SE Mauritius), atolls (Aldabra) and the patch reefs (Mauritius and the Zanzibar Channel).

According to Sheppard (1987), the total number of coral reef species recorded in different parts of the region are shown in Table 6.

Table 6: Number of coral reef species

Country	Number of species
Kenya-Tanzania coastline	112
Mozambique	149
Reunion	127
Mauritius	136
Tulear, Madagascar	113

5.4 Shorelines

Shorelines, also known as coasts, are where the land meets the sea. Shorelines are rich in flora and fauna. Most of the organisms that live on the seashores are specially adapted to survive well in this unstable environment. Shorelines are both ecologically and economically important. For example, sandy beaches are important as nesting habitats for marine turtles. They also offer recreational areas for tourists and local people alike.

The primary coastal types of the WIO region include: Exposed low-lying sandy coasts; Exposed rocky coasts; Fringing reef coasts; Patch reef coasts; and Inlets, estuaries and creeks associated with the primary coastal types (R.S. Arthurton in Kairu and Nyandwi, 2000). The component facies for each of the coastal type, their main characteristics as well as some of the areas where they found are indicated in Table 7.

Table 7: Primary coastal types of the WIO region and their component facies in relation to their resource implications and susceptibility to physical change

(based on R.S. Arthurton in Kairu and Nyandwi, 2000)

Primary coastal type	Component facies	Resource implications	Susceptibility to physical change
Exposed low-lying sandy coasts	Sand beaches including spits and delta barriers	Tourism, recreation, sand mining	Shoreface erosion / accretion
	Sand dunes	Groundwater, minerals, coastal defence	Beach head erosion / accretion, Aeolian deflation / construction, degradation by man
	Beach plains, delta plains and hinterland	Agriculture, settlement, tourism	Beach head erosion / accretion
Exposed rocky coasts	Pockets beaches	Recreation	May be ephemeral
	Rock shores / platforms		Resistant
	Rock cliffs	Coastal defence	Resistant except where soft / weathered
	Hinterland	Maybe groundwater	"
Fringing reef coasts	Forereef and reef apron	Coral reef ecosystem	Dynamite fishing, bleaching, pollution and siltation affecting coral growth, storm damage
	Reef bar	Reef ecosystem, eco-tourism & coastal defence	Tourism-related damage, sea-level rise
	Backreef lagoons	Reef ecosystem, eco-tourism	Tourism-related damage, sea-level rise
	Backreef platforms with sediment veneer	*Halimeda* thickets, seagrass meadows, seaweed culture	Sediments may be ephemeral, especially in landward parts; pollution, eutrophication
	Backreef rock platforms		Resistant to erosion
	Beach-rocks	Coastal defence	May be resistant to erosion
	Sand beaches	Tourism, recreation, sand mining	Shoreface erosion and accretion

	Sand dunes	Coastal defence, groundwater	Beach-head erosion and accretion, aeolian deflation and accretion/construction
	Beach plains	Agriculture, settlements, tourism	Beach-head erosion and accretion
	Rock cliffs	Coastal defence	Resistant except where soft or weathered
	Hinterland, limestone terraces	Groundwater, tourism infrastructure	"
Patch reef coasts	Offshore patch reefs	Coral reef ecosystem	Dynamite fishing, bleaching, pollution
	Intertidal flats (sediments)	Mangrove stands, seagrass meadows	Sediments may be ephemeral, erosion exacerbated by mangrove clear felling
	Rock platforms		Resistant
	Beach rocks	Coastal defence	May be resistant
	Sand beaches including spits	Tourism, recreation, sand mining	Shoreface erosion / accretion
	Beach plains, delta plains	Agriculture, settlements, tourism	Beach head erosion / accretion
	Rock cliffs	Coastal defence	Resistant except where soft or weathered
	Hinterland, reef limestone terraces	Groundwater, tourism, infrastructure	"
Inlets, estuaries and creeks (associated with primary coastal types)	Swamps and marshes	Mangroves stands	Erosion exacerbated by clear felling
	Channels, tidal inlets	Ports, industry, urban development, aquaculture	Possible lateral channel migration
	Rock platforms		Resistant
	Rock cliffs	Coastal defence	Resistant except where soft or weathered
	Older beach plains and dunes	Agriculture, mineral, groundwater	Erosion due to channel migration

6 REGIONAL DIMENSIONS OF PHYSICAL ALTERATION AND DESTRUCTION OF HABITATS (PADH)

6.1 Coastal Tourism

6.1.1 General Overview

Tourism is one of the leading economic sectors in most of the countries in the WIO, providing employment, foreign exchange and international recognition. Western Indian Ocean region has much to offer in terms many excellent natural and cultural resources that have the potential to serve as world-class tourist attractions. The beauty of its beaches, favourable climate, the unique biological and cultural diversity, has made the Western Indian Ocean region an increasingly popular tourist destination. The WIO region experiences relatively calm conditions throughout much of the year, with monsoons and storms somewhat restricted seasonally.

According to the World Tourism Organisation (WTO) international tourist arrivals to Africa as a whole grew at an average annual rate of 6.2% between 1990 and 1995, with above average increases recorded in the Southern African sub-region (24.2%) and Eastern Africa (10.8%), and it is anticipated that arrivals will continue to increase at an average annual rate of 5.5% per year until 2020. In the Southern Africa and Eastern African sub-regions growth rates are estimated at 7.5% and 5.2% respectively, while Africa's share of global tourist arrivals will rise from 3.6% in 1995 to 5.0% over the same period. It is estimated that total international tourist arrivals to Sub-Saharan Africa, including the Indian Ocean, will increase from about 27 million in 2000 to 47 million in 2010 and to 77 million by the year 2020, with Southern and Eastern Africa (including the Indian Ocean islands experiencing the fastest growth rates.

It is estimated that this region receives more than 2 million visitors annually, with annual arrivals ranging between some 24,000 in Comoros to 940,000 in Kenya in 1999. Kenya leads the region, both in terms of the number of tourists and the revenue generated. However, much of this tourism is centred on the inland wildlife parks, rather than the coastal zone. In the Seychelles, coastal tourism is the mainstay of the economy, accounting for 18.5% of the GDP, as well as 70% of foreign-exchange earnings and nearly 20% of employment.

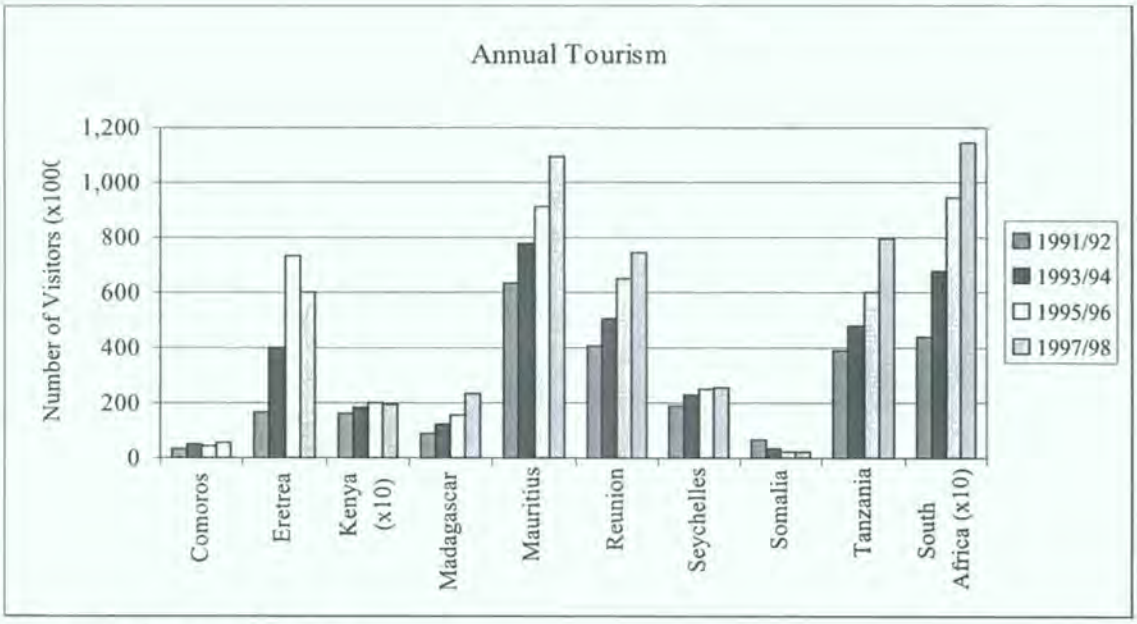

Figure 6: Regional Tourism

(*Source: World Tourism Organization (WTO)*)

6.1.2 Socio-economic importance

Tourism is the most important pillar of the most of the countries in the WIO region economy through direct and indirect contributions to the domestic economy (GDP), and through inflows of foreign currency, including tourism receipts and foreign direct investment.

Comoros

The Comores Archipelago comprises of four islands namely Grande Comores, Anjouan, Moheli, and Mayotte. The latter is still under French Administration.

Tourism industry is still not well developed and this is attributed largely to the political instability. The areas most frequented by tourists are the beaches of northern part of the Grande Comores, the beaches of Chomoni, Bouni, the salt lake, and turtle island on the Grande Comores. They also visits to turtle beaches of Moheli and beaches of Mutsamudu and Moya on Anjouan.

About 27 000 tourists visited Comores in 1994, however the following year the number decreased to 23 000 due to political instability. The tourism industry is contributing about 9.1 % of the GNP and employs about 500 people in direct and indirect activities.

Kenya

Kenya has a well-developed tourism sector. The main tourist attractions are the rich, natural resource endowment, comprising long sandy beaches; varied scenery; warm climate and impressive wildlife in and outside the National Parks.

In early 1990's approximately 800, 000 tourists visited Kenya. Before the slump in 1998, tourism was a leading foreign exchange earner in the country. The industry supported 560,000 people in both formal and informal sector and accounted for 18% of all Kenya's export and foreign currency earning. The coastal tourism industry accounts for 60% of earnings from tourism and employs thousands of coastal dwellers.

To meet the demand for tourist accommodations, the hotel industry in the coastal areas has grown tremendously in the 1980's and 1990's particularly in the Diani Beach, Mombasa North Coast and Malindi.

Madagascar

Although tourism industry is in its infancy, it is the country's second-largest source of foreign currency revenues, and is growing at 18% per year. There is a huge potential for growth in tourism, since the country has a lot to offer in terms of its nature- and culture-based tourism. Madagascar has many endemic plants and animals and interesting cultures.

Some of the popular centers include: Ampasilava, Anakao, Ifaty, Île Sainte Marie, and Nosy Be. Annually, Madagascar receives over 80 000 tourists and tourism account about 2% of the GNP

The tourism industry in Madagascar is highly dependent upon coastal attractions, generating a revenue amounting to over 91 million US$ in 1998 (Min. Tourisme, 1999).

Mauritius

Mauritius, which is based on "sun, sea and sand" for its development and success, is a well-established tourism destination with good infrastructure and a variety of accommodation and services offered to tourists.

During the 1980's and 1990's, the tourism industry has emerged as the fastest growing sector and established itself as the third major industry in Mauritius. According to the GOM, (2002), the number of tourists visiting Mauritius increased from 291,550 in 1991 to 660,300 in 2001. The contribution of tourism increased from 3% to GDP in 1995 to 13% in 2001. The total direct employment in the tourism industry has more than double from 1990 to 2001, increasing from about 9,000 to 20,000. The number of hotels increased from 75 in 1990 to 93 in 2000, while room capacity rose from 4603 in 1990 to 8000 in 2000, and was expected to rise by another 7% during 2001.

Mozambique

The coast of Mozambique has many excellent natural and cultural resources that have the potential to serve as world-class tourist attractions. In general, however, this potential has gone unrealized. Before the independency of Mozambique in 1975, Mozambique had a thriving tourism industry, mainly in the centre and south of the country, with most of the tourists coming from (the former) Rhodesia and South Africa.

Coastal tourism is well developed in the southern part of the country, particularly south of Save River. This region is characterized by beautiful sand beaches and extensive corals.

After the civil war ended in 1992, tourism has re-emerged and is now one of the fastest-recovering sectors of the economy, with most tourists still coming from South Africa. The most popular areas include: the Porta do Ouro – Machungulo Peninsula – Inhaca Island coastline, the Macaneta Peninsula, the Bilene – Xai-Xai – Chonguene coastline, the Inhambane coastaline, and the Bazaruto Archipelago.

Tourist arrivals increased from 136,000 in 1994 to about 550,000 in 1998. In 2000 there were 157 hotel establishments with 2,978 rooms and 5,382 beds.

Table 8: Infrastructures for Accommodation (1994 – 2002)

(In 1975 the number of Infrastructures for Accommodation was 285)

Infrastructure Category	1994	1995	1996	1997	1998	1999	2000	2002
Luxury	2	2	2	2	5	5	6	10
1st Class	9	11	13	19	22	22	25	35
Economic	12	19	22	23	27	28	34	40
Other Categories	113	131	134	133	133	137	226	264
Total	136	163	172	177	187	192	285	339

Table 9: Bed Supply by Category (1994 – 2002)

(for comparison purpose, in 1975 the number of beds was 8185)

Hotels Category	1994	1995	1996	1997	1998	1999	2000	2002
Luxury	593	593	593	593	1368	1368	1458	1877
1st Class	528	528	557	624	972	1370	1508	2252
Economic	1031	1563	1731	1613	2006	2152	1953	2036
Other Categories	4621	4726	4820	4316	4324	4379	5660	6127
Total	6773	7439	7768	7494	9068	9289	10527	12215

Seychelles

The Republic of Seychelles comprises of 115 islands, although the bulk of the population, infrastructure and development is located on the main island of Mahe. Tourism is also concentrated mainly in the Mahe Island and surrounding granitic islands.

The economy of Seychelles is largely dependent on tourism and fisheries. Tourism emerged in the 1980s as the most important economic sector in Seychelles. As in most of the tropical islands states, tourism industry in Seychelles is solely based on beach tourism. In 1971, the number of visitors was about 3000 and since then tourist arrivals grew to around 50,000 per year in the early 1980s, to a peak of 130,046 in 1996. While arrivals declined slightly between 1996 and 1999, they recovered to 130,046 in 2000.

In 2000, 130 000 tourists generated US$112 million in 2000, corresponding to 20 per cent of GDP and 60 per cent of foreign exchange earnings (Shah 2002). Tourism industry provided approximately 5,000 direct jobs or about 17% of total employment.

Tanzania

Tanzania's coastal region is endowed with historical attractions such as historical buildings ruins and monuments, particularly in Zanzibar, Kilwa and Bagamoyo; cultural attractions mainly related to people's values, customs and traditions; and natural scenery such as beaches of Bagamoyo and Zanzibar, Jozeni rain forest, coral reefs of Zanzibar, Pemba and Mafia; and Amboni Caves.

Tourism development in Tanzania is primarily concentrated in the northern wildlife areas such as Serengeti, Ngorongoro crater and Lake Manyara. Over 80% of the tourists coming to Tanzania visit the northern wildlife areas while less than 10% visits the coastal areas.

The number of tourists visiting Tanzania Mainland has increased from 103 361 in 1986 when the Government introduced reforms which allowed tour operators to retain half of their exchange income for reinvestments, to over 564,000 in 1999, before decreasing to 459,000 in 2000. Tourism industry in Tanzania is a major source of foreign exchange, accounting for about 16% of national GDP, and nearly 25% of the total export earnings. The value of foreign currency earning grew from US$ 65 million in 1990 to US$ 725 million in 2001.

6.1.3 Environmental impacts

Though tourism brings with it major economic gains as shown by its contribution to the GDP for the countries, tourism has been identified as one of the sectors impacting on the marine and coastal environment in a number of countries, and especially those where coastal tourism is significant, such as Kenya, Mauritius and Seychelles.

There are a number of ways in which tourism-related activities impact coastal and marine environment:

- **Change in land-use pattern.** Tourism's competition with traditional activities for scarce natural resources, such as land, fresh water, timber or marine edible species, is the main contributing factor to the negative impacts of the industry as evident in many parts of the region. Tourism-related changes of the environment include land conversion for infrastructure development (ports, roads and accommodation establishments); and physical degradation of reefs through jetty construction. Others include: dredging and reclamation; and disturbance to wildlife such as nesting turtles and seabirds leading to higher mortality and decreased fecundity.
- **Demand created by the tourism industry.** The tourism industry contribute to the overexploitation of marine species to meet increased demand of seafood; deforestation of mangroves for construction materials; and buying and collecting reef species as souvenirs.
- **Modification works to "improve" coastal and marine environment for tourists.** A number of modification works have been undertaken in Mauritius with the intention to create conducive environment for tourists. These works included: removal of beach rock and coral debris in lagoons to create swimming areas for tourists; dredging to deepen lagoons for ski and boat lanes and blasting of coral reef to create a safe boat passage (Table 10)

- **Recreational activities.** The increasing number of tourists lead to an increase in demand for recreational activities, which involve beaching, swimming, snorkeling, diving, and the use of fast boats (skiing), small sailing boats, glass bottom boats, wind surf and water taxis as well as large catamarans. Individually or in combination these activities caused damage to seagrass and coral communities through mainly the use of crude and inefficient anchors as well as trampling
- **Poor planning.** Tourism infrastructures are commonly built on sand dunes and even down to the high water mark level on the shore and by doing so interrupting with the natural sedimentary cycle and therefore causing erosion. Inappropriate coastal defence schemes particularly for hotels are also contributing to shoreline change problems experienced in many places in the region.
- **Pollution.** Most of the hotels have inadequate or non-existent waste disposal facilities and infrastructure, such as sewage treatment and/or sewerage facilities and therefore discharging untreated sewage directly into the coastal environment

Here are some of the examples of the impacts that could be attributed to the tourism industry:

- **Clearing and degradation of coastal vegetation.** Coastal vegetation such as mangroves are prone to degradation and removal from a multitude of developmental and exploitative activities. At the Makonde Beach and Resort in Mtwara, Tanzania, for the purpose of getting a better view of the ocean, the Hotel management cleared the mangrove forest behind the hotel. Ever since, the Hotel is seriously threatened by erosion and the seawall built is proving to be ineffective (Francis, et. al., 1997).
- **Loss of seagrass beds.** Their location in shallow waters close to the shoreline renders seagrasses very susceptible to activities related to unplanned and unmanaged urban, tourism and fishing activities. In Mauritius, hotels have been removing seagrasses in the belief that they are unsightly and harbour organisms causing injury to bathers (Daby, 2003). In Flic en Flac, Grand Baie and Belle Mare/Palmar regions, hotels have cleared the sea grasses in the lagoon to create bathing areas and ski lanes impacting on the sea floor causing loss of habitats and floor stability (Ramessur, 1991 and Daby 2003).
- **Destruction of Coral Reefs.** Coral reefs throughout the region are being destroyed by a variety of coastal developments and as a direct result of human activities. 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. In relation to tourism in Kenya, most coral reef decline has occurred in the popular tourists' destinations of the Diani Reefs and in the Mida Malindi tourist paradise area of Watamu. In Mozambique, reef damage has taken place in the south of the country where tourist activities are growing. In both Mauritius and Seychelles, the popular tourist diving sites are suffering from overuse by tourists. As a result of tourism activities, coral cover is reported to have diminished through trampling, damages by boats, clearing for ski-lanes etc. resulting in changes in the biota, decline in fish catch and the proliferation of unwanted marine organisms. The reduction of coral cover In Mauritius has been associated with the proliferation of the sea urchins. The problem was so acute in some areas of Flic en Flac that hotels had to resort to manual removal of these sea

urchins in front of their premises (Prayag et al, 1995). In Grand Baie, Mauritius, the lagoon floor is littered with coral rubble, mostly caused by boat anchors.

- **Shoreline modification.** Construction of hotels and residential housing has transformed the natural setting of the shoreline of most of the coastal areas in the region. The beaches and dunal complexes have been mostly affected, these have had to be levelled off and the surrounding of hotel complexes modified considerably. This transformation has modified the existing habitats/ecosystem and consequently affected the existing biota. In Coastal Plateau of La Digue, Seychelles, loss of habitat has occurred mainly as a result of land-use conversion (housing and tourism development), which affects woodland and sandy foreshore habitats.
- The development of hotels along beaches is also another reason for the declination of nesting sites. In the east coast of Unguja island, Zanzibar, there are more than 20 hotels compared to none in 1988 and most of these have been built within the areas that have been used by turtles for nesting (Khatib, 1995). Car driving leads to physical damage(destruction of the substrate and sandy coverage) as well as posing a major threat to the turtle nesting sites on the eastern coast of southern Mozambique (Bandeira, 1995)

Table 10: Examples of modification works undertaken by some large hotels in Mauritius (Daby, 2003)

Name of Hotel	Purpose	Works Undertaken
Le Cannoniers	Creation of an artificial beach and a swimming zone for tourists	Removal of beach rock and coral debris in lagoon
Victoria	Creation of an artificial beach and adequate lagoon depth for boating and water skiing activities	Removal of beach rock and lagoon coral colonies; seafloor dredging for ski lane, boating and swimming
La Plantation	Creation of adequate lagoon depth for boating and water skiing activities	Removal of coral colonies and seafloor dredging to deepen passages for boat movement
Radisson	Shore landscaping; creation of a swimming zone for tourists	Removal of beach rock and clearing of corals, coral debris and seagrass in lagoon, artificial beach
La Pirogue	Creation of a safe boat passage for hotel clients	Widening and deepening of gap by blasting coral reef
Sugar Beach	Creation of a swimming zone for tourists	Clearing of seagrass beds and coral heads, removal of basaltic boulders and coral rubble
Mauriplage	Protection of shoreline and beach and creation of a swimming zone for tourists	Clearing of lagoon rocks, seagrass and coral colonies; erection of artificial wave breakers, artificial beach
Berjaya	Shoreline protection and artificial beach	Removal of beach rock and construction of seawall, lagoon seabed clearing for swimming
Chandrani	Shore landscaping, creation of a swimming zone for tourists and a ski lane	Removal of beach rock; clearing of lagoon seagrass beds, coral heads and coral rubble; dredging to deepen lagoon for ski lane,

		artificial beach
Le Touessrok	Shore landscaping, creation of a swimming zone for tourists and boat and ski lanes	Removal of beach rock; clearing of lagoon seagrass beds, coral heads and coral rubble; dredging to deepen lagoon for ski lane and boat lanes

6.1.4 Legal and institutional frameworks

Legislation and institutions relating to tourism in most of the WIO countries is fairly sparse. Most of the countries' commitments to tourism as a sector are apparently located in policy rather than legislative instruments. The most relevant laws and institutions on tourism, from a PADH perspective are those concerned with land tenure, land use and planning. For example, in Kenya the laws include the Land Planning Act (Cap 303); the Land Control Act (Cap 302); the Land Acquisition Act (Cap 295); and those laws which define the maritime zones for purposes of jurisdiction and resources access and exploitation (for example the Maritime Zones Act. No. 60 of 1989 (Cap 371).

In Kenya, the laws which are exclusively "tourist" in nature include the Tourist Industry Licensing Act (Cap 381) and the Kenya Tourist Development Corporation Act Cap 382. There is no " Tourism Act" or legislation that deals with the substantive issues in the entire tourism sector as such. However, the latter two legislations establish important institutions for the development and regulation of tourism in Kenya.

In Tanzania, land use and planning legislation does not also directly deal with tourism, except to the extent that tourism infrastructure and developments including those at the coastal and marine environments, is subjected to land use and planning legislation. The same position obtains in South Africa, Mozambique, Seychelles, Mauritius, Comoros and Madagascar. However, in terms of the requirement for EIA the framework legislations in virtually all the project countries oblige tourist establishments' developers to seek and obtain EIA authorization to keep the integrity of the environment. The general disposition in each of the project countries is that tourism is an important socio-economic activity, and therefore developments in this sector are generally very welcome. Policy, institutions and some legislation tends towards encouraging development and expansion of tourist activities and infrastructure. This may mean, at least from a legal point of view that legislation or the responsible institutions would not become very eager to discourage developments though harsh penalties or controls. This explains relatively relaxed penalties and sanctions, as well as enforcement regimes for the tourism sector.

None of the project countries prohibits tourist developments along its coastal and marine environment. As long as government authorization procedures are adhered to, including the requirement for EIA where these are prescribed, and commercial licensing, tourist establishments operate in virtually all the coastal zones of all the project countries.

In Seychelles, for example, the only piece of legislation that makes specific mention of tourism is the EIA regulations. Unfortunately, the rules have been shown to be weak and defective when it comes to regulating coastal tourism. However, the framework environmental legislation, the EPA maintains high standards, particularly effluent standards when physical developments have already occurred.

Most of the national legislations relevant to tourism are administered by central government or departments directly controlled by Government. Land use and planning legislation as well as tenure systems especially in the land ward side of the maritime zones are predominantly public. However, there are many private land holdings (mainly on long lease) on the beachfronts. The government institutional structure governing land use and planning may be too rigid or even too lax as to be ineffective.

Effective enforcement of land-use and planning standards necessarily requires a large outlay of policing machinery or else a system of voluntary compliance based on incentives. Tourist establishments could be persuaded to regard the environmental integrity of the coastal and marine areas as their primary responsibility.

6.1.5 Case studies

Case study1: Effects of seagrass bed removal for tourism purposes

Background

This case study is based on the information provided in the article by Daby (2003). The article reports the results of a study conducted to assess the ecological effects of seagrass bed removal to create swimming zones for tourists in front of major hotels.

There is stiff competition for tourists among hotels owners in Mauritius which have led them to undertake a number of modifications in the areas adjacent to the facilities with the intention of creating an "attractive" environment for their tourists. Modifications undertaken include: shore modification and landscaping; lagoon seabed clearing and dredging and coral reef blasting (Table 10). Furthermore, the hotels owners believe that seagrasses are unattractive and harbour organisms causing injury to their visitors and therefore have been removing them from areas in front of their facilities.

Lagoons are one of the main geomorphologic features of Mauritius. Lagoon morphology varies from single lagoons consisting of a sandy beach and a reef zone, to complex system comprising of a variety of habitats: beaches, mangroves and sand or mud swamps, lagoon channels, seagrass beds, coral heads and colonies, sand beds and a reef zone. Seagrasses, which cover about 30 km2 of the Maurtian lagoon, often grow close to beaches and help to stabilize sediments and provide nursery grounds for reef species.

The most abundant species in Mauritian lagoons is *Syringodium isoetifolium* followed by others such as *Thalassodendron ciliatum, Halophila ovalis, Halophila stipulaces, Halophila decipiens, Halodule uninervis, and Cymodoces serrulata.* They normally found as extensive beds of mixed species and monospecific stands constituting natural habitats for a diverse group of organisms in the same lagoon

Study site

The study site chosen for the research was an areas in front of the Club Mediterranee in the northern part of Mon Choisy Bay. The main aim of the study was to examine the environmental changes resulting from clearing of seagrass bed to create a swimming zone for hotel clients. Changes in sediments characteristics, water quality, infauna distribution, and regrowth of seagrass were monitored for a period of one year after the clearing and compared with conditions prevailing in an adjacent undisturbed area (control). The two areas are separated by a 100 m long jetty

Results

Key results from the disturbed area were:

- Highly turbid water overlying a destabilized lagoon seabed
- Complete loss of sediment infauna
- Significant declines in dry weight biomass of *Syringodium isoetifolium* (72%) and *Halodule uninervis* (65%)

6.2 Mangrove (in relation to activities such as salt works, aquaculture, agriculture and mangrove harvesting)

6.2.1 General Overview

Mangroves are associated with coastal wetlands and contribute significantly to the functioning of coastal ecosystems. Mangroves are salt-tolerant forests or swamp ecosystems that occur along tropical and sub-tropical coastlines, usually in sheltered bays and around river mouths. Globally, about 75% of low-lying tropical coastlines receive freshwater drainage and support mangrove systems (Wang et al 2003). Through the action of its roots, a mangrove forest recycles nutrients and traps land-based debris, sediments, and suspended particulate matter carried to the coast by rivers. The forests and the roots secure the land, preventing shoreline erosion. Thus, mangroves build land through the accumulation of silt and detritus. A mangrove coastal barrier may be battered and damaged in severe storms but it grows back naturally.

Mangroves are also important for the health and water quality of near-shore ecosystems such as seagrass beds and coral reefs that develop best in clear waters. Mangroves protect coral reefs by reducing siltation as they trap the sediment washed down from upland waters.

Mangrove forests also function as irreplaceable feeding and nursery grounds for many ecologically and economically valuable fish and shellfish species including prawns and crabs. Tree biodiversity in mangrove sites is low because few tree species can withstand high salinity, anaerobic sediments, acidic soils, and unstable substrates.

Overview of the situation of mangroves in the western Indian Ocean countries in the context of PADH is presented in the following paragraphs.

Mauritius

Mangroves covered a large part of the coastline of Mauritius in the past, but its area has decreased markedly with the development over the last three decades (Bhikajee and Bhagwant, 2003). The mangrove strips are relatively narrow and appear to have been impacted since long by the construction of coastal roads. According to the authors, mangroves are now to be found only at the mouth of rivers and estuaries such as Riviere Noire, Baie du Cap, Trou D'eau Douce, Poste Lafayette, Bras D'eau and Poudre D'or.

In the 1992 report on the *State of the Environment in Mauritius*, disappearance of mangroves and sedimentation were identified as major environmental problems in the marine environment. Although mangrove destruction is presently not a major issue in Mauritius, a replanting programme is in progress in the areas where mangroves were thriving in the past. Also Clause 6 of The Fisheries and Marine Resources Act of 1998 mentions that "No person shall cut, remove, damage or exploit a mangrove plant or part of a mangrove plant…"

Kenya

In Kenya, highly productive mangrove swamps have colonised most of the estuaries and creeks, except the Sabaki estuary where heavy siltation has prevented this. Mangrove swamps along the Kenyan coast cover a total estimated area of 52,980 ha (UNEP, 1998), with largest stand (area 34,500 ha) found in the Lamu-Kiunga area (UNEP 1998, WWF 2001), followed by the Vanga-Funzi system (6,980 ha) in the south, and Tana River delta system (4180 ha). The mangrove swamps, sea-grass lagoons and coral reefs form an inter-linked ecosystem of great ecological and socio-economic importance to the coastal area.

Eight species of mangrove trees and shrubs are found along the Kenya coast of which *Rhizophora mucronata* and *Avicenia marina* are the most common.

Rich in productivity and biodiversity as a habitat, mangrove forests in Kenya provide sanctuary to a variety of terrestrial fauna, which include many bird species, large and small mammals (monkeys, pigs, hippos, buffalo), crocodiles and other reptiles. The Tana River delta and Mida creek mangrove systems (part of the Watamu-Malindi marine protected area) exemplify this.

Seychelles

It was reported in 1772 that mangroves fringed the east coast of Mahe so thickly that it was difficult to find passages though them to get to shore (Payet, 2003). However, after more than 200 years of human intervention less extensive mangrove areas now exist in the granitic islands of the Seychelles, although some significant stands remain on the outer coral islands. For example, the Aldabra atoll has about 800 ha of interesting mangrove areas and Cosmoledo atoll about 100 ha, in contrast to only about 20 ha for the Port Glaud mangrove area on the granitic island of Mahe.

In the best-developed mangrove forests are located behind beach ridges near open stream mouths. On the Western coast of Mahe, a last continuous mangrove belt exists between Port Launay and Port Glaud, with other areas significantly destroyed. On the East Coast of Mahe, five species of mangroves have re-colonised the area created by the East Coast Reclamation project. On Praslin, only small, isolated mangrove swamps have survived near river mouths at Grand Anse, Anse Takamaka and Anse Lazio. The areas along the southeastern coast, which originally were much more extensive, have been destroyed. On Curieuse Island, a well-developed, intact and extensive mangrove swamp is located around the Turtle Pond lagoon. Some modified mangrove areas also exist near La Passe and Grand Barbe on Silhouette Island.

Mangrove species found in Seychelles are typical of the Western Indo-Pacific region, with *Rhizophora mucronata* or Avicennia *marina* being the common pioneer species on the seaward side (Stevenson *et al.,* 1997). Also present are *Sonneratia alba*, *Bruguiera gymnorhiza* and *Ceriops tagal*. In small areas with considerable freshwater discharge *Lumnitzera racemosa* is dominant, and there are occasional large trees of *Xylocarpus granatum*. There are no endemic plant species in the mangal. The mangrove forests support a wide range of marine invertebrates, as well as fish, birds, amphibians and reptiles. Spiders and insects are other species that utilise mangroves in the Seychelles.

Tanzania

Along the 800 km Tanzanian coast, mangroves occur on gently sloping shores, and around river estuaries, creeks, and bays. The Rufiji River delta, which contains nearly half of the mangrove area in Tanzania, has about 50,000 hectares of mangroves and is the largest single mangrove forest in the eastern African region (Wang et al 2003).

Mangrove forests in Tanzania occupy about 225,000 ha which is about 0.3% of the forest cover in the country (Mariki, 2000). Of these, the Rufiji Delta, located about 150 km south of Dar es Salaam, contains the largest continuous block of mangrove forest in East Africa, comprising some 53,000 hectares. This delta also supports the most important fishery in Tanzania's coastline, accounting for about 80% of all shrimp catches in the country. The Delta is home to about 41,000 people, many of whom are small farmers and traditional fishers.

Nine mangrove tree species are found in Tanzania (Table 11). Of these, *Avicennia marina, Rhizophora mu-cronata*, and *Ceriops tagal* are predominant, while *Xylocarpus mulleccensis* is rare (Semesi and Adelaida 2000). All mangrove forests in Tanzania are gazetted as forest reserves. Conservation and management of these forests are guided by forest policy and ordinances of the Tanzania government.

Recognizing their value, the government of Tanzania initiated a Mangrove Management Project (MMP) in 1988. The actual implementation of the MMP started in 1994. MMP is designed to benefit coastal communities that directly rely on mangroves for their livelihood. The project emphasizes mangrove conservation and sustainable utilization.

Madagascar

Mangrove forests in Madagascar cover an area of 327,000 hectares, accompanied by an extremely diverse fauna. In Madagascar, mangroves are exploited mainly at the artisanal level; however, there is large-scale destruction of mangrove to make room for industrial shrimp farming (Andrianarivo 2003).

Comoros

Mangroves may be found on three of the four islands of the Comoros archipelago, namely La Grande Comore, l'île d'Anjouan and l'île de Mohéli. (Ali Abdallah 2003). On the Anjouan island where mangroves are most developed, it has resulted in the creation of a marine protected area around Bimbini.

Table 11: Mangrove Species found in the Western Indian Ocean Region

Family	Species	Mauritius	Kenya	Seychelles	Tanzania	Madagascar	Comoros	Mozambique
Verbenaceae	*Avicennia marina*		v	v	v			
Rhizophoraceae	*Bruguiera gymnorrhiza*	v	v	v	v			
	Ceriops tagal		v	v	v			
	Rhizophora mucronata	v	v	v	v			
Sterculiaceae	*Heritiera littoralis*		v		v			
Combretaceae	*Lumnitzera racemosa*		v	v	v			
Sonneratiaceae	*Sonneratia alba*		v	v	v			
Meliaceae	*Xylocarpus granatum*		v	v	v			
	Xylocarpus molluccensis				v			

6.2.2 General issues of mangrove destruction in relation to tourism in the WIO region

Mauritius

The rapid development of tourism in Mauritius has led to several unplanned facilities and infrastructure. For example, the construction of tourist hotels in the Grand bay in the north-west area of the island triggered the setting up of restaurants, shopping facilities, discotheques and private apartments for rent. Land being limited in that zone, marginal low-lying swamps increased in value. Between 1975 and 2002, 66 % of the wetlands were filled to accommodate private bungalows, tourist facilities and a government conference centre (Bhikajee and Bhagwant, 2003).

The direct impact of the tourism industry on coastal resources may be categorized as follows:

- Increased demand for building materials for the development of tourism infrastructure. Specifically, demand for mangrove poles and coral blocks for construction of hotels, resulting in increased pressure on mangroves.
- Development of inappropriate beach protection structures which has tended to aggravate beach erosion, posing a serious threat to tourist infrastructure such as beach hotels.

Kenya

Development of the tourism industry has contributed to the growth of urban centres in the vicinity of tourist resorts. In particular, Malindi, Watamu and Ukunda/Diani developed primarily as service centres for the industry. The development of urban centres has increased the demand for mangrove poles hence increased exploitation of mangroves.

Seychelles

Rapid social and economic development in Seychelles has intensified the pressure on the coastal environment as the scarcity of flat land has led to land reclamation over the reef flats. The modification of the coastline for beachfront developments such as housing, hotels and roads, has resulted in the removal of coastal vegetation from dune land, thus increasing the vulnerability of beaches to sand erosion. Much of the development that has led to modification and/or loss of habitats have been associated with improvement to infrastructure for tourism, housing and recreation, which has benefited local populations.

6.2.3 Socio-economic importance

Mangrove forests in the coastal area of the region have significant social and economic value. Their overall benefit lies in their function of supporting the coastline from erosion and providing habitats for marine species. Exploitation of these species is part of coastal people's livelihood endeavours and contributes to national economies. These functions are irreplaceable. The rate of exploitation of mangrove forests has however been increasing due to extensive harvesting and clearing for a range of activities including infrastructural development for various purposes at both the local and national levels

At the national levels, mangrove exploitation is sometimes not counted as a significant economic activity. However, a significant proportion of mangrove ecosystems have been disturbed when areas are cleared for conversion into salt works, mariculture and aquaculture activities or for major constructions such as recreational facilities, ports and harbours.

Until the 1960s, tanin production and export of timber from mangrove trees provided a significant portion of the GDP of some of the countries in the region. In the present decade, the magnitude of mangrove exports has considerably declined into smaller scale exports. The rapid expansion of tourism in the region, particularly since the mid 1980s, has also increased the rate of exploitation as a result of tourist hotels opting to build shelters of exotic traditional designs using mangrove wood. In addition, some tourist establishments clear mangrove forests in order to create convenient recreational facilities such as swimming and boating bays.

At the local level, numerous activities involving exploitation of mangroves have provided a living to the growing populations within coastal areas for decades. These forests have been a major source of household energy needs, providing the most affordable fuel wood for many households. Coastal people also exploit mangrove timber and poles for construction. Charcoal and a variety of other products have also been obtained from mangroves. Some mangroves are used for medicinal purposes and for customary rites. Molluscs, crabs, fishes and shrimp caught within the mangrove ecosystems are direct sources of food and income for many people in parts of the region (UNEP, 1998). In some areas, mangrove forests are continuously cleared for agricultural production that is necessary for household food security. Needless to say, with extreme poverty facing a majority of the inhabitants in these areas, the engagement of activities that invariably result in mangrove forest depletion, is seen as an unavoidable means for their survival.

The socio-economic importance of mangrove exploitation in the region on a nation-by-nation basis is discussed in the following sections. Although the actual extent and value of mangrove destruction as a result of these various socio-economic and development activities has not been comprehensively documented and assessed, the threat of the various benefits are gradually being superseded by negative implications due to PADH (Mwaipopo and Lufumbi, 2003). Specific issues in some of the countries are presented below

Mauritius

In Mauritius, mangroves do not have a use-value, even at the local level. There is no widespread traditional use for mangroves. The two species occurring in Mauritius, *Bruguiera gymnorhiza* and *Rhizophora mucronata* are not exploited and only a few parts of the plant (e.g. its bark) are traditionally used for medicinal purposes. However, the non-market value of mangroves (indirect benefit associated with the preservation of the ecosystem) becomes evident when the importance of the coastal zone in foreign exchange generation is considered.

Kenya

In Kenya, coastal communities have traditionally exploited mangrove resources for a variety of socio-economic reasons. Mangrove trees have been exploited for use in house construction with *Rhizophora mucronata* being the preferred species for building poles. *Lumnitzera racemosa* and *Ceriops tagal* are substitutes. Mangrove poles are the preferred building materials, especially in the rural areas. There has also been a demand for mangrove poles for construction of tourist facilities, such as hotels and sheds. Some of the mangrove species namely *Avecinia marina, Heritiera littoralis, Sonneratia alba* and *Xylocarpus granatum* are preferred for boat building

Most of the mangroves are sources of tannin and dyes and also produce high quality firewood and charcoal for domestic and industrial use, such as in brick and calcium (lime) manufacturing. Products from a few species possess medicinal properties (*A. marina and X. granatium*) and/or have been used as human and animal food (*S. alba*). High quality mangrove wood has been utilized for making various domestic utility items (e.g. drums, beds etc.) and fishing gear (e.g. traps, etc.).

Until it was banned in the late 1980's, export of mangroves to the Middle East and Gulf countries was a thriving business in Lamu. Commercial harvesting often involves indiscriminate felling of mangroves and terrestrial forests. In contrast, subsistence harvesting is usually need-driven and selective. Over-harvesting has resulted in decreased mangrove cover (which is yet to be assessed and documented) decreased size of mangrove poles, and replacement of high quality mangroves with inferior species (WWF 2001).

Expansion of salt production and agriculture are now posing serious threats to the mangrove ecosystems although the activities are central for the livelihoods of coastal people. In the Ngomeni Swamps for example, over 5000 ha of mangroves were cleared to give way for the construction of solar-salt pans. To date the area covered by the saltpans exceeds 6,500 ha with the figure increasing with time. The salt manufacturers are now extending the operations northwards towards Lamu, another rich mangrove area, hence the impact on mangroves is expected to be more severe in the coming years.

Seychelles

There is not much information on the local uses of mangroves in the Seychelles

Madagascar

Mangroves are an important source of income, not only for the country but also for the local population. The mangrove trees are used in building and to a lesser extent as firewood. Traditional and industrial fishing and other extraction activities are practiced in several areas mainly for shrimp. The local population has for many years been involved in these activities, which have resulted in very low impacts on the ecosystem. In Baly Bay for example, the collection of crabs is carried out all year round to feed the local needs.

However, during the last ten years, shrimp has become one of Madagascar's main seafood exports, and the development of shrimp farming is reaching critical levels. For example, the Baly Bay region now has about 600 hectares of semi-intensive shrimp farms; the industry having started there in 1998. This has meant extensive exploitation of the mangroves. Social and economic impacts of these activities on mangroves are still difficult to assess due to lack of the necessary information.

Mozambique

Mangrove forests in Mozambique have been depleted over the years mainly for firewood and construction. This is observed all over the coast, especially in the vicinity of large cities such as Beira and Maputo. Other causes for depletion include clearing for saline, salt production, and for agricultural practices, mainly seen in the northern provinces.

Tanzania

Mangrove forests are an important economic and ecological resource in Tanzania. They are principal providers of useful products such as firewood, charcoal, poles, tannin, and traditional medicines. It is estimated that over 150,000 people make their living directly from mangrove resources in Tanzania (TCMP 2001).

Because of their importance, all mangrove areas are legally protected in Tanzania. The key to their protection lies in the wise management and use of mangrove habitat, and in the enforcement of existing rules and regulations. Harvest restrictions, conservation areas, replanting, public education, and permits for timber harvesting are currently the principal approaches to mangrove conservation and sustainable use in Tanzania.

Up to the mid 1990s, exploitation of mangroves for poles (for construction) and bark (for tannin extraction) for export was common (Mwaipopo and Lufumbi 2003). By then, significant income in foreign exchange encouraged the exploitation of mangroves. In 1979 Tanzania earned 4 million shillings in foreign exchange after selling 30,000 scores of mangrove poles (Havnevik 1980 in Mwaipopo and Lufumbi 2003).

Major economic activities impacting on mangrove areas are *mariculture* and *salt production* by solar. Solar salt contributes about 76% of the total salt produced in Tanzania (TCMP, 2001). This is a big industry, employing many people in household based or private companies. *Mariculture* on the other hand is becoming an important

sector regarded as having the potential to provide an alternative source of livelihood for coastal communities.

6.2.4 Environmental impacts

Mangrove wetlands provide significant flood and storm control functions, protecting coastal infrastructure and settlements. Alteration and destruction of the mangrove ecosystem has resulted in the damage to coastal infrastructure and settlements as exemplified by the some beach areas in Diani (Kenya), where property owners have been forced to put up defence structures to protect their investments from coastal erosion.

The Gazi and Tsunza bays (Kenya) have suffered massive siltation due to the clear felling of mangroves and other coastal vegetation. The problem was further compounded by the El-Nino rains of 1997-8 during which massive siltation of mangrove areas occurred. Significant efforts have been made and studies done in the case of Gazi, while awareness to the Tsunza problem has been brought to the fore. Little documentation however exists to highlight the problem to the wider stakeholder community.

During the past decades, degradation of mangroves occurred in many parts of Tanzania (Table 12). Besides a decrease in the area coverage of mangroves, there was also considerable decrease in the density, height and canopy cover of the mangroves within the forests. The areas hardest hit were those near urban centers, such as Maruhubi, Zanzibar, Kunduchi and Mtoni, Dar es Salaam and forests around Tanga town. Less accessible areas such as Rufiji remained largely pristine. The major immediate causes of mangrove forest degradation were the over-harvesting of mangroves (46%) for firewood, charcoal-making, building poles and boat-making and the clear-cutting of mangrove areas (30%) for aquaculture, agriculture, solar salt works, road construction, urbanization and hotel construction (Wang, et. al., 2003).

In several areas, particularly around the Rufiji Delta, Tanzania mangrove areas are cleared for rice cultivation. This practice has now become a threat to the survival of the mangrove forest in the area (Ngusaru *et al*, 1999). Under this practice, rice fields have to be renewed every 4 to 11 years (7 years on the average), because after this period the rice yields fall drastically. The old farms are then usually abandoned and new areas of mangrove have to be cleared (Semesi, 1991). Nearly 1700 ha have been cleared between 1989 and 1999 in the northern part of the Rufiji delta as a whole. Besides of the impact of the clearings on the mangrove system itself, the use of persistent pesticides in these clearings for the destruction of the crabs attacking the rice shoots is an issue of concern. It should also be noted that many of the abandoned older clearings, for example around the Bumba river, have been colonised by *Barringtonia racemosa* and not by mangrove.

The siting of prawn/shrimp farms within mangrove areas has been argued to be environmentally and socially destructive, and has met significant resistance. A case in hand is the abandonment of plans to build one of "the world's largest shrimp aquaculture facility in the Rufiji Delta of Tanzania, that had been proposed by a company called the African Fishing Company (AFC). The AFC had proposed to establish about 20,00

hectares of shrimp farms in the area – establish ponds, a hatchery, a processing plant and a feed mill and this would have involved destroying 1200 hectares of mangroves in the area. In its proposal, the AFC envisaged to realise US$500 million a year in export profits. The Government and Tanzanian Cabinet in 1997 approved the project but environmentalists said the damage to the environment and consequently to the local people's well-being would far outweigh the profits (WRM, 2001). Consequently, the project has been halted.

If the alteration and destruction of mangroves and other coastal wetlands continues, re-establishment and maintenance expenditures for protecting coastal infrastructures and settlements would increase. Also, unless properly controlled, these alterations will have adverse effect on the coastal environment and ecosystems.

Table 12: Comparison of mangrove areas (in hectares), 1990 and 2000

Coastal districts	1990 Mangroves		2000 Mangroves	
	Mangrove Vegetation	Salt crust areas	Mangrove Vegetation	Salt crust areas
Tanga and Muheza	9 217	4	9 313	23
Pangani	3 799	0	3 879	0
Bagamoyo	5 039	0	5 051	0
Dar es Salaam (Ilala, Kinondoni & Temeke)	2 494	0	2 516	0
Kisarawe	4 159	102	4 092	75
Rufiji	49 799	1 169	48 030	2 361
Kilwa	21 826	720	21 755	797
Lindi	4 034	183	9 458	21
Mtwara	9 226	183	9 458	402
Total	109 593	2 199	108 138	3 679

6.2.5 Legal and institutional frameworks

From the national reports, it is evident that relevant legislation (and institutional arrangements) on mangroves seems to be rather fragmented, sparse and indirect. Generally, the countries in the Region do not have specific legislation on mangroves or any legislation that deals with mangroves per se. In fact few of the countries' legislation even mention "Mangroves" directly (Momanyi 2003). However Kenya's Forests Act (Cap 385) has subsidiary legislation that identifies mangroves either as harvestable timber or as specified forest reserves for protection. Section 6 of Mauritius Fisheries and Marine Resources Act (1998) also directly mentions mangroves and prohibits their destruction. This is in reference to their importance as breeding and/or nursery grounds for fish.

Momanyi (2003) gives a comprehensive review of national legislation and institutions in the WIO Region with respect to PADH. The following are extracts from the review and also from the national reports.

Mauritius

In Mauritius, national legislation pertaining to the three main priority areas, (namely Coastal Tourism, Mangrove destruction and Mining/Sediment Transport/Port & Land Area Reclamation) are currently contained in several sources, which are predominantly sectoral and often overlapping. Important national legislation includes:

- Beach Authority Act 2002;
- Environment Protection Act 2002;
- Fisheries and Marine Resources Act 1998;
- Forests and Reserves Act 1983;
- Ports Act 1998;
- Town and Country Planning Act 1954;
- Wildlife and National Parks Act 1993;

Although Mauritian legislation affecting the coastal zone is fragmented, recent developments have begun to reflect a more integrated approach (Bhikajee and Bhagwant, 2003). Thus, the Environment Protection Act of 2002 establishes an Integrated Coastal Zone Management Committee, with cross-sectoral representation, to develop management plans, monitor coastal waters, and make recommendations to the Minister of Environment.

Comoros

The Comoros has a framework Act on environment (No. 94-018 of 23 June 1994). This Act aims at:

(a) Preserving the diversity and environmental integrity of the Islamic Republic of the Comoros, as an integral part of the universal heritage which is vulnerable to degradation;
(b) Creating a quantitative and qualitative utilisation of natural resources for the present and future generations; and
(c) Guaranteeing to all citizens a safe and balanced living environment.

The national policy, the environmental action plan and the environmental diagnosis were elaborated in 1993: The basic principle and objectives of the National Policy on Environment may be summarised as follows:

(a) To ensure a rational and sustainable management of resources;
(b) to define or reinforce sect oral policies;
(c) to safeguard and protect the biological diversity and zones with ecological or cultural interests;
(d) to develop or promote environmental knowledge;
(e) to put in place appropriate mechanisms for the management of marine and coastal areas by elaborating a development policy aimed at ensuring the maintenance of the coastal area taking into account its tourist potential; rational

management and exploitation of marine resources, the control and regulation of pollution in marine and coastal areas.

Seychelles

Wetland and Mangrove legislation in Seychelles is very sparse, fragmented and indirect. The legislation focussing specifically on mangroves and wetlands is not very clear and does not address properly the current degradation of wetlands in Seychelles. Seychelles is not yet party to the Ramsar Convention on Wetland Conservation.

In Seychelles, the management of wetlands falls under the responsibility of the Ministry of Environment, Division for Policy, Planning and Services. A wetland unit was setup within that Division in 1999, and currently has over 20 full-time staff. The primary role of this unit was to control the problem of the water hyacinth in the wetlands. The work of this team now includes enforcement and monitoring of wetland habitats.

Tanzania

In Tanzania, mangroves generally fall under forestry and related legislation, institutions and policy instruments. They include:

- Forest Ordinance chapter 389 (1957) as amended variously in 1964, 1979 and 1991;
- Tanzania Forestry Research Institute Act 1980.

Policy and related instruments include:

- National Forest Policy, 1998;
- Tanzania Forest Action Plan 1990/91 – 2007/08;
- National Forestry /Book keeping Programmes (under way);
- Management plan for the Mangrove ecosystem in Tanzania 1991;
- Mangrove management project; and
- National Forest Research Master Plan 1991-92.

Madagascar

In Madagascar, environmental laws are fairly recent and often without texts directing or norms regarding their application. This order is based on the French judicial system where laws are general and not applicable without a decree, which is effectively the legal tool of application (SEACAM, 2001). In recent times, environmental legislation is being re-organized and therefore their application is rather limited. Laws often lack-supporting information associated with limited training and awareness at all levels of government and other stakeholders (SEACAM 2001).

Madagascar has framework legislation and several institutions for coastal and marine activities including, pollution management and environmental protection; exploitation of mangroves and coastal and marine protected areas (SEACAM, 2001).

Madagascar also has a framework environmental legislation (LOI No. 90-033 Relative a la Charte de Le Environment Malagasy) which outlines the fundamental principles including the principle that the environment is an important pre occupation of the State and its protection is a matter and responsibility for all (Part II). It also provides for the establishment of a national environment policy and a plan of action for environment with stated objectives. The two (policy and action plan) are detailed as integral parts of the environment legislation. As an island state, naturally the coastal and marine environment is of primary importance in the frameworks established for the country.

Currently, there is no co-ordination structure for the entire marine and coastal environment, such as, for example, a National Planning Authority for Coastal Marine Zones. However there is on-going discussion of future national polices framework for the coastal and marine areas (SEACAM, 2001). In the meantime several important (albeit largely sectoral) institutions are concerned with the coastal and marine activities. These include: The Ministry of Fisheries and Marine Resources and its Directorate for Marine Fishing and the Directorate for Marine Aquaculture (established 1997); Ministry of Waters and Forests and its Directorate (established 1997), Ministry for Town and Country Planning and its Directorate of Lands and Tenure Services; the National Office For Environment (ONE); Ministry for Scientific Research with its National Centre for Oceanographic Research and the National Centre for Industrial and Technology Research. Other important national institutions include the ministries and departments of energy, agriculture, and industry.

In Madagascar, protected areas are in two broad categories; those forming part of the national protected areas network managed by the National Association for the Management of Protected Areas (ANGAP); and those outside the national network under the auspices of the Ministry of Waters and Forests. With regard to mangroves (mangrove harvesting, agriculture, aquaculture, salt works etc) developments are also generally effected by the decree on "Compatibility of investments with the Environment" whereby environmental impact assessments are required for major developments and investments under the auspices of the ministry of Waters and Forests. A Forestry Policy guides the exploitation of mangroves.

Kenya

Kenya has framework environmental laws and institutions, as well as numerous sectoral laws relevant to physical alteration and destructions of habitats in the coastal and marine environment. Some of these laws deal with the priority areas herein including tourism, mangroves, ports land reclamation mining and damming of rivers. At the national level, the National Environment Secretariat (NES), established in 1974 to co-ordinate the environmental activities, existed under the auspices of the Ministry of Environment and Natural Resources (NES was, at inception in the office of the President, but was

transferred to the Ministry of Environment in 1979). NES was established by a presidential directive, Act No. 5 of 1969, by the founding president of Kenya.

Kenya's socio-economic activities and processes are organized in a conventional sectoral manner. Many policy statements, legislations and corresponding institutions are therefore largely sectoral. However, government structure and institutional details are largely centralized, with much less emphasis on decentralised and devolved power structures. Most of the legislations and institutions relevant to PADH are therefore scattered across various sectors and line ministries or public departments.

6.2.6 Case studies

Case study 1: Enhanced Community Participation in Mangrove Forest Management in Kenya

Enhanced community participation in mangrove management as a case of best practice in both legal and institutional arrangement in addressing the PADH issue is exemplified by the community mangrove reforestation initiative at the Gazi Bay in the south coast of Kenya. Gazi bay is one living example of a degraded area due to the over-cutting of mangrove vegetation. The uncontrolled cutting of mangroves has led to loss of land due to erosion of the de-vegetated shoreline. The degradation of the shoreline prompted the community mangrove planting rehabilitation project under review here.

Gazi Bay is located approximately 50 km south of Mombasa and has a vegetation cover of mangrove forest spanning some 615 ha. A community project was initiated in January 1994 with the objective of rehabilitating degraded and deforested areas of the forest (Kairo 1995). The project involved the transplanting of mangrove propagules or saplings of *Rhizophora mucronata, Ceriops tagal, Bruguiera gymnorrhiza, Avecinia marina and Sonneratia alba.* A survival rate of between 10-70 % was reported 9 months after transplanting.

Though the immediate objective of this project was to rehabilitate degraded and deforested areas of the Gazi Bay mangrove forest, the overriding aim of the project was to enhance community participation in forest management and influence forestry policy and legislation towards sustainable use of forest resources by local people. This effort was effected to lobby against the ban on mangrove forest by the government and to give impetus that communities can manage their traditional resources. The ban on harvesting mangrove products denied the local population their natural right to the use of mangrove resources without alternatives to their livelihood considered. The promotion of community management of the mangroves and its resources, the project proponents considered would inculcate a sense of ownership of the resource and therefore enhance its sustainable utilization.

This effort was followed by a mangrove awareness workshop organized by the Kenya Marine and Fisheries Research Institute in March 2003, bringing together stakeholders and government on mangrove legislation and sustainable utilization and the role of co-management of the resource. Here the role of local communities came out prominently. This act was directed at influencing the Forest Bill 2000, a regime under which, traditional ways of exploiting mangrove forest by local people, the so-called forest adjacent dwellers, may be allowed.

Case study 2: Severely Impacted Area and Ecological Restoration of Wetlands: Mare Soupape on La Digue, Seychelles

Background

On La Digue, it is estimated that 70% of the total population of about 2,500 live and depend on the coast, as almost two-thirds of the island is mountainous and rocky, and therefore inaccessible to development and human settlement. The marine ecosystem and the low-lying coastal belt are the backbone to the island's socio-economic development. A large coastal wetland supports a diversity of wildlife, including the endemic Paradise Flycatcher.

This multiple and diverse use needs, conflicts, resource constraints, institutional support, and awareness at this interface are very important issues that needed to be addressed (Payet, 2003).

Physical characteristics

La Digue Island lies 50 km Northeast of Victoria, Mahe, the capital of the Republic of Seychelles. It is the fourth largest granitic island in the Seychelles group, after Mahe, Praslin and Silhouette. However, it the third most populated island with a population growth rate of about 0.4 %. It also lies four and a half kilometres from Praslin, the second largest island in the archipelago. Praslin provides electricity and the closest air-link to the island.

There are hourly sea-links between Praslin and La Digue (during the day), and daily links between Mahe and La Digue.

The island, with an area of ten square kilometres, is protected on all but its south-east shores by an encircling coral reef of outstanding biodiversity and landscape. The highest hill on La Digue, which rises up to three hundred and thirty-three metres, covers almost the entire hinterland, the narrow coastal plain lying to its west. The island's only plateau is about 2.75 km long and 1 km wide. The wetland, called Mare Soupape or 'turtle swamp' measures over 18 hectares and is located on the coastal plateau. Sluice gates have been built at the two extreme discharge points to minimize saltwater intrusion. La Digue depends on ground water for its water resources so conservation of the wetland is also an important issue for the residents.

Ecological characteristics

La Digue is also host to one of the world rarest birds, the Paradise Flycatcher. Set on La Digue western plateau and rising up to two hundred metres, the Paradise Flycatcher reserve covers fifteen hectares of forest dominated mainly by *Terminalia catappa* (Badamyen) *Calophyllum inophyllum* (Takamaka), *Cocos nucifera* (Coconut), *Casuarina equisetifolia* (Casuarina) and so on.

Wetlands are essential features of island topography, and they control the outflow of water into the marine environment, thus minimising the risks of coastal flooding after torrential rains. Their convective feature allows them to expand during periods of heavy downpours and accommodate the huge amount of floodwaters. Therefore a the typical wetland on La Digue is found to be a few centimetres below sea level, so that it can effectively capture the surface runoff and then by slow dissipation through surface outlets or ground water shuttles into the marine environment. La Mare Soupape also harbours a plethora of plants and organisms. Among those include the freshwater terrapins (*Pelusios subniger* & *Pelusios castanoides*) and insects for both the Fly Catcher and the

Seychelles Cave Swiflet (*Collocalia elaphra*), and typical marsh-plants like reeds, sedges, grassess and water plants (e.g. *Cyperus articulatus*, *Typha javanica*, *Ipomoea aquatica* and *Eleocharis dulcis*). The large wetland harbours a wide variety of insect faunas, and endemic species of terrapin.

Protection of land and the marsh has always been a very controversial issue, as it involves land acquisition, an issue not favourable as the indigenous population is very closely associated with the land. Logging and construction activities have also contributed to the decrease in potential habitat.

Socio-economic aspects

The population on La Digue depends upon the wetland for two basic services: water resources and tourism. Tourism infrastructure caters for about three hundred and fifty beds, which is mostly concentrated on the coastal plain. Migration to La Digue includes mainly professionals in government and the service sectors, whereas from La Digue mainly students leave for further education on the mainland. An estimated 15% of the population is engaged in agriculture, with La Digue having the highest number of cattle per head in the Seychelles. In the fisheries sector, it is estimated that only 11 % of the population are engaged in artisanal fishing. On the other hand, tourism employs, directly and indirectly about 34% (indicative) of the population. An estimated 80% of the population of La Digue has access to treated water, sourced mainly from ground aquifers. The island is also well service with electricity, IDD telecommunications, a school and a small hospital. The main staple diet on the island consists of almost fish and rice, with meat eaten on special occasions. Annual consumption of fish is about 75 kg per person.

Main Impacts and Restoration Activities

The main impacts of human activities on the wetland on La Digue include sea level rise, invasion of the water lettuce (*Pistia stratoites*), and pollution in the form of solid wastes and wastewater.

According to a recent survey carried out by the Conservation and National Parks Section of the Division of Environment (CNP-inform, 1992) there has been a marked decrease in total woodland area of the western coastal plateau. This is due to logging activities since 1978, which has reduced the total area of the reserve (about 161.3 ha.) by 25.5 %. However, the Fly Catcher population seems to be stable, indicating that probably the adjoining marsh is contributing as nesting habitats for the species. There is also evidence to show that logging activities have intensified over the last four years, from a 1% decrease/year to a staggering 4 % decrease/year.

Several restoration efforts are ongoing:

1. Replanting of the original woodland – replanting activities is undertaken periodically by Ministry of Environment staff.
2. Removal of the invasive water hyacinth. This is a permanent and ongoing effort, whereby all those invasive lilies are manually removed and destroyed.
3. Schools are being involved as well in ensuring that the reserve also remains clean of litter which is a common problem in the wetland.

Case Study 3: Mangrove Forest Conservation: Bee-keeping in the Mida mangrove forest-Kenya

The bee-keeping project in the mangrove forest of Mida Creek in Malindi, is an offshoot of the Kipepeo butterfly farming in the Arabuko-Sokoke forest, a programme supported by the European Union through the National Museums of Kenya. When the butterfly project was started, it was observed that the local community in Malindi used to harvest honey both in the Arabuko-Sokoke Forest and in the Mangrove Forests of Mida, albeit at a small scale. This activity promised to be a very lucrative business if well developed. At the same time, the communities harvested mangrove and the other forest products directly as another source of income. The direct harvesting of the forest products was considered to be occurring at a rate that was unsustainable. A balance had therefore to be found that could improve income without necessarily destroying the forest. The bee-keeping project was conceived and promoted.

Having realized the potential of the indirect use of the forest, the communities living adjacent to the forest formed themselves into an association that protect the forest and are organized to make the best use of their newly found source of income. One of the challenges the association faces is the lack of market for their honey. In addition, the production techniques of the honey are considered primitive and not meeting international standards. Therefore, considerable support is required for the project to adopt modern methods of honey production and processing in order to attract those markets that demand higher specification standards. If this last hurdle is resolved, the project will be a standing example of best practices in the conservation of important coastal habitats, while providing sustainable means of livelihood for the communities residing in these areas.

Today, the proceeds from honey gathering are high enough to make up for the lost income from the sale of mangrove poles now long lost due to the ban on mangrove poles harvesting.

6.3 Ports and Land reclamation and damming of rivers

6.3.1 General Overview

Port development in the Eastern African region has been stimulated by local and national circumstances, such as the demand for port services from the hinterland, both in terms of export generation and import consumption. The ports of Mombasa, Dar es Salaam and Beira provide strategic entry points for goods on transit to the land-locked countries of Burundi, Rwanda, Democratic Republic of Congo, Uganda, Malawi and Zambia.

Many of the major ports in the region have recently undergone expansion and other developments as a response to global market conditions, such as trade liberalization, international political changes and development in technologies (Hoyle 2000). This activity invariably involves dredging to increase port depth in order to accommodate bigger ocean vessels. The cargo bays themselves are also being expanded and subsequent overlays of concrete mixtures to establish the loading and off-loading bays. The benefits of these activities have increased port efficiency and thus reliable revenues.

Land Reclamation projects are often implemented to alleviate the acute problems of land shortage. Land reclamation due to scarcity of land has also been necessary to serve various purposes such as investment for tourism, extension of ports, and construction of roads and to provide space for service infrastructure such as dumping sites. These projects however have a permanent impact on the economy and social structure of the country. Whilst they offer many potential advantages, they also have many disadvantages, including loss of critical habitats and the high cost of reclamation.

The construction of dams for storage of water and for harnessing hydroelectric power has had a negative impact on the coastal and marine environment. For example, the alteration of the flow regime of the rivers means alluvial sediments are trapped, resulting in impoverishment of sediment supply at river mouths and deltas. The effect is the recession of the shoreline and the disruption of the spawning and growth cycles of marine fish and prawns. The situation in some of the countries in the region is reviewed.

Mauritius

In Mauritius, occasional droughts present a serious challenge for the provision of water to agriculture, industries and for domestic uses. Inadequate and insufficient water storage facilities may become serious constraints for national development. In this context, the Midlands Dam, the first of the five proposed dams, has recently been completed across Grand River South East. It has a storage capacity of 25.5 million cubic metres and will meet 100% municipal water requirement of the northern part of the country. It would also satisfy the total requirement of the Northern Plains Irrigation Project covering about 1900 ha and allow the irrigation of an additional area of 2850 ha. The socio-economic value assigned to such water is huge considering that all the sectors of the economy rely heavily on this commodity.

Tanzania

Tanzania has four major harbours, Dar es Salaam, Mtwara, Tanga and Zanzibar. The mainland ports are under the Tanzania Harbours Authority. The main port at Dar es Salaam has undergone a modernization programme to enhance its competitiveness among ports South of the West Indian Ocean. More recently, improvement of the Dar es Salaam Port Entrance Channel was one of the major works undertaken. This project "took off in July 1997 by shifting the old fish market and the ramp to Magogoni Ferry.

Kenya

Historically seaports have played a major role in the economic development of the Kenya coast and eventually influenced a hinterland extending into East and Central Africa. Ports that are operational in Kenya are Mombasa, Lamu, Malindi, Kipini, Kilifi, Mtwapa, Gazi and Shimoni under the jurisdiction of the Kenya Ports Authority. Kenya's largest port at Mombasa, provides one of the country's economic strongholds, maintaining maritime trade, commerce and harbour activities. Mombasa port handles liquid and solid bulk cargo destined to Kenya, Uganda, Rwanda, Burundi and parts of Congo, Sudan and

Ethiopia. The other ports are generally smaller, mainly serving small crafts that transport consumer goods and also fishing boats.

Port activity, damming of rivers and agricultural production along the costal zone of Kenya are high in comparison to other countries in the region due to the advanced economy. Developments at the Mombasa port are a long-term plan in order to extend facilities for oil reception and the container terminal, indicating extensive use of land (Hoyle, 2000).

Damming of rivers in Kenya is developed in the quest to meet energy needs through hydroelectric power generation. The Tana River, the longest river in Kenya, is 850 km with a catchment area of 95,000 km^2. It extends into the Mt. Kenya region, and is the most dammed river in Kenya with 5 major hydroelectric power schemes on it. The Athi-Galana-Sabaki River complex is 650 km long with a catchment area of 70,000 km^2 extending into the Nyandarua mountain range. Damming activities on the Tana River have led to reduced stream flow (now less than 50% of that measured in the 1950s), thus denying the estuaries the much-needed freshwater inflow to sustain the ecosystem.

Mozambique

Maintenance of Mozambique's *harbours* is also a major contributor to PADH. The country has three large ports: Maputo, Beira and Nacala, and several small ports (Inhambane, Quelimane, Pebane, Angoche and Pemba). The major harbours provide significant service to foreign countries including Swaziland, South Africa, Zimbabwe, Zambia, Malawi and the Democratic Republic of Congo. The total cargo handled in 1995 and 1996 was about 7.5x10(x6) tons and 8.4 x 10(x6) ton respectively.

Seychelles

Rapid social and economic development has intensified the pressure on the coastal environment as the scarcity of flat land has led to land reclamation over the reef flats. *Land reclamation* is probably the single most serious activity impacting on the coastal environment of Seychelles, propelled by the scarcity of land in the islands. The Seychelles International Airport, most commercial and fishing ports were built on reclaimed land from the sea. In 1973, 102 hectares of land was reclaimed at Anse Des Genets and used for the airport, a cruise ship port, and a storage facility for a power station. In 1986, in Victoria to Providence islands, 133 hectares were reclaimed and used for housing, industry, and water front developments. The most recent phase, East Coast Phase III, ending in February 2003, included the reclamation of about 15 zones with a total area of about 343.5 ha. (or 848.8 acres). This required about 11.6 million m^3 of coral fill from the bottom of the sea, along the east coast of Mahe island, and created a stockpile of a total of 3.5 million m^3 of fill to meet construction demand for sand. This was by far the largest reclamation project undertaken by the country and its primary objective is to cater for the physical requirements of the future urban development of Greater Victoria over the next 25 years.

As coral rubble is used as fill, there is consequent loss of all shallow marine habitats in the vicinity, and some modification of surrounding habitats.

Another contributing factor to the modification of the coastline is the increase in beachfront developments, for housing, hotels and roads, which has resulted in the removal of coastal vegetation from dune land, thus increasing the vulnerability of beaches to sand erosion.

6.3.2 General issues of ports, land reclamation and damming of rivers in relation to tourism in the WIO region

Mauritius

Beaches provide protection to the backshore and dunal complexes where most hotels are located. Changes in the beach profile has serious impacts on the tourist industry. In Riambel and Flic en Flac, the beach is very eroded and has produced beach scarps of 1-2m. Soft remedial steps have been taken to mitigate the impacts. The use of gabions (large rectangular metal wire baskets holding broken basalt rocks) to curtail the negative effects of waves is becoming increasingly popular but the effectiveness of these structures needs to be monitored. Furthermore gabions decrease the aesthetic value of the area, reduce the recreational beach area, prevent easy access to the sea, add to the cost of maintaining the beaches.

Kenya

Cultivation upstream on rivers that discharge into the sea, have also resulted in high levels of suspended soils. These sediments have reduced the recreational value of the area and consequently tourism because they interfere with the aesthetic value of the beaches, coral reefs and mangroves. However, farming activities upstream are expected to continue since farming is a significant economic activity even for coastal people. National records have classified 87% of coastal land as agricultural, while 70% of the labour force in the area is engaged in agriculture (GOK 1996 in Mwaguni & Munga, 2003). Demands to maximise food production have encouraged farming activities in this area to adopt irrigation schemes.

Seychelles

The modification of ecosystems and/or ecotones has always been significant in the socio-economic development of the country, as upland areas are mostly unsuitable for either agriculture or other types of development. On the coastal areas, where land is at a premium, reclamation has been practiced extensively ever since the islands were first settled. Under such circumstances, it is difficult to identify immediate negative socio-economic impacts, as much of the development that has led to modification and/or loss of habitats have been associated with improvement to infrastructure for tourism, housing and recreation, which has benefited local populations.

Haphazard developments including construction of coastal residences and also tourist hotels have fuelled the demand for building sand which has been mined from inland areas along the coastal strips. This has caused huge crevices, which are lower than the water table to be backfilled during periods of heavy rain. In addition to natural factors, the coastline is continuously being eroded and this has caused the beach to retreat inland to as much as 10 metres in some places over a ten-year period.

6.3.3 Socio-economic importance

Improvement of port infrastructure, land reclamation and river damming are activities that have significant social and economic value. They facilitate international relations, trade and regional development while creating employment and incomes for local people on a wide scale. Yet, these activities have stimulated sediment movement and siltation and an increase in the level of suspended soils in the marine waters, destroying the quality of the waters. Specific examples are given below.

Seychelles

Land reclamation projects have a permanent impact on the economy and social structure of the country. Whilst it offers many potential advantages, it also has many disadvantages, including loss of habits and the high cost of reclamation. Although the size of the GDP relative to the investment could raise concerns on economic stability, the projects offer Seychelles new opportunities for economic diversification, and especially consolidate other economic sectors, rather than the exclusive dependence on tourism and fisheries

In addition, fisheries and biodiversity are invariably affected by land reclamation activities. Coastal fisheries in crustacean and molluscs will be more or less eradicated in the short-to-medium term. For the East Coast Phase III reclamation project it has been estimated that fish habitat loss would amount to US$600,000 per year. The loss of income to local subsistence fishermen will therefore be significant.

On the other hand, the cost of management of such "modified habitats" has increased, particularly on the large reclamation areas on the East Coast of Mahe, and the threat of sea-level change will greatly add to such costs as additional coastal protection measures will be required.

Kenya

The reduction of water flow due to damming has affected the productivity of the mangrove ecosystems, threatening the future socio-economic well-being of coastal communities. River Tana discharges about 4,000 million m^3 of freshwater and 3 million tonnes of sediments annually through an expansive delta into the Ungwana Bay and about 2,000 million m^3 of freshwater and 2 million tonnes of sediments annually into the Malindi Bay. The high volumes of freshwater carry with it nutrients which maintain the

high productivity estuarine conditions of the Ungwana and Malindi Bays that constitute the richest fishing ground for artisanal fishers, semi-industrial fishers and prawn trawler operators in Kenya.

It is clear that the reduction in the discharge of freshwater into the Ungwana and Malindi Bays can result in far reaching changes in the ecosystem, impinging on the socio-economic well being of the coastal community.

Mauritius

Port activity in Mauritius has increased over the last four years. This is possibly due to improved infrastructure and facilities, but with a cost to the environment. The new container terminal at Port Louis harbour was constructed on reclaimed land. The area was already impacted by the presence of other port infrastructure. Port Louis handles about 4.8 million tonnes of cargo annually. Over the past years an average annual growth of 8% has been registered in total cargo traffic. Some 1900 vessels call at Port Louis annually and over the recent years a vessel traffic growth of 4% has been recorded.

Another economically important activity is sand mining that until 2001 was a large employer of coastal populations. It was undertaken by 25 co-operative associations using 310 boats and employing nearly 1,000 people. In economic terms this business had an estimated turnover of US$8 million per year (Dulyamamode *et al* 2002). The devastating impact of this practice became felt on the destruction of lagoon ecosystems and habitats, and was later found to cause suspension and movement of sediments. After a moratorium period, sand mining was declared illegal with effect from 1st October 2001. The workers of this sector are currently being financially compensated and alternative jobs including training facilities are being offered. Adequate substitute materials are now available, particularly through the use of advantaged technologies for crushing rock and utilising it for construction (Bhikajee & Bhagwant, 2003).

Comoros

The main ports of the Comoros are Toamasina, Mahajanga, Antsirana (Diego Suarez), Taolagnaro, Antsohimbondrora, Morondava and Toliara. The ports are mostly used for maritime cargo.

Extraction of coastal materials is an ongoing concern in the Comoros, and is practiced at different scales in the region. Coral sand, pebbles, gravel for concrete and corals for lime have been mined for building mosques, cultural centres, public buildings, individual houses and for surfacing of roads.

Figure 7: Sand mining in a lagoon

Seychelles

Dredging and land reclamation have continued on a large scale in Seychelles and one output is the creation of large coral fill stockpiles, which at least have provided alternatives for illegal sand extraction from the beaches.

Land reclamation has had an important and permanent impact on the Seychelles economy. The projects have offered the country new opportunities for economic diversification and consolidation of other economic sectors, rather than making the country rely exclusively on tourism. The socio-economic importance of wetlands in the Seychelles islands may not be quantifiable at present due to the absence of studies on this issue and primarily because they are not commercially exploited. The cost of indirect destructive uses such as land reclamation can however provide an insight into the perceived value of these wetlands. On average reclamation of a wetland for one house would cost about 25,000 to 50,000 Seychelles Rupees, which is much cheaper than the estimated cost for a similar sized plot of land on the coast, which can range from 80,000

to 100,000 Seychelles Rupees. In most situations availability of coastal land becomes an added problem.

However, when the value in terms of services to the environment is considered, such as protection against potential flooding, the cost of wetland conversion becomes more real. For example, recent flooding within the Anse auz Pins area on Mahe, may include costs such as damage to property and roads. Another problem is to do with irrigation activities whereby diversions of fresh water have brought about shortages. Also the reduction in flow is causing stagnation and fouling of water bodies. Consequently residents are subjected to unpleasant odours from anaerobic decomposition. Siltation is another problem that is caused by deforestation, construction on steep slopes, and dumping of construction materials.

The benefits of the additional land may not be totally exploited if suitable land use policies are not put in place. For example the last reclamation is estimated to have cost government a total of US$ 110 million, with a foreign exchange component of US$ 47 million. The costs also increase significantly to justify the strict environmental regulations imposed by the EIA and the Ministry of Environment. Additional contributions to the cost also included raising the ground level of the reclamation to 3.2m, to accommodate anticipated sea level rise

Tanzania

Port activity in Tanzania is one of the country's economic strongholds, as the port controls significant amounts of bulk cargo for the country and its neighbours. At local level also, the country's ports offer sizeable employment opportunities. The Tanzania Harbours Authority has 3163 permanent employees (2003); down from 9349 in 2002. Port and harbour activities are also offer local populations with casual labour opportunities and subsidiary jobs such as food vending. Intake of casual labourers ranges from 20 to 250 people a day. They earn an income of TShs 2500/= a day and TShs 5000/- on weekends (averagely $2.5-$5).

Dredging works in the Dar es Salaam port were completed in April 1998 at a cost of about $24 million. Other complementary works (on shore works) such as building a new and permanent ramp and installation of Navigational Aids and a new Signal station were completed in 2002. The economic benefits of the dredging works in particular have been significant. These include increase in harbour efficiency since big ships can enter the port for 24 hours instead of waiting for high tide only.

6.3.4 Environmental impacts

Mozambique

Mining of minerals is carried out all over the country and has increased since 1992 (end of civil war). The activities involve extraction of minerals such as gold, copper, marble, and stones for building. Sand mining for building purposes is also undertaken along riverbanks and in the coastal areas. These activities induce high rates of erosion, destruction of the environment and pollution of coastal waters. Some types of mining involve the use of pollutants that are poured into the sea.

The two largest ports of Mozambique, Beira and Maputo, are situated at river estuaries and therefore are heavily affected by siltation. To keep the navigational channels operational continuous dredging is carried out. As a result, the bottom topography of the surrounding ocean bed is altered and a re-suspension of sediments occurs.

Mozambique is also planning to construct an open sea harbour with associated land infrastructures such as railways, housing, shops, etc. at Ponta Dobela, in Maputaland near Maputo. This will definitely have an impact on the environment.

Further inland rivers are dammed to alter the flow of water for various purposes. This has affected the import of sediments and nutrients in the river delta areas and causes imbalances in sediment fluxes, leading to chronic erosion or sedimentation.

Kenya

Dredging for port development and maintenance of the port of Mombasa and other lesser seaports, has the effect of increasing the intensity of suspended materials in the water, damages the benthic habitat and organisms, and has the potential of mobilising toxic heavy metals and organic contaminants in the water column. The subsequent dumping of dredged material in the sea increases turbidity resulting in shadowing and/or smothering of benthic organisms. This may further mobilise toxic inorganic and organic contaminants in the dumping area. The dumping of dredged material in mangrove areas resulting in habitat destruction was reported to have occurred in Lamu.

From time to time the dredging of the navigational channel in the Mombasa inshore water areas is conducted since it is necessary to maintain the depth required for shipping activities. The dredged material is usually dumped at a deepwater site off the entrance into the Mombasa harbour. This has caused significant levels of suspended solids on the Kenyan coastal waters. Titanium is to be mined in Kwale soon and there is the need for a loading facility. Two sites have been proposed namely Shimoni in Kwale District and a site within the Mombasa harbour area. The setting of such a facility will inevitably entail major works for the development of port facilities.

Tanzania

Some environmental effects are also said to have generated from dredging around the Dar es Salaam port. Examples that are cited include increasing levels of siltation in the area due to the increase in current flow.

Zanzibar port has also expanded considerably in terms of marine transportation particularly after the liberalisation of trade in the country. The number of cargo vessels calling at the Zanzibar harbour has shot up from 40 in 1990 to 190 in 1995 (Mwaipopo and Lufumbi 2003). These developments have increased the risk of oil pollution in the harbour areas, threatening the reef formations fronting this area.

Seychelles

In Seychelles, the first reclamation undertaken in the early 1970's under the supervision of the British Government was not subject to an Environmental Impact Assessment, and this trend continued until the East Coast Reclamation Phase II.

All of the earlier reclamation activities led to siltation of reefs and destruction of live coral (Payet, 1998) however, in the longer-term siltation of nearby reefs may be due to land run-off as well as unstable reclaimed areas. In the second phase of the East Coast Reclamation, silt screens and filter cloth were used to mitigate siltation, and filter cloth liner covered by rock armoring at the base of the fill area was utilized to trap suspended solids. This approach reduced the impact significantly. Monitoring of the impact was also initiated during the second phase, as a result providing critical background data in determining the extent of environment protection of subsequent phases of reclamation.

According to a survey undertaken by De Silva (1986) within the Ste Anne Marine Park and other sites within close proximity to the dredged areas, serious levels of stress due to sedimentation were apparent. There were signs of sediments on the reef and benthic organisms, and there were signs of excessive mucous secretion, pale spots (expulsion of zooxanthellae), tissue loss and coral deaths. Impact of sediment ranging from very fine clayey particles to crushed coral was reported. Continued re-suspension of fine sediments in the vicinity of coral reefs may prevent substrate consolidation and subsequent re-colonisation by many benthic organisms, especially planktonic larvae of corals, as well as other reef invertebrates, which require hard bottom to become established.

However, it was also noted that up 40% of the live coral in the fore-reef area appeared to have recovered reasonably well, especially the *Porites sp.* and *Platygyra sp.*

The indirect biological or environmental effects associated with dredging and reclamation includes:

- reduction of feeding and respiratory efficiencies and induced mortalities in bottom dwelling, non-mobile organisms such as bivalves and corals, attributed to increased sedimentation;

- Reduction of primary productivity (destruction of seagrass bed) due to reduced light transmission as a result of turbidity in the water column.
- Introduction of abnormal volumes of organic material and nutrients, increasing biological oxygen demand and, in turn, reducing levels and productivity;
- Re-introduction of toxic substances uncovered by the dredging activity in the water column. Posing risk of introducing in the food web;
- Inadvertent destruction of adjacent habitat (Ste Anne Marine Park and reef slope of the fringing reef) critical to life cycles of certain organisms;
- Disruption of migratory routes of mobile marine organisms and possibly sea birds.
- Other effects on corals include reduced rates of growth (possibly due to declines in photosynthetic rate of the symbiotic zooxanthellae) and reduce species diversity.

Mauritius

The 1995 report of the World Bank mentioned that: "The proposed container terminal facilities at Mer Rouge site is unlikely to have any major negative environmental impact on the landside as the land has recently been reclaimed with no established fauna and flora. On the marine side the dredging of the channel and turning basin has already been completed since 1990" – before the requirement of a formal EIA became mandatory.

6.3.5 Legal and institutional frameworks

Seychelles

A number of regulations provide the framework for reclamation of the coast in the Seychelles. These include:

- Land Reclamation Delegation of statutory Functions order (1972) and subsequent amendments (1975, 1978, 1988)
- Land Reclamation (East Coast Development) Retrospective Authority order
- Land Reclamation (Retrospective Authority) order (1987), and
- Land Reclamation Act 1991 (Cap 106)

The land reclamation act provided the framework for the authorisation of land reclamation. Currently, only the President may authorise "any owner of land…to fill in the whole or any portion of the foreshore which borders on the land belonging to such owner" (Sec 2 (1)). The law goes further in specifying the rights of the individual with respect to that law.

There are also the:

- Town and Country Planning Act, 1972,
- Removal of sand and gravel Act (1982),
- Minerals Act 1991, (Cap 129), and

- The Environmental Protection Act (1994).

The Town and Country Planning Act, 1972 does not refer to reclamation, but controls all development, including land reclamation. Therefore all reclamation projects are also subject to the Planning Authority approval. The Removal of Sand and Gravel Act (1982) apparently does not cover extraction of sand from the bottom of the sea, although it clearly states in Section 3(2) (a) that prohibition includes abstraction of sand or gravel from any place, including the public domain. On the other hand, the Minerals Act 1991 (Cap 129) governs and defines minerals and its extraction within the Seychelles. It specifies that the entire property in and control of all minerals in, under or upon any land in Seychelles or in all rivers or streams throughout the Seychelles is hereby vested in the Republic and the Republic shall have the exclusive right of prospecting and mining for such minerals (Section 3). Under the Environment Protection Act 1994 land reclamation is an activity which is subject to environmental authorisation following an environmental impact assessment.

Whilst many of the legal gaps indicated above are also applicable to this issue, some pertinent issues arise here with respect to the regulation of reclamation activities. For example, an overview of the law has revealed that there is no specific requirement for environment protection for reclamation activities. The only evidence of this is in the EPA regulations, which only list land reclamation as an activity subject to an EIA. Whilst this is an essential first step, it does not go as far as stating which types/size or location of the proposed development and whether all land reclamation projects should be subject to a full EIA. Noting the potential environmental effects and impacts a reclamation project may have on the environment; such guidelines should be available and inserted into law. Secondly, there is no process or ambient standards (e.g. silt concentrations) for the reclamation process.

Provisions to make use of proven approaches and use of best technologies, which have the minimum impact on the environment, are not clearly specified. The reference to 'natural beauty ' in the Land Reclamation Act is a clear reference to an impact on amenity values; however, it stops short on how this should be evaluated or measured.

The law is surprisingly very silent on the issue of development planning of reclaimed lands, although there is some emphasis in the TCPA on land use development plans. This provision should be extended to reclaimed areas, stipulating also the need to conserve and extend existing public services such as storm – water discharge.

Mauritius

As noted in section 4.5 above, national legislation pertaining to Coastal Tourism, Mangrove destruction and Mining/Sediment Transport/Port & Land Area Reclamation are currently contained in several sectoral and often overlapping sources. Important national legislation includes: Beach Authority Act 2002; Continental Shelf Act 1970; Environment Protection Act 2002; Ports Act 1998; Removal of Sand Act 1975; Rivers and Canals Act 1863; State Lands Act 1874 and Town and Country Planning Act 1954.

At present the institutional, policy and legislation framework for the management of the coastal zone in Mauritius is fragmented and, despite the recommendation made in the *1991 State of the Environment Report* that "control, custody and management of a coastal zone should be vested in an Authority", there is no Government body with overall responsibility for the coastal zone. At present, various ministries and para-statal organisations share in the management of the coastal zone including: Ministry of Environment; Ministry of Fisheries; Ministry of Local Government, Rodriguez and Rural and Urban Development; Ministry of Tourism; Ministry of Agriculture, Food Technology and Natural Resources; Ministry of Public Utilities; Ministry of Housing and Lands; Ministry of Public Infrastructure, Land Transport and Shipping;Mauritius Ports Authority; National Coast Guard; Beach Authority (created by the Beach Authority Act 2002);Waste Water Authority; Police Force and the Police de l'Environnement; and Municipal and District Councils.

The Ministry of Environment has set up an Integrated Coastal Zone Management Division. This division was set up on the recommendation of the National Environment Strategy (2000-2010) and it is expected to have a regulating role in coastal zone management (Bhikajee, 2001). However, the creation of the Integrated Coastal Zone Management Committee and the Environment Coordination Committee, as spelt out in the new Environment Protection Acts of 2002, is expected to provide a better coordination among the various enforcing agencies.

In addition, the Environment Protection Acts of 1991 and 2002 provide for the setting up of the National Environment Commission under the Chairmanship of the Prime Minister and having all the Ministers as members. The aims of the commission are to:

i. set national objectives and goals;
ii. determine policies and priorities for the protection of the environment, having due regard to the recommendations of the Minister;
iii. review progress made by public departments on any aspect of environmental management projects and programmes;
iv. ensure co-ordination and co-operation between public departments, local authorities, and other government organisations engaged in environmental protection programmes;
v. make such recommendations and issue such directions as it may determine to public departments; and
vi. monitor and review the activities of public departments concerned with the protection and management of the environment.

It is expected that the above initiatives will largely help in decreasing the overlap of responsibilities and provide for better coordination between the various organizations involved in coastal area management.

Mozambique

A relatively new environmental law, "Lei do Ambiente" was approved by the Mozambican parliament in 1996. It constitutes an important first attempt to introduce new concepts and a new vision and strategy for the environment in the country (SEACAM 2001). According to this framework legislation MICOA has the responsibility to take measures to control and monitor the environment and supervise the implementation of its provisions. In addition recent legislation has contributed fundamentally to a better use and protection of coastal resources. Also the level of the enforcement is remarkably low and weak (SEACAM, 2001).

However, Mozambique was one of the first countries in the region to establish an integrated coastal zone management unit (1995).

The "General Regulation of the Maritime Affairs" (Decree no. 265 of July 31, 1972) indicates in its first article that the Marine police have the role to enforce the legal instruments with regard to marine trade, game fishing, fishery industry, safety and the disciplines of maritime navigation, safety of the mining of the water beds, etc. This law is still in force.

Madagascar

Madagascar has framework legislation and several institutions for coastal and marine activities including, ports and marine transport; pollution management and environmental protection (SEACAM, 2001).

Madagascar also has a framework environmental legislation (LOI No. 90-033) Relative a la Charte de Le Environment Malagasy) which outlines the fundamental principles including the principle that the environment is an important pre occupation of the State and its protection is a matter and responsibility for all (Part II). It also provides for the establishment of a national environment policy and a plan of action for environment with stated objectives.

As indicated above, there is no co-ordination structure for the entire marine and coastal environment.

There are certain laws and institutions dealing with the key sectors of relevance to this study; namely ports, harbours, mining and damming of rivers. With regard to ports and harbours, mining, land reclamation and damming of rivers, each of the various economic activities has sectoral legislation and institutional arrangements. However, each of the sector developments must also comply with the requirements of environment impact assessment (Decree on Compatibility of Investments with the Environment). The law requires that environmental impact statements be prepared as a prerequisite for obtaining permission for key developments of the ports, mines (including sand mining), reclamation of land and the damming of rivers. Other relevant legislation to these sectors is land planning and tenure laws, including the decree on " Reserved Land Rights and the

law on " Private State Lands". These legislative texts permit Government ministries and public entities to fulfil socio economic and cultural policies on public land. In particular, ports developments and mining tend to be public enterprises.

Finally, the absence of a clear and specific environmental policy for marine and coastal zones in Madagascar makes law enforcement extremely unclear and problematic. Also as government institutions and structures become devolved and decentralised from central government and regional administrations it is yet unclear if the system will devolve power or simply create additional bureaucracies of government institutions.

Kenya

There are several legislations, which deal with land tenure, land-use and planning generally. These are deemed important because tourism, mangroves and ports, mining and land reclamation have a logical correlation with land use and planning legislation. Consequently developments of tourist establishments, ports, mines, damming of rivers and even the alterations of mangroves are contemplated by the planning requirement under cap 303.

Other laws in this league are the Land Acquisition Act (Cap 295) and the Land Control Act (Cap 302). The former deals with the compulsory acquisition of land for the benefit of the public (subject to compensation) and the latter with the controlling of transactions in agricultural land.

Prior to 1999, Kenya did not have a framework environmental legislation. Environmental rules and requirements were scattered in numerous sectoral statutes, often with sectoral institutions to deal with limited competencies. In 1999, after a culmination of concerted efforts, Kenya enacted the Environmental Management and Co-ordination Act (No. 8 of 1999). This landmark legislation in the evolution of Kenya's environmental governance was an effort at further improving environmental co-ordination and to fill existing gaps in the previous legal and institutional dispensation. The Act also created important institutional arrangements for the management and regulation of Kenya's environment.

Among the key institutions include the National Environment Council (NEC) (Part III, S. 4). The NEC is a policy organ chaired by the minister in charge of environment with a wide variety of different stakeholder representatives and the Director– General as Secretary. The NEC is responsible for policy formulation; the setting of national goals, objectives and priorities for the protection of the environment; the promotion of co-operation among public developments, local authorities and other stakeholders (S. 5) There is a procedure established for the NEC (S. 6). The Act also establishes the National Environment Management Authority (the "Authority" or NEMA).

Finally, some legislations and institutions are relevant to ports, mining, land reclamation and damming of rivers. They include the land- use and planning legislation reviewed above. The Kenya Ports Authority Act (Cap. 391) vests the operation and management of ports in the Kenya Ports Authority, a parastatal/ statutory corporation. The Authority has

power to (a) construct any wharf, pier, landing or any other work deemed necessary; (b) control the erection and use of wharves in any port or approaches to such port; and (c) construct new ports. This is an important mandate, considering that Mombasa port is one of the biggest and busiest in the western coast of the Indian Ocean with a very large hinterland reach. The development of port facilities is also usually accompanied by land reclamation. There is minimal, if any, non-State intervention in the administration or regulation of the ports sector.

The line Ministry of Transport and Communications exercises overall oversight of the Kenya Ports Authority. Damming of rivers is an activity contemplated by the land-use and planning legislation. But it is also covered by the Water Act Cap 372 (Revised 2002), which provides for the conservation and controlled use of water resources (inland waters mainly); the Lakes and Rivers Act (Cap 409) to regulate dredging and use of steam vessels on certain lakes and rivers (including Tana and Athi Rivers) which drain into the Indian Ocean along Kenya's coast. Also relevant is the Tana and Athi Rivers Development Authority Act (Cap 443), which is an authority to provide for the establishment of an authority to advise on the institution and coordination of development projects in the area of the Tana River and Athi River basins and for, related matters.

There is also the Irrigation Act (Chapter 347), which contemplates damming of rivers for purposes of irrigation. The Act establishes the National Irrigation Board as a body corporate and defines its functions and powers. It is yet another parastatal/statutory corporation directly controlled by the line ministry.

What is apparent is that the large number of statutes reviewed above in respect of various activities leads to duplications, overlaps, inconsistencies, and a system of very weak penalties (except perhaps for the newly enacted EMCA 1999). For example, it is not clear whether the framework legislation supersedes the sectoral laws in certain respects; whether the various institutions created (parastatal and central government departments) are able to work in harmony without overlapping mandates and inter - institutional jealousies.

Comoros

The framework Act on environment (Part 3) provides for a mandatory impact assessment study as a prerequisite for the developments, which have or are likely to have environmental impact. This Act is not well known and despite its existence many irregularities do occur. This Act is too general and it is noteworthy that there is no specific chapter or article on the coastal zone. However, owing to the scantiness of the islands and the myriad dangers facing them (floods, rise in sea water levels etc) emphasis should be put on the coastal zone, more so due to the fact that the Island depends on activities concerning the coastal zone and marine environment (ports, tourism, fishing etc).

Some of the other laws relating to the sector under review include the Decree 22.02.1935 which defines "Port" and establishes the national office for ports (Loi no. 81-37, as amended by Loi no. 82-25 of 19.11.1982).

The problem of the application of this Act and of other regulations is common in the Comoros and particular attention should be put in enforcement. The Act is either generally ignored in application or not applied. The problem of impunity remains a major obstacle in the application of the Act. The national policy and action plan on environment exist but unfortunately the institutional structures charged with the responsibility of execution/ implementation presents some limitations, such as on human resources, technical and financial capabilities. The main obstacles are essentially as follows:

(a) Lack of enough personnel at the directorate general of the environment since its creation;
(b) extent and complexity of problems in resolving beforehand the implementation of certain measures;
(c) weak legal and regulatory systems;
(d) weak and inefficient institutions;
(e) low level of education of actors in various environmental disciplines;
(f) in sufficiency in communication, information and sensitisation between government and public entities on one hand and the population on the other; and
(g) constant and regular mobility or turn over of managers/ directors in the administration of the environment.

6.3.6 Case studies

Case Study1: Severely Impacted Area and Ecological Restoration of Reclaimed Areas: East Coast of Mahe, Seychelles.

Background

Since the first reclamation in 1973 for the main port and the international airport, other reclamation works have taken place around Mahe. The phase 3 of the East Coast Project completed in February 2003, which has resulted in the reclamation of 297 hectares of land around the capital city of Victoria. The primary objective of the project was to cater for the physical requirements of the future urban development of Greater Victoria over the next 25 years. However, in view of the disastrous impacts of such activities a restoration programme is proposed as part of the environmental impact assessment process. This restoration programme is then adopted by the developer within an environmental management plan.

Restoration management plan

Following completion of the project the contractor is expected to green the reclamation zone, and restore the coastal mangroves. However, since growth of mangroves is accelerated in Seychelles, on several occasions it was not necessary to plant mangroves as they seem to grow better naturally. What was observed is that the mangroves tend to be mono-species in the first stage, and

then starts to become more diverse as the stands mature. Such re-colonisation of mangroves also brings about a number of birds and fish.

Whatever the works to be executed, the littoral channels will require, after the construction of the reclamation retaining embankments, regular maintenance in order to eliminate the accumulation of debris, flush the eventual sedimentation zones. At the same time, it is imperative to organise the collection and treatment before safe disposal of effluents; the training of watercourses to reduce flood-induced erosions; water quality monitoring programme.

The rock armouring should be maintained to protect the coastline from erosion as the incident waves are expected to be quite strong, compared to when the coast was located one km inshore. Periodic inspections of the rock armouring would indicate whether silt is seeping out into the ocean. All efforts should be undertaken to minimise this small but long-term outflow of silt into the coastal area, especially within the vicinity of Ste Anne Island.

Reclaimed sediment contains excessive amount of salts and a high pH, and since it is primarily calcareous in nature with no nutrients, certain plants ideal for landscaping will find it difficult to adapt to such conditions. Consequently the following strategies have been found to work in the first stage of a restoration project:

1. Through the action of the rain, the salts are allowed to slowly leach out.
2. Spread and apply organic compost and slurry to condition the soils
3. Aggressively plant Casuarina, Albizia and even some grasses and sedges commonly encountered on the outer islands to allow the first line of plant colonisers to become established.

The expected results from these activities include stabilisation and enrichment of the soil. The dispersion of fine sediments through uplift and deposition by the wind should not be ignored, and if vast areas are left unplanted, the atmospheric deposition of the silt may lead to additional impacts in the coastal marine environments.

In a second stage the reclaimed area is planted with various local exotic plants and soon it is difficult to say which land is reclaimed and which one is not.

Case Study 2: Damming of rivers in Mozambique

The damming of a river can lead to drastic consequences in the environment as it reduces the water flow and the import of sediments and nutrients to the coastal waters. This may also cause imbalances in sediment fluxes that in turn cause either chronic erosion or sedimentation. In addition, the associated wetland may also change to affect the vegetation cover and the associated wildlife.

Modification of stream flow is mainly caused by the operation of the dams. Major dams constructed in most systems have deprived the lower regions of water. The rivers mostly affected by the dams in the upper riparian countries are Incomati, Limpopo, Pungoe and Zambezi.

River Zambezi is the largest river in East and Southern Africa. The average annual discharge is about 140,000 m^3, representing about 67% of the total discharge of all the rivers of Mozambique (Sætre and Jorge da Silva, 1982). Under natural conditions the Zambezi River, like the rest of the rivers of

Mozambique, is torrential with high flows during the wet season, i.e. from November to March, and relatively low flows in the dry season (April to October). On the average 60 - 80% of the mean annual flow occurs within few months of the year. Zambezi has about 30 dams of which two (the Kariba and the Kahora Bassa) are large dams meant to produce electricity. Lake Kariba is the largest reservoir with a storage capacity of 160,000 million cubic meter of water (Water in Southern Africa, 1996).

The operation of the Kahora Bassa dam started in 1974. As a result of these dams the runoff seasonal cycle of Zambezi changed: the wet season runoffs have been reduced by about 40%, whereas the dry season runoffs were increased by about 60%, as shown in the figure below (Hoguane, 1997). In addition to the changes in the seasonal cycle there was a reduction in the runoff. Before the operation of the Kahora Bassa dam (i.e. before 1974), the maximum flows were mostly over 10,000 $m^3 s^{-1}$. After the regulation, the maximum flows were mostly below 5,000 $m^3 s^{-1}$ (Hoguane and Dove, 2000). This implies that the dam might have contributed to the reduction in flows by about 50%.

7 CONCLUSION AND RECOMMENDATIONS

7.1 Regional Overview: Coastal Tourism

In most of the countries of the region, coastal tourism development is increasing, as tourism is seen as a viable option for economic growth. In the past two decades and during the past decade, the tourism industry has emerged as one of the fastest growing sector and established itself as one of the main pillar of the economies of some countries such as Kenya, Seychelles and Mauritius.

Each country in the WIO region has unique characteristics and is at different levels and stages of tourism development, however, it is clear that most of the countries have the following in common:

- Tourism is rising sharply, and is increasingly viewed as an important economic opportunity at local, regional and national levels
- Mauritius and the Seychelles, for example, can be seen as very tourism-dependent countries in the WIO region. However, most countries still depend on subsistence economies involving fishing, agriculture and animal husbandry.
- Tourism is directly dependent on natural assets, such as scenic landscapes, coastlines and beaches, coral reefs, rainforests or savannahs, and colorful, dangerous or unique animals.

However, current unsustainable practices by most hotels (including lack of medium and long-term planning, poor site management, poor or non-existent waste water management, etc) are impacting on the health and well-being of the marine and coastal environment. The negative impacts of coastal tourism are evident in many parts of the region. These impacts include physical destruction of coastal habitats by construction works, dredging and reclamation, anchor damage to corals by tourist boats and coral breakage by divers, pollution from wastewater discharge from coastal resorts, over-exploitation of fish and shellfish to meet increased demand of food, and disturbance to wildlife such as nesting turtles and seabirds leading to higher mortality and decreased fecundity.

Legislation and institutions relating to tourism in most of the WIO countries is fairly sparse. Most of the countries' commitments to tourism as a sector are apparently located in policy rather than legislative instruments. The most relevant laws and institutions on tourism, from a PADH perspective are those concerned with land tenure, land use and planning.

In Tanzania, land use and planning legislation does not also directly deal with tourism, except to the extent that tourism infrastructure and developments including those at the

coastal and marine environments, is subjected to land use and planning legislation. The same position obtains in South Africa, Mozambique, Seychelles, Mauritius, Comoros and Madagascar. However, in terms of the requirement for EIA the framework legislations in virtually all the project countries oblige tourist establishments' developers to seek and obtain EIA authorization to keep the integrity of the environment.

The magnitude of the environmental, social and economic implications due to coastal tourism in the region has not been comprehensively assessed but all indications illustrate the negative environmental, social and economic costs that countries bear or threatened with. Tourism and related infrastructure have encouraged rapid and large increase in population densities especially on the coastal urban areas that in turn have contributed to the pressure on the coastal environment. Examples of environmental pressures resulting from the tourism industry include threats to coral reefs as a result of boating and reef walking, whereas the collection of shells and ornamental fish for the tourist market add indirect pressure on the coral ecosystem.

7.2 Regional Overview: Mangrove Destruction

Mangroves are important components of coastal ecosystems in all the Western Indian Ocean countries. Mangroves are associated with coastal wetlands and contribute significantly to the functioning of coastal ecosystems. Ten mangrove tree species are found in the WIO region. Of these, *Avicennia marina, Rhizophora mu-cronata*, and *Ceriops tagal* are predominant, while *Xylocarpus mulleccensis* is rarest.

In most of the sites where mangrove ecosystems are prevailing, there is an accelerated rate of mangrove loss. In Mozambique, the rate of mangrove loss between 1972 and 1990 was 3.6% of the total area of mangrove in 1972. This is alarming compared to 0.2% annual rate of deforestation in the country. Maputo Province shows the highest rate of deforestation with 15.2% of the mangrove area of 1972 lost; this is equivalent to 0.84% loss per year. In Kenya, most of the estuaries and creeks, except the Sabaki estuary, are colonised by highly productive mangrove swamps but the loss of mangroves since pre-agricultural times is thought to amount to 70%. Mangroves covered a large part of the coastline of Mauritius in the past, but its area has decreased markedly with the development over the last three decades. Over two hundred years ago mangroves fringed the east coast of Mahe, Seychelles, so thickly that it was difficult to find passages though them to get to shore. Now only less extensive stands exist, especially on the granitic islands.

Demand for mangrove products for local uses such as fuel wood, charcoal, construction (boats and houses) and for making lime, tannin, etc has not abated despite the establishment or putting in place of programmes for community-based mangrove conservation in some of the countries of the region This is because mangrove forests still provide the cheapest and relatively easily accessible sources for several subsistence needs for poor coastal populations. These impacts are likely to be more intense in future due to several reasons including the high demand for relatively cheaper solar salt and the

conversion of wetlands into agricultural ventures like rice and fish farms and it may be problematic to constrain poor communities from practising uncontrolled harvesting.

Several studies indicate that mangroves often yield greater social net benefits if they remain as natural ecosystems. This is because the total values and benefits of mangrove ecosystems when determined from both marketable and non-marketable goods and services are irreplaceable, and often, many conversion-based alternative uses have proved to be expensive to construct and maintain, or have produced disappointing economic results due to low and declining productivity. Examples include clearing mangroves for shrimp farming. The net benefit usually drops after a period of 5 years due to ecosystem degradation that cannot support the activity any longer.

For a comprehensive valuation of the benefits of mangroves, an in depth study has to be conducted on the national and local benefits of aspects such as the value of timber and non-timber products from mangrove forests. It is however clear that destruction of mangrove ecosystems has led to a loss of direct and indirect social and economic values and services affecting people at household and national levels.

It is evident form this review that relevant legislation (and institutional arrangements) on mangroves in the Region seems to be rather fragmented, sparse and indirect. Generally, the countries do not have specific legislation on mangroves or any legislation that deals with mangroves per se. Some exceptions are Kenya's Forests Act (Cap 385) which has subsidiary legislation that identifies mangroves either as harvestable timber or as specified forest reserves for protection and Section 6 of Mauritius Fisheries and Marine Resources Act (1998) which directly mentions mangroves and prohibits their destruction. But this is in reference to their importance as breeding and/or nursery grounds for fish.

In Mauritius, national legislation pertaining to mangrove destruction is contained in several often overlapping sources although recent developments have begun to reflect a more integrated approach.

Kenya's new framework legislation on the environment (Environmental Management and Co-ordination Act, No. 8 of 1999), a culmination of many years of concerted efforts by government and a variety of other stakeholders, places the environment, including PADH, at the centre of legal and administrative process, as well as in the key socio-economic and other undertakings of the country. Previously, environmental considerations were generally regarded as peripheral and incidental to Kenya socio-economic processes.

7.3 Regional Overview: Ports, Land Reclamation, Mining and Damming of Rivers

Activities relating to expansion of ports, mining, reclaimed land and damming of rivers have significant impact on local economies and National revenues. They, however, also significantly contribute to physical alteration and destruction of habitats. The net benefit may therefore be negative if these activities have to be assessed on the basis of a sustainable development framework.

What is apparent however is that these activities have all signs of increasing. For example, dredging activities for port expansion and maintenance have all indication of continuing. This has mostly been due to inter-port competition and concentration. Political and economic circumstances affecting the region as a whole, such as economic liberalisation have encouraged port expansion in order to increase efficiency. In a situation where ports in neighbouring regions are currently wining some percentages of the cargo services originally handled by some of the region's ports, some countries have been compelled to expand and modernise facilities to be competitive. For example, the bulk of Zambian cargo traditionally handled by Dar es Salaam port is slowly declining as political reform in South Africa has enabled the later to win some of this trade. In 1997, the Tanzania Harbours Authority initiated a US$24m modernisation programme in an attempt to win back such trade.

There is also a tendency to modernise 'central' ports as strategic investment relegating other ports to smaller roles and activities. In East Africa, concentration on the ports of Mombasa and Dar es Salaam has relegated the position of the Tanga and Mtwara ports to minimal contribution. These ports currently handle less than half a million tonnes of cargo per year compared to the 8million and 5million tonnes of cargo handled by Mombasa and Dar ports respectively.

There are several Land Reclamation projects in the Region, often implemented to alleviate the acute problems of land shortage for extension of ports, construction of roads, and to provide space for service infrastructure such as dumping sites. These projects have a permanent impact on the economy and social structure of the country. Whilst they offer many potential advantages, they also have many disadvantages, including loss of critical habitats and the high cost of reclamation.

Although the percentage of GDP relative to these investments could raise concerns on economic stability in the countries of the region, the projects offer the countries new opportunities for economic diversification, and especially consolidate other economic sectors. However, the benefits of this additional land may not be totally exploited if suitable land use policies are not put in place.

Mining of sand and other aggregates has also contributed to destruction of the coastal zone, predominantly the coral reefs, and have consequently exposed the shores more to

wave action, storm surges and inundation (Mauritius). Uncontrolled mining of sand and gravel have also diminished the aesthetic value of the coastal belt in several places particularly near large cities whereby huge pits have been left unfilled creating lakes that breed mosquitoes and thus posing a threat to people's health (Kenya, Tanzania).

The construction of dams for storage of water and for harnessing hydroelectric power has had a negative impact on the coastal and marine environment of the Region as is the situation elsewhere. For example, the alteration of the flow regime of the rivers means alluvial sediments are trapped, resulting in impoverishment of sediment supply at river mouths and deltas. The effect is the recession of the shoreline and the disruption of the spawning and growth cycles of marine fish and prawns.

However, the enhanced soil erosion caused by agricultural production and intensified farming practices especially cultivation close to river banks, result in increased levels of suspended sedimentation, which lead to siltation of lakes created as a result of damming of the river. For a predominantly rural-based population, whose farming technology is predominantly crude, poor farming practices will continue and hence continued siltation.

It is apparent that in most of the project countries there are various types of legislation which deal with ports, land reclamation, mining and damming of rivers and they relate to physical alteration and destruction of coastal and marine habitats. In particular, legislation on ports (and harbours) tends to be fairly explicit in most of the countries, probably because of the supreme socio-economic importance of ports in each of the countries. Ports are also important in political and military/strategic terms because of the maritime zones claimed by the coastal states.

Ports legislation is usually pre-occupied with development and expansion of physical infrastructure and port capacities and the administrative structures which are most traceable directly to central government. The ports authorities are traditionally state enterprises in most of the project countries. They therefore would usually be presumed or claim to be acting in the national or public interest. However, the national legislative studies have shown that where there are environmental impact requirements, they affect even public entities like the respective ports authorities. Enforcement mechanisms would naturally be weaker or compromised where public enterprises e.g. environmental authorities are expected to oversee or supervise other public entities to ensure environmental compliance.

On the contrary, there are direct mining legislation and less direct legislation on land reclamation and damming of rivers. However, since there are usually compelling socio-economic imperatives for land reclamation (for example agriculture, Mariculture development of port facilities), damming of rivers (for example for hydroelectric power generation, irrigation, fisheries development, etc), legislation, if any, on these activities tends to have either weak and inoperative provisions or ineffective enforcement mechanisms. Perhaps the most important legislation in most of the countries in this regard is EIA Regulations, and to a lesser extent, legislation that creates protected areas such as forest reserves, marine national parks and nationally controlled coastal or marine zones.

A good example of apparently rare legislation is the Land Reclamation Act 1991 (Cap 106) of the Seychelles. It basically provides a framework for the authorisation of land reclamation, rather than prohibition of reclamation. In 1997, the Government of Mauritius declared a ban on sand mining from the lagoon. It extended a moratorium until October 2001 when the ban was enforced.

The review has shown that the countries in the region have all made relevant legal and institutional arrangements for their environments and particularly the coastal and marine areas. The laws and institutions are predominantly sector based. However there are framework environmental laws and institutions in each country to place environmental issues at the centre of government business. In their own right each of the countries is a success story. In the circumstances, it is plainly hard to identify " best practices" or "models" particularly when it is considered that each of the countries is a sovereign state with its own laws, institutions, standards and processes. The choices necessarily place higher " premiums" on certain national laws and institutions than on all others.

7.4 Recommendations

On the basis of the thematic reports, country reports as well as the coastal erosion reports, the following recommendations are proposed:

7.4.1 National Recommendations

Research and Monitoring

- Data quality and insufficient data on some environmental indicators. Overall, there are several aspects which have not been discussed in the report for the all countries because of either, lack of data or the quality of data is poor. Long term and consistent monitoring/spatial data is lacking. Often only one time assessment data is available in most cases and little historical data exists, making it difficult to determine changes in the ecosystems or habitats. All the countries should establish systematic monitoring programmes on various aspects such as pollution, habitat degradation, water quality, and shoreline changes.
- Few valuation studies and data. While the drive towards increased economic development is inevitable, the lack in most of the countries of the region, of capacity in the economic evaluation of environmental assets is of great concern, and is an issue that needs to be urgently addressed and integrated into the planning process. Loss in tourism revenues because of the degradation of environment or data on infrastructure damage and repair is hardly available. Also, much of the socio-economics information available is qualitative in nature, giving qualitative descriptions of impact measures.

Legal and Institutional Framework

- Although many countries have, to a lesser or greater extent, legal frameworks to regulate and control the utilisation of coastal and marine resources, these are sector specific. It is recommended that each of the countries establish and or strengthen national legal and institutional arrangements for the implementation or integrated coastal zone management. This would avoid a fragmented, piecemeal or sector based approach to legislation, institutional and policy formulation for the coastal and marine environment. It would also ensure that legislation is in proper tandem with existing or proposed institutions, policies and action plans.
- Setback strategies involve the restriction of development of certain types within a prescribed distance from the shoreline. In order to regulate development in the coastal zone, it is important that environmental sensitivity maps with guidelines on the nature and type of development that could be allowed in such areas be prepared. The coastal classification map and its derivative susceptibility assessment provide important guidance in the placing of setback limits.
- It is recommended that some of the specific amendments and/or inclusions into national legislation and institutional arrangements could include the progressive total ban/abolition of sand mining as an economic activity in all (or at the most sensitive) beach areas as has been done in Mauritius and Seychelles. The affected counties could declare a moratorium and then ban the activity subject to compensation for those directly affected. Others could include a mandatory process of public and private sector consultation before important environmental decisions are made. This is to encourage public participation in environmental decision-making and governance to avoid concentrating too much power on government authorities and officials and to improve implementation and enforcement mechanisms.
- It is recommended that the EIA regulations be established and strengthened in each of the countries. All projects and developments of environmental or socio-economic importance, including tourism, mangrove harvesting or clearing or change of land use and ports and mining must be subjected to vigorous and mandatory environmental impact assessment. However, the technical rules could be reviewed and simplified to enable the rules to be consumer/user friendly and to command public acceptance. Within EIA regulations or in parent environmental legislation, there should be complete avoidance of developments in critical or vulnerable areas such as wetlands, mangroves, sea grass meadows, productive estuaries, shellfish beds, and coral reefs. Those who undertake such activities as mining, tourist and ports developments should be compelled by law to undertake mandatory restorative or rehabilitative activities such as filing up pits and burrows, replanting of vegetation, etc. The EIA process should also ensure strict adherence to all procedures, including scoping, mitigation and restoration.
- Involvement of community members, students from coastal schools, and private sector in coastal monitoring programmes and beach clean-up campaigns, is important as it heightens their sense of coastal stewardship. The potential exists to involve the private sector, especially hoteliers, in monitoring beach changes. These changes have obvious implications for hotel operations

Alternatives Techniques

- Countries such as Comoros, which relies on beach sand for construction, should be assisted financially and technically to find alternative sources of sand.
- Re-vegetating beaches and dunes with native vegetation. This has proven to be effective in preventing further erosion of beaches and dunes.

7.4.2 Regional Recommendations

- Under the auspices of the Nairobi Convention, regional guidelines/Code of Conduct for shoreline change be developed. Such guidelines/Code of Conduct should contain precise recommendations, practical and realistic principles as well as rules for good practice for local, regional and national authorities and other key stakeholders. The guidelines/Code of Conduct should contain such information as the status and trends of coastal defence measures applicable to the region and the potential impacts of different measures
- An important corollary of the review of national legal and institutional provisions would be to expedite the review of the relevant regional laws, particularly the Nairobi Convention and its protocols (1985) to enable a better regional framework for tackling environmental degradation especially physical alteration and destruction of habitats in the coastal and marine environment. Such review must necessarily acknowledge the immense socio-economic value of some of the activities and sectors causing or responsible for physical alterations and destructions of habitats in our coastal and marine environments. Moreover, there is need for the enactment of new protocols to the Nairobi Convention, particularly a protocol on land based sources and activities(LBA/S) Also, the concept of sustainable development would have to be firmly embedded in regional and national laws and their corresponding enforcement agencies.
- It is also recommended that the region consider elaborating a detailed EIA framework to be adopted under the Nairobi Convention to strengthen and consolidate the efforts and gains made by the National Governments in environmental assessment for projects and activities. Such a framework may take the form of detailed regional guidelines or a protocol additional to the Convention.
- Implement actions to reduce and prevent the degradation of the coastal and marine environment caused by physical alteration and destruction of habitats through:
  - A regional workshop to finalize various tools and guidelines which outline how all parties should address physical alteration and destruction of habitats in a sustainable and cost effective manner
  - Set up and implement demonstration projects on replenishment of eroded beaches (2), construction of wetlands for wastewater treatment (1), storm water management (1), Integrated basin management (1), Mangrove rehabilitation (Several), Small scale mariculture for fish to illustrate sustainable use and management of coastal zones

- Develop a detailed fundable proposal on promoting environmental sustainability within the Tourism industry based on public private partnership and taking into account of the need to provide community benefits and alterative livelihoods

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Fostering regional cooperation in the protection, management and development of the coastal and marine environment

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