

**PHYSICAL ALTERATIONS  
AND  
DESTRUCTION OF HABITATS  
IN  
MOZAMBIQUE**

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## Executive summary

Major tourism impact in the physical alteration and destruction of habitats is mostly due to the tourism operation, rather than building of tourism infrastructures. The major degrading tourism activities are building in sand dunes and in mangrove swamps, and driving in coastal dunes. The major areas affected by tourism are the southern part of Mozambique, in the parabolic dune environment. Mangrove destruction is mostly due to urban expansion. There are some minor threats to mangrove due to prawn culture in the central part of the counter and due to salt production in Maputo. Dredging of the navigation channels is the activity related to the operation of the ports that causes physical changes in the environment. The Maputo and Beira ports, are constantly being dredged because of siltation. These harbours are located in estuaries. There is a threat to destruction of a natural reserve for building a harbour in Ponta Dobela, in the Southern Part of Mozambique. Sand mining occurs in the vicinity of large urban centres. The quarries are abandoned living large swamps. Erosion occurs all over the country. The major causes are related to sediment deficit in the estuaries and coastal areas due to the effect of the dams. Deforestation of sand dunes also causes erosion. The are mostly affected by erosion are Nacala, Quelinae, Chinde (Zambezi Delta), Beira, Macaneta and Maputo.

The government developed a set of sectoral and cross-sectoral legislations and Laws regulating the exploitation and use of natural resources, and protection of ecosystems and environment as a whole. On the other hand, there are several institutions dealing entirely or partially with one or more issues regarding coastal affairs. There is no single institution responsible for all the coastal affairs. There were created a number of inter-institutional committees, which include besides the government representatives, non-governmental organisations and private sectors, to address issues that transcend the mandate of single institution. There is overlapping in the legislations and in the mandate of the institutions that need to be understood and sort it out. This can be achieved through an adequate harmonization of the legislations and coordination between the institutions.

Another constraint to action is related to the lack of our understanding of the ecosystem structure and function, which could help the enforcement of the law and in the management. There is a lack of qualified personnel. Very often we do not know how most of the ecosystems function, how each intervening factor contribute to the system, and how the different factors inter-related one to another. Institutional capacity goes from the lack of infrastructures for research and monitoring to the lack of co-ordination among different institutions dealing with marine issues. Lack of co-ordination often leads to duplication of actions with unnecessary expenditure of resources. Sustainable exploitation of resources requires a thoroughly research and permanent monitoring, which is too expensive for a developing country. In addition to these limitations, in some cases the legislation may not easy sustainable development, particularly where there is a free access to the resources, or absence of regulation in the extent to which and/or sustainable ways of resource exploitation.

Thus, the following actions are recommended:

- harmonization of the legislations,
- establishment of an effective coordination mechanism between institutions
- building capacity for research, management and surveillance.

## **1. Introduction**

Mozambique is situated in the eastern coast of Southern Africa, between the latitudes 10°27' S and 26°52' S and longitudes 30°12' E and 40 ° 51' E. The Mozambican coastline, the third longest in Africa, is about 2700 Km long. Mozambique is rich in land, marine and mineral resources. Coastal resources comprises fisheries, agriculture and forest, and it is a potential for tourism development. These resources and activities have a great potential to contribute significantly to the national income as well as providing social and economic benefits to about half of the Mozambican population that lives in this area.

The natural disaster, such as floods and droughts, allied to the growing number of population and the development of the activities in the coastal areas are leading to the degradation of the coastal environment due to inadequate development strategies adopted. For the purposes of this document we will refer to the physical environment in the coastal areas in both marine and land areas.

The present study aims at reviewing the actual legislation and institutional setting with regard to physical alteration and destruction of habitats in Mozambique, with a particular focus on tourism, mangroves, ports, land reclamation and damming the river. During the course of this study a literature review, interviews with relevant stakeholders and case study on the Macaneta peninsula erosion were conducted.

## **2. Current legislation and institutional setting**

In Mozambique there is no specific legal framework to address the issue of Physical Alteration and Degradation of habitats. Perhaps the Law of Soil, Fauna and Flora which addresses more specifically the issues of soil degradation and erosion is the most closely related to the issue. However, this law was developed to address the agriculture activities. Other Laws that indirectly address the physical alterations and/or destruction of habitats are the Environmental Law, the Law of Fisheries, The Law of Tourism, the Law of Maritime Transports, among others.

The existing laws and legislation may be grouped into two major categories: (i) the sectoral and (ii) the cross-sectoral Laws and legislations. The sectoral Laws regulate the licensing and the activities within a specific sector, with the view to assure the rational exploitation of the resources concerned, as for instance: the Law of Fisheries is concerned with regulating the exploitation of fish assuring the maintenance of fish stokes; the Tourism Law is concerned with the regulating the tourisms activities making sure the activity compiles with the national sectoral policy. The cross-sectoral laws are those that applies across all the sectors and activities such as the Environmental Law.

The most important legislation related to the protection of environment, including prevention of habitat degradation is the environmental law that imposes an Environmental impact assessment prior to any development initiative.

## 2.1 Review of some of the important regulations

Table 1 presents a summary of the Law and legislation related to the exploitation of natural resources, protection of habitats and regulation of development activities. Some of these Laws and legislation may be related to the physical alteration and destruction of habitats due to tourism activities, mangrove harvesting, port operation and damming the river.

**The Environment Law** (Law No. 20 of 1<sup>st</sup> of October, 1997) “The constitution of Mozambique gives to all the citizens the right of living in a balanced environment, as well as the responsibility of its protection. The materialization of this right there is a need of having the correct management of environment and its components and the creation of favourable conditions for the health and the well being of the people, to the cultural and socio-economic development of the communities and the preservation of the natural resources that sustain them.” Thus, this Law has the main objective the legal base definition for correct use and management of the environment and its components, in order to achieve the sustainable development in the country. In order to achieve the sustainable development, this law defines the creation of different environmental instruments, the “**The national programme of environmental management, the National council for sustainable development**”. Apart from that, the Law has foreseen the creation of local environmental institutions and the involvement of the communities at the various level of the management. It is pointed out that, for issuing the licence to undertake large development projects that involve the building infrastructures of large impact on the environment, an EIA should be undertaken.

**“Regulation for Protection of the Soil, Fauna and Flora in the Overseas Provinces”** (Decree no. 40040 of February, 1955) –This Decree aimed at the protection of the soil, fauna and flora. The Executive organs would be the provincial services of Agriculture and Forests for fauna and soil issues and the Services of Veterinary for the fauna issues.

This regulation also created the National Council for the Protection of Nature, with advisory and legislative competences and with the role to coordinate and guide the preservation of the soil, flora, fauna and natural monuments. Regarding the soils, the Council could determine that any official entities rendered, to the Services of Agriculture, the special collaboration that was necessary to execute its task.

The adopted measures for the soil protection were the prevention of erosion and improvement of the already eroded land, defence against the sand **movement** and the restoration of the areas already invaded by sand, conservation and improvement of the soil vegetation, conservation and correction of the deposits and water courses, rational use of soil with maintenance of its productivity.

**“Regulation of the Wild Fauna Protection”** (Decree legislative no. 2496 of July 4, 1964) – This regulation was elaborated as a complement of the previous decree and it indicated “that the providences to take into account for the protection of wild fauna are mainly for its conservation as an element of bio-ecological equilibrium to be developed for the man's usefulness avoiding however that elapse damages from it.” The decree attributed the competence for the fauna inland waters to the Forest services and it was not clear who would be in charge of the marine waters fauna although it could be presumed that the responsible would be the Veterinary services.

**“Regulation of Forest in Mozambique”** (**Portaria** government decree no. 2642 of September 20, 1965) – This regulation was also created as a complement to the decree no.

40040. The flora protection besides resulting from the providences for conservation of soil or to issues to this related it is undertaken by the protected areas and other preservation measures taken by other competent services or **particular entities** in harmony with the law. The main objective for the flora protection is to assure the biotypes maintenance to which the survival of animal and vegetation species are related; maintain the necessaries conditions for the existence of native biotypes; maintain the representatives of the fundamental populations types of different floristic species and avoid the massive destruction of forest that are of public or scientific interest.

The decree also emphasized that the concessions of land for agricultural, cattle rising or forestry purposes should take into account the economic role of the forest and the vegetation cover, the principles of protection and conservation of cultivated flora; the methods of its use in order to increase its productivity; creation of new forestry resources; restoration of the forest in areas that have been deforested; keep the trees cut down at the minimum level during the occupation of land independently of the use it is meant for; protection of the water courses and sources; stabilization of dunes and defences against the sand invasion. This regulation and the previous one are being reviewed under the laws revision processes being undertaken by the National Directorate of Wild Fauna and Flora.

**“General Regulation of the Maritime Affairs”** (Decree no. 265 of July 31, 1972) – This ordinance indicates in its Article I, that “the Marine Partitions have the role to make the **legal instruments be observed** regarding to marine trade marine, game fishing, fishery industry; safety and it disciplines of the maritime navigation, fluvial and lakes, to the **illumination** and traffic signs of the margins for safety sailing, assistance to people and vessels/boats in danger, supervise the discipline and assist the beaches users; safety of the river basins exploration, ..., water pollution, safety of the mining of the **water beds**;

The Partitions Marine takes charge also of the general supervision of the respective jurisdiction areas, without the attributions policemen's of the port authorities' damage.” This law is still in use and it is implemented by SAFMAR (Maritime Safety Agency).

**“Protection measures against the Pollution of Waters, Beaches and Margins in Ultramar” (Decree no. 495 of October 20, 1973)** – This document deliberates, in its Article 1st, that: “it is prohibited, except with for special authorization, the dumping or spillage, in the contiguous zone and territorial sea, in the Ultramarine provinces, as well as in the ports, docks, boilers, river beds and in navigable and not navigable rivers, beaches, margins, and other areas of the marine authorities jurisdiction of the, of any harmful and residual substances, as well as of any other substances or residues that somehow can pollute the water, beaches and margins, such as oil products or mixtures that may pollute the water, the beaches and margins, such as oil products. No acquired rights can be recognized concern to contamination, but if it occurs, the law provides that appropriate schedules should be granted for authors to gradually reduce the characteristics of dumping material to acceptable standards, and whoever causes water pollution, should, at their own cost, restore the site to its normal condition and at the same time pay the fines.

It is also prohibited the pollution of any area under of the maritime authorities by any agent from outside. The maritime authorities would take any necessary penalisation in order to prevent or punish the polluters. The Article II prohibits the national ships to discharge persistent oils (fuel-oil, oil heavy diesel) or of wastes in the sea.

The legal documents above exposed are related to the coastal environmental administration of Mozambique during the colonial period (before the national independence, 1975). After the national independence, in 1975, the ordinances and the mentioned regulations were largely maintained with small alterations or in the entire (for example, the ordinances 265<sup>th</sup> and 495<sup>th</sup> that more specifically refer to the coastal administration). In addition, there were introduced new laws/regulations, such as “The Land law – the Law that regulates the use and exploitation of the land” in 1979. The period after independence, there was few legislative activity produced, just to highlight the Ordinance - Law No. 31 of the 19<sup>th</sup> of August, 1976 that establishes the right sovereign of the state on the exploration of the marine economic resources and the Law no. 6 of 3<sup>rd</sup> of July, 1979 that it disposes on the use and exploitation of land (regulated by the Ordinance no. 16 of 1978). The second phase was characterized (1990), by the promulgation of laws and several norms regarding the dynamics of the activities developed in the coastal zone. Among the several regulations for the coastal areas it's relevant to mention some of them, because of their importance for the management of these areas:

**“Law of the Fishing”** (Law No. 3 of the 26<sup>th</sup> of September, 1990, regulated by the Ordinance No. 37 of the 27<sup>th</sup> of December, 1990), that disposes on the fishing industry in the country and it establishes the administration mechanisms, licensing and control of this activity.

**“Law of the Water”** (Law No. 16 of the 3<sup>rd</sup> of August, 1991), rules the use and control of the inland waters. The Water Law, enacted in 1991, defines the general principles of water management, the user rights and the institutional control and monitoring of water usage. Water is considered as a property of the State and the public may be granted rights to the use of water. The law establishes the principle that polluter with regard to pollution and environmental protection, above the accepted levels, must be penalized, paying by the damage. The law defines the concept of water contamination, to allow protection measures using scientific knowledge.

**“Law of the Sea” and “Maritime Courts”** (Law No. 4 and No. 5 of the 4<sup>th</sup> of January, 1996) which regulates the maritime activity in the country and define the competent judicial forums in the matter. There are three s the territory, and of the coastal zone in particular. The regulations are:

**Law of the Local municipalities/autarchies** (of 18<sup>th</sup> of February, 1997); this is about the organization and the local government's competences and it regulates the decentralised according the legislation and the previous laws. In the article 6th, this document defines the issues related to the environment among the attributions of the local **Autarchies/ municipalities**;

**The Land Law (Law no. 19 of 1<sup>st</sup> of October, 1997)**, which establishes the farmer's framework of the country and regulates the access to the use of soil, being therefore, the basic document for the orientation of the land occupation and appropriation of spaces and defines the limitations and the requirements for its acquisition. Among the established limits, there are included the protected areas, as they are considered as being of public interest destined for the conservation or preservation of certain animal species or vegetation, biodiversity, historical monuments and natural landscape. Preferentially the management would be with the participation of local communities according the specific legislation. This law divides the protected areas as total and partial being partial the territorial sea, **the coastline/ maritime**

**rim**, the island contour, bays and estuaries measured from the **maximum high tide mark/line** up to 100 meters in the interior part of the territory. This law emphasise that the use of this area need a special licence according to the requirements defined by the legislation among them the Protection of the environment.

**Table 1.** Sample of existing legislation and period of establishment

Legislation Code	Law and regulation
Decree No 547, July 23,1927	Prohibits the cutting of mangrove in specific areas of the coastal strip
Decree No 40040, February, 1955	Protection of the soil, fauna and flora in the ultramarine
Decree No 1993, July 23,1960	Defines the establishment of Gorongosa national Park
Decree No 2496, July 4,1964	Protection of the wild fauna
Decree No 2642, September 20,1965	Protection of the forest
Decree No 2787, May23, 1967	Prohibits hunting at Inhaca and Portuguese Island
Decree No 2568,October 7,1967	Establishes the security roles for sitting of storage facilities for crude oil, its derivatives and residues
Decree No 2707, December 23,1967	Creates an area for special surveillance within Inhaca and Portuguese Island
Decree No 47, May 25, 1971	Defines the establishment of Bazaruto National Park
Decree No 51, May 30,1972	Defines penalties to be applied to collectors of plants and animals within the boundaries of national parks and reserves in Mozambique
Decree No 265, July 31, 1972	Security, safety and surveillance of the navigation, fishing game, protection of human lives, to the safety of the mining of beds of the waters, waters pollution.
Decree No 495, September 20,1973	Determines a set of protection measures against water pollution, pollution of beaches and coastal areas
Decree No 495, October 20,1973	Protection of water pollution
Decree No 20, December 30, 1981	Ratifies the Convention on International Trade of Endangered Species of Wild Fauna and Flora
Decree No 18/81	Ratifies the African Convention for the Conservation of Nature and Natural Resources
Decree No 3, September 26, 1990	Licensing and control of fishing industry
Decree No 16, August, 1991	Control and monitoring of water use
Decree No 2/92, June 3, 1992	Creates the National Commission for Environment (NEC)
Decree No 4 & 5, January 4, 1996	Regulate the maritime activity
Decree No , February 18, 1997	Regulate the functioning/organization of local governments/autarchies concerning the environment
Decree No19, October 1, 1997	Regulate the access and use of the soil
Decree No 20, October 1, 1997	Protection of the people to the right of living in a balanced environment

**Source:** Chonguica, 1997 and Hoguane, 2000

## 2.2 Institutional setting

Due to the growing number of issues related to coastal and marine areas and the need to address them, there have been different institutional arrangements, within the country, aiming at coordinating and better implement the programmes and activities related to the management of the country resources in a sustainable manner. There are a number of constraints faced on the process of approaching the sustainable use and management of the resources in a country where the resources themselves are scarce. There should be consideration regarding institutional constraints related to the policy, legal and the administrative and organizational aspects of resource management and the limited number of the human resources to deal with the issues. One of the major constraints is associated with



the difficulty in coordinating the activities of the different sectoral institutions with a view to achieve a common goal of protection of habitats. As mentioned above the sectoral policies are directed to assure maximum revenue and very little on the conservation. Only the coordinating institution that is the ministry of environment is fighting to enforce the conservation of habitats and ecosystems. Table 2 presents some of the institutions related to the exploitation of the resources and development in the coastal areas.

**Table 2.** Institutes involved in coastal zone research, planning and management.  
(a) = Only for Inhaca Island

<b>INSTITUTION</b>	<b>RESEARCH</b>	<b>PLANNING</b>	<b>MANAGEMENT</b>
<b><i>Ministry of Co-ordination of Environment Affairs</i></b>	X	X	X
Eduardo Mondlane University			
Department of Biological Sciences	X		X(a)
Department of Physics	X		
Department of Geography	X		
Department of Chemistry	X		
Department of Forestry	X		
<b><i>Ministry of Transportation and Communications</i></b>			
National Institute of Hydrography and Navigation	X	X	
National Directorate for Marine Affairs			X
Maritime Administration	X		
National Meteorological Institute	X		
<b><i>Ministry of Agriculture &amp; Rural Development</i></b>			
National Directorate of forestry & Wildlife	X	X	X
National Agronomic Research Institute	X		
National Directorate of Geography & Cadastre	X		
Institute for Rural Development	X		
<b><i>Ministry of Fisheries</i></b>			X
Fisheries Research Institute	X		X
Small-scale Fisheries Development Institute	X	X	
National Directorate of Fisheries Administration		X	X
<b><i>Ministry of Tourism</i></b>			
National Directorate of Tourism		X	X
<b><i>Ministry of Industry &amp; Commerce</i></b>	X	X	
Department of Commerce	X	X	
<b><i>Ministry of Mineral Resources and Energy</i></b>			X
National Directorate of Mineral Resources			X
<b><i>Ministry of health</i></b>			
Laboratory of Environmental Health & Water	X		
<b><i>Ministry of State Administration</i></b>			X
<b><i>Ministry of Public Works and Housing</i></b>			X
National Water Directorate			X
Provincial Directorate for Water Affairs			X
Southern Regional Water Administration			X
Water Companies			X
<b><i>Non-Governmental Organisations</i></b>			
Grupo de Trabalho Ambiental	X		X
Nature Conservation Union	X		X
Forum Natureza em Perigo	X		X
World Wide Fund for Nature	X		X
Consulting Companies	X		
National Tourism and hotels Association		X	X

Source: modified from Massinga & Hatton (1996), Motta (2001)

## **2.3 Tourism**

The Mozambican coastal area has a great potential for different economic activities including tourism and aquatic sports. Within the variety of natural ecosystems that characterize the coastal area there are bays and islands with beautiful sandy beaches and extensive corals that attract investments for tourism. Some of the tourism activities include beach sailing and game fishing with competitions taking place yearly.

Before the independency of Mozambique in 1975, the tourism was mainly restricted to the southern part of the country and the visitors were mainly from South Africa. After the Peace Agreement, in 1992, when Mozambique achieved the political stability, the coastal tourism activity, which had decreased drastically during the civil war, grew faster. The number of requests, both at national and local levels, for licenses for implementing tourism is growing.

In terms of the legislation and institutional setting, the tourism activity in Mozambique is guided by the strategic plan of tourism, developed and enforced by the Ministry of Tourism. The national vision of tourism development as stated by the government reads “ Mozambique long for a tourism activity to become a visiting card and one of its strong sources to contribute for the national economy based in a worldwide acceptable and environmentally sustainable practices”. The national strategy for the development of tourism aims, among others at:

- Promotion of a tourism development based in the carrying capacity of the ecosystems;
- Guarantee the development of a tourism industry that takes into account in its planning and implementation phases environmental considerations regarding the conservation and sustainable use of the biodiversity.

Any tourism development needs to have an EIA approved by the Ministry of coordination of Environmental Affairs, before the government approval through the Ministry of Tourism.

Because most of the tourism developments are taking place in the coastal zone, the Maritime Law that prohibits building of infrastructures within 100 m from the high water level in the beach, should be taken into consideration. Thus, for any tourism development in the coastal areas the following legislations have to be fulfilled: (i) the development should be within the national priorities for tourism development – enforced by the Ministry of tourism

### **Gaps and needs**

The EIA is requested only for large investments and the accumulative effect of small development initiative are seldom considered when conducting an EIA. And, as a consequence, some of the investors would apply for many small investments and so, avoiding EIA. This is a gap in the legislation.

It is shown clearly that there are many legislations and institutions related to tourism development and its impacts in the physical alteration and destruction of habitats. Often, the linkages between the legislations and the responsible institutions are not clear. It happens often that the licensing institution may approve certain development project without consulting other institutions that have ward to say. So, there is a need for harmonizing the

operation of the various legislations/regulations and definition of the role of its institution involved.

On the other hand, the tourism operation is not monitored. The establishment of a tourism infrastructure may not cause the destruction of habitats, but the operation of the tourism activity could result in considerable degradation of the surrounding habitats. For instance, the tourism operation such as diving, driving Four Wheel Vehicles in the sand dunes and along the beaches could cause habitat destruction.



**Plate 1.** A tourism infrastructure built in a coastal dune. The project was approved by the municipality, but it did not have the approval of the Ministry of Environment.

## **2.4 Mangroves**

Mangroves are protected habitats by Law in Mozambique. Their exploitation is essentially regulated by the Decree no. 40040 of February, 1955, that regulates the Protection of the Soil, Fauna and Flora in Mozambique, and the Decree No. 2642 of 20<sup>th</sup> of September, 1965 that aims at protection of biological diversity. Further, because the mangrove occurs in the coastal zone areas, they are also regulated by the maritime law.

The Licence of exploitation of forest resources is issued by the ministry of Agriculture. The ministry is also responsible for the enforcement of the Law during the exploitation. EIA is required for the forest concessions at large scale. Small initiatives do not require EIA.

The exploitation of the mangroves as resources requires licence from the ministry of agriculture. These include the exploitation of mangroves for firewood, charcoal production and for building material.

Mangroves are also depleted by urban development, which is regulated by the municipalities; and by the construction of tourism infrastructures, regulated by the Ministry of Tourism. Urban expansion is often made by individual request for land for house and do not require EIA. However, in the vicinity of large cities or sites with high population density, should be a development plan. These plans should, in principle exclude the mangrove swamps. Unfortunately, in some places there are no such plans, and in the places where they are, the applicants manage to get approval from the city council to build in the places they want, taking advantages of the lack of coordination between the Ministry of Environment and the city council.

Other form of mangrove depletion is related to the development of mariculture and salt production, whose activities are regulated by the Ministry of Fisheries and the ministry of Industry, respectively. Both the activities require an EIA, enforced by the Ministry of Environment.

### **Gaps and needs**

The major handicap is, similarly to that stated for tourism, lack of coordination and capacity among the institutions involved in the enforcement of the law.

## **2.5 Ports, land reclamation and damming the rivers**

Port operations in Mozambique are governed by the Ministry of Transport and communications, through mainly, the maritime and rail transport legislations. Because the main harbour of Mozambique are located in estuarine environment, they are affected by siltation, thus, they require to be dredged continuously. This brings other environmental problem associated with the resuspension and damping of sediments.

In Mozambique there are no serious cases of land reclamation, however some localized initiatives of enhancing sedimentation have been taken in the Macante Peninsula, where the combined effects of the river (in one side) and the ocean waves (in the other side) are threatening to cut off the peninsula, and in the “dos Bons Sinais” River near Quelimane, where the river eroded a large portion of the Madal coconut plantation.

Damming of the river is responsible for major environmental problems in the downstream ecosystems. Courses of water are obstructed in the dams upstream, for production of electricity, for provision of water for irrigation and for urban and industries. The management of water in Mozambique is under the department of water responsibility of the Ministry of Public Works and Housing. The building of a new dam does require an EIA, which assures that the environmental issues are taken care of. In the construction of the existing the environmental issues were not sufficiently considered.

The operation of existing dams is, in most of the cases, directed to management of draughts and floods, production of electricity and supply of water. The environmental issues are often neglected. One of the major reasons for this is associated with the lack of knowledge of the minimum stream requirements for the health of the ecosystems, and for the fact that the rivers of Mozambique are international, i.e. are shared with one or more countries, so that the national legislation on its own is not sufficient for their sustainable management.

### **Gaps and needs**

Since the river flow impacts in many sectors, such as energy, agriculture, forestry and wildlife, coastal development, fisheries and others, the river managers should adopt an integrated and participatory approach for the management of the rivers. And, since the rivers are international, there should be regional as well as international policies and institutional dimensions in the management of rivers.

### **3. Socio-Economic issues**

Physical alteration and degradation of habitats of the coastal and marine environment has immense socio economic implications as the majority of the Mozambican population live in these areas and they benefit from the activities related to coastal resources. Erosion in the coastal areas is due to the combination of natural forces and human activities that take place at the interface between the land and the ocean. Natural forces that lead to erosion in the coastal zone are mainly due to the atmospheric factors, action of waves and storms while the human impacts are related to the damming of rivers, removal of coastal natural vegetation such as mangroves, destruction of offshore barriers, dune vegetation and sand mining.

The major environmental impacts of human activities are as follows:

- Destruction of vegetation cover. This has further consequences in the loss of the habitats, which supports the land ecosystems, with implications in the biodiversity.
- Destruction of mangroves. This has implication in the coastal protection and in biodiversity, since the life cycle of considerable coastal fisheries species and the productivity of coastal waters are related to mangroves and mangrove swamps.
- Chronic sand sedimentation and erosion. This result in destruction and alteration of habitats.
- Destruction of the coastal protection. This is an issue of major concern if considering that some parts of the coastal zone (e.g. Beira) are below the Mean Sea Level.

On conducting socio-economic analysis of the implications of habitat destruction due to an human activities, one of the major challenges is to balance the socio-economic gain and the loss due to the given activity that caused the habitat destruction.

#### **3.1 Tourism**

The income due to tourism has been increasing steadily since the peace agreement in 1992. Historically, Mozambique had a thriving tourism industry, mainly in the centre and south of the country, with former Rhodesia and South Africa providing the potential markets. Now the opportunity exists to tap both these historical markets and the tourism markets of the north. Soon after the war stopped development plans were put forward. Mozambique has excellent potentials for both the coastal and wildlife based tourism.

Coastal tourism is well developed in the southern part of the country, south of Save River. This region is characterised by beautiful sandy beaches and extensive corals. This type of tourism expanded rapidly after the end of the civil war in 1992. Many areas in the southern Mozambique are now experiencing tourist pressure due, in part, to uncontrolled tourism development. Some of the tourism activities include beach sailing, and game fishing. Several game fishing competitions take place a year in Bazaruto, Inhambane, Maputo and Ponta do Ouro.

Wildlife based tourism offers good prospects for economy. There are two major forms of land based tourism: (i) Photo-safaris and (ii) hunting safaris. Photo-safaris were very little significant in the past two decade. Safari companies were unable to attract this kind of clients,

due to civil war that affected the country. Hunting safaris contributed considerably for the country's economy. Between 1965 and 1970 about 1310 tourists hunted in Mozambique. The resulting revenue was about US\$87000 per year for the government (licenses and administrative fees) and US\$642000 per year for the safari companies. In the recent years, the flux of tourism increased from 136 thousands in 1994 to about 550 thousands in 1996, representing an income of over USD50 million per year.

The major problem in the tourism lies in the fact that development of tourism requires constructions of infrastructures, such as hotels and roads, and on the other hand these infrastructures destroys the environment, which is the main attraction of the tourism. Thus, the major challenge is to find the balance between tourism development and conservation of the aesthetic values of the sites.

There are no estimates of the socio-economic losses that might come as a result of the destruction of the habitats due to tourism development. The main reason lies in the fact that whenever such initiative is put in place, the socio-economic gain is estimated based in the employment and income provided by such initiative.

### **3.2 Mangroves**

Mangroves are ecologically and socio economically important systems. Ecologically, they are associated to artisanal and coastal fisheries because they are nurseries for fisheries of important commercial value, such as penaeid prawns; they protect the coast by preventing the erosion and also they catch and stabilise the silt, they are the main source of nutrients to the adjoining seas.

An attempt was made in Indonesia to relate the commercial shrimp catch to the total area of mangroves. A linear relationship was found to exist, where prawn production increased with the size of the area of mangrove. The implication is that any reduction in the area of the mangrove will cause a drop in shrimp production. If the mangroves are intensely affected by development, there is a large probability that the commercial shrimp catch would fall drastically.

For instance, mangroves are responsible for the production of at least 250,000 tons of fish per year, at a rate of 0.5 ton of fish per hectare of mangroves, which in terms of monetary value is about USD300 ha<sup>-1</sup> per year.

Mangrove forests are being depleted in coastal areas, especially in the vicinity of the large cities such as Maputo and Beira. The local communities, depending on their culture and habits, use them for different purposes. Generally they are used for poles and timber for building, boats, firewood, charcoal, fish traps, and medicines.

### **3.3 Ports and land reclamation and damming the river**

#### **The operation of ports**

There are three large ports in Mozambique: Maputo, Beira and Nacala, and several small ports: Inhambane, Quelimane, Pebane, Angoche , Pemba. Mozambique harbours provide

services not only for national customers but also, and mostly, for the neighbouring countries. Perhaps most of the foreign services provided by Mozambique is through its harbours.

Mozambique harbours handle annually several tons of cargo to and from: Swaziland, South Africa, Zimbabwe, Zambia, Malawi and Congo. The total cargo handled in 1995 and 1996 was about  $7.5 \times 10^6$  ton and  $8.4 \times 10^6$  ton, respectively.

Both the road and railways networks are built to facilitate regional trade rather than the national economic integration of the country. The transport sector used to be an important foreign exchange earner from the transit facilities offered to the neighbouring countries. The total goods transported through the Mozambican railways were  $3.1 \times 10^6$  ton and  $4.1 \times 10^6$  ton, respectively.

The maintenance of the harbour through dredging has economic implications. Recent surveys showed that between  $1.2 \text{ Mm}^3$  to  $2.5 \text{ Mm}^3$  of sediments need to be dredged annually from the Maputo and Beira Ports respectively (FAO, 1999). No estimate of the costs of land reclamation, despite this is not yet a major issue in Mozambique.

### **The operation of the dams**

The operation of the dams causes profound changes to watershed and alters totally the river dynamic. There are two main functions of the river damming:

- The storage of water to compensate the fluctuations in river flow or in demand of water and energy;
- To rise the level of water upstream to enable its diversion into a canal or to increase “hydraulic head” (difference in height between the surface of a reservoir and the river downstream).

The creation of storage and heads allow dams to generate electricity, water for agriculture, industries and households, control floods, assist river navigation by promoting regular flows and drowning rapids, reservoir fisheries and leisure activities such as boating.

For instance, the Cahora Bassa Dam in the Zambeze River is of great economic importance for the country, besides its ecological impacts. It has currently producing about 2075 MW, with potential to increase up to 3375 MW. The annual average is 14676 GW hours. In addition it has created an important fisheries in the artificial reservoir, which benefits large portion of population. The fish catches in the Cahora Bassa reservoir is over 5,000 tons per year. The Pequenos Libombo dam in the Umbeluzi river in Maputo, supplies water to the capital, whose population is about 2 million.

But generally the overall impacts of dams are negative. The dams are associated with reduction of runoff and with abnormal floods. This in turn causes the deterioration of the water quality, with severe implications in the human health. The Table 3 presents the number of water born diseases observed in Mozambique. The medical treatment of the water born diseases is estimated in USD15.00, for dysentery, USD10 for Cholera and USD5.00 for Diarrhea, per person. On average the annual health cost for dysentery, cholera and diarrhoea exceed over USD 250,000.00, USD 2,480.00 and USD 350,000.00, respectively. The Cholera epidemy that affected the country in the year 2000 had cost over USD 100,000.00 in health

treatment, over 200 deaths, caused a deficit of about USD 30,000.00 to USD 60,000.00 in fish product export. The European Union had temporarily banned Mozambican fish products, those processed inland with fear of contamination by cholera.

In the floods of 1978 about 219,000 were Displaced; 59,400 ha of cropland were destroyed; 72,000 homes were destroyed; 155 schools were destroyed, beside road and railways infrastructures. The overall cost of the flood damage and relief work were about 101 Million USD. In the floods of the year 2000 Over 2 million people were directly affected by floods, from which over 650 people died, over 500 000 were displaced and others lost their belongings.

**Table 3.** Number of cases of water born diseases reported in coastal provinces (Anon, 1998).

Province	1994			1995		1996	
	Diarrhoea	Cholera	Dysent	Diarrhoea	Dysent	Diarrhoea	Dysent
Maputo	61750	36	19424	50258	9264	50572	7971
Gaza	16909		8854	14463	2661	16966	2188
Inhambane	8509		2118	8904	1496	13966	1802
Sofala	27405	440	3816	38368	5158	35883	6508
Zambézia	46759	1	10287	36319	4982	46197	7874
Nampula	40249	12	6311	29851	4940	20523	3475
C. Delgado	17884	212	9311	10901	3239	17479	4298

Because the dams are associated with artificial flows that are too high in the dry season and too low in the wet season, they contrast with the natural behave of the ecosystems. Recent studies showed that an improvement in the Cahora Bassa Dam could result in an increase of the catch rates of shrimp in Sofala bank by about 10kg per hour, which would represent an increase in the income of about 10 million USD per annum (Hoguane, 1997).

#### **4. Major causes of physical alteration and habitat destruction**

The alteration and destruction of physical environment is generally related to different activities such as fisheries, urban development, tourism, mining, ports, damming of rivers. These activities lead to the degradation of land, coastal erosion, water pollution, water shortage, loss of biological diversity, destruction of corals, depletion of fish stocks, destruction of sea grass, mangrove deforestation, among others. Some of the issues that cause physical alterations and destruction of habitats in Mozambique are as follows: Tourism, urban development, mangrove depletion, sand mining, dam and harbour operations. Perhaps one of the major forms of physical changes in Mozambique is erosion and changes in the extensions of the wetlands, particularly relevant in Marromeu, in the lower Zambezi.

##### **4.1 Tourism**

Tourism represents a potential activity that boosted after the civil war, and it is increasingly becoming one of the major sources of foreign income in Mozambique. The threat it represents is related to the removal of mangroves for building tourism infrastructures or leisure houses, and to bad tourism practices such as driving four-wheel drive vehicles on the dunes, causing erosion.



The Costa do Sol mangrove swamp and the sand dune along the beach, in Maputo, are being threatened by the construction of expensive leisure houses. Driving four-wheel drive vehicles on the dunes are particularly of concern in the southern part of the country, in Ponta d'Ouro, Macaneta, Xai-Xai and Inhamabne.



**Plate 2.** Stretch of a sand dune in Macaneta showing tracks of vehicles.

#### **4.2 Mangrove depletion**

Mangroves forests occur in the entire Mozambican coast, especially near the river mouths and the most common type is the fringing. They are well developed in the northern and central part of the coast, provinces of Sofala and Zambezia while in the southern coast; Maputo Bay has the largest concentration. Mangroves forests are being affected and depleted due to natural and human impact. Natural impacts are related to extreme climatic changes, such as droughts and heavy rains. Both droughts and floods can alter the physical environment of the mangroves forests by promoting the hipper - salinization or super-dilution thus affecting their development. Human activities leading to depletion of mangrove forests are related to building, farming, salt mining, mariculture, tourism and industrial infrastructures among others.

Mangrove destruction is observed all over the coast particularly in the vicinities of the large cities, like Maputo and Beira as they are densely populated. The trees are used for different purposes (such as building, firewood and charcoal) depending on the use and custom of the local population. In addition, mangroves are cleared out for building and for mariculture.

There is no recent information regarding the mangroves forests in Mozambique. In 1994, a survey aiming at the compilation of information about the mangrove vegetation density for different coastal provinces was made using satellite imagery. The results showed (Table 4) that, in 18 years, the highest deforestation rate was observed in southern Mozambique, in Maputo Bay (15.2%) followed by Sofala (4.9%), in the central Mozambique. Besides these rates in Maputo Bay and Sofala Province the observed exploitation rate over whole Mozambican coast was the (0.2%).

**Table 4.** Mangrove areas and changes occurred in between 1972 and 1990

Provinces	Area of mangrove (ha)		Area depleted (ha)	New area (ha)	Deforestation rate (%)
	1972	1990			
Maputo	14 605	12 599	2 217	211	15.2
Gaza	378	387	0	0	0.0
Inhambane	20 094	19 848	246	0	1.2
Sofala	129 997	125 317	6 334	1 654	4.9
Zambézia	159 417	155 757	3 766	106	2.4
Nampula	55 849	54 336	2 006	493	3.6
Cabo Delgado	27 730	27 836	0	106	0.0
Total	408 079	396 836	14 569	2 570	3.6

Source (Saket and Matusse, 1994)



**Plate 3.** Mangrove in Costa do Sol threatened by urban development.

### **4.3 Ports and land reclamation and damming the river**

#### **Claim of land for harbour and operation of ports**

Claim of land for ports is not yet an issue of major concern in Mozambique. However it may be of concern in the future, for an open sea harbour with associated land infrastructures that would include railway, residential village and stores are planned for Ponta Dobela, in Maputaland, in the vicinity of the Maputo Reserve. This is raising concern among the ecologist and environmentalists.

Of major concern in the present is the dredging of the navigation channels. The Maputo and Beira harbours, the two most important harbours in the country are located in estuaries. Hence, are heavily affected by siltation. In order to keep the navigation channels operational and to serve large ship, these have to be dredged continuously. This causes alteration in the bottom topography and re-suspension of sediments.

#### **Sand mining**

Mining of minerals have been increasing since the end of civil war in 1992. Mining is carried out all over the country, manly in the inland. These activities are related to the extraction of energetic, metallic and non-metallic minerals (coal, natural gas and petroleum; copper, gold, iron; marble and precious stones). Mining of sand for building is often undertaken along the riverbanks and margin and in the coastal areas. Often, the quarries are abandoned after the sand is exhausted, and moving to a new site. As a consequence, lakes are created. These activities induce high rates of erosion, destruction of the environment and pollution of coastal waters.



**Plate 4.** Sand mining in the vicinity of Maputo city.



**Plate 5.** Sand quarry abandoned, transformed in a lake in the vicinity of Maputo city.

#### **4.4 Case studies – Erosion**

The erosion problem occurs almost all over the country. The sites of particular concern are Beira city, Zambezi Delta, Macaneta and Maputo.

In Beira, important infrastructures including the harbour and almost the whole city are notably under threat of collapsing. Some of the causes that provoke the coastal erosion in Beira city are:

- Lack of maintenance of the protection infrastructures
- The destruction of sand dunes
- The cutting of mangroves for the construction material and firewood
- The removal of beach sand for construction or for exploitation of heavy minerals causes the retreat coastline.

The other factor that contributes for the erosion in Beira is related to the geomorphologic nature of the soil as the city was built in a swamp and also it is below the medium sea level. These aspects have significant consequences during the rain season





**Plate 6.** Erosion in the sand dune in coastal area, in Nacala, Northern Mozambique.

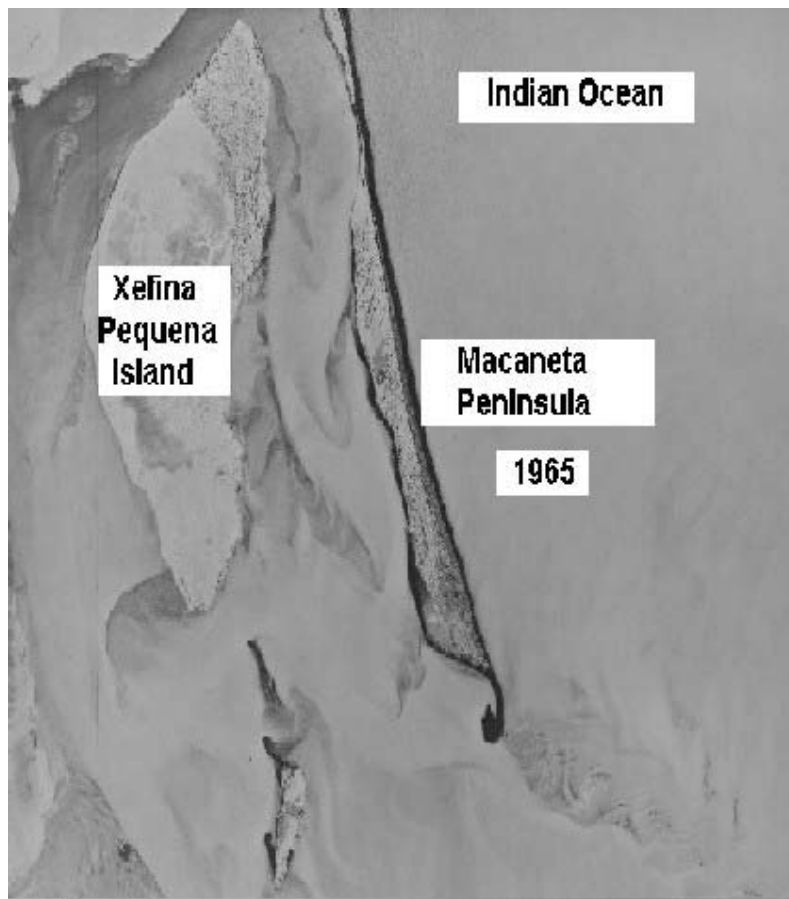
### **Erosion in Macaneta**

The Peninsula of Macaneta situated in Maputo Province, contributes for fisheries developed in Maputo Bay as it serves as a coastal protection of the Incomati Estuary (nursery ground) from the rough weather. There are a large agriculture farms with sugar cane, banana plantations and fields where local population grows food in the Incomati southern valley and there are important tourism centres.

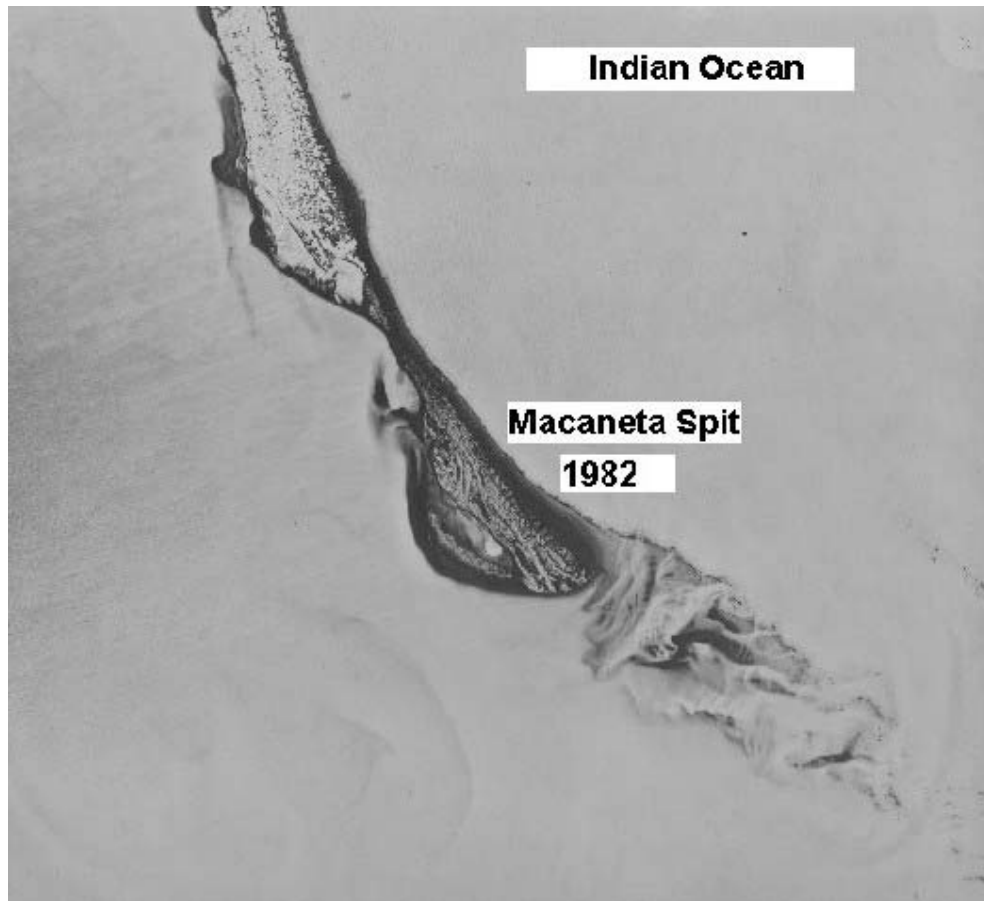
The peninsula is eroding from both sides, the seaside due to the waves from the Indian Ocean and in the continental side due to winds and the Incomati River dynamics. The peninsula and the narrowest part (100 m wide) of it, the Macaneta Spit, have been suffering/subject to morphological changes due to erosion caused by different factors such as clearing of vegetation over the dunes and the meteorological conditions. If the peninsula breaks in two parts it would cause drastic environmental and socio-economic problems. The problem of an Island formation, the Peninsula would be shortened and the seawater would flood the river valley and the grassing field. The estuary would also be pushed further upstream causing salt intrusion and mangrove trees would be affected the biodiversity because the species composition in the estuary would change.

The Macaneta Spit is building up sand/sediment that may have been removed from the surrounding areas. According the analysis of the aerial photographies, the spit was displaced, pushed and stretched South-Easterwards during the period 1965 to 1982. From 1965 to 1982 the spit was displaced for an area of about 0.3147 km<sup>2</sup>, and during the period 1982 to 1991

the displacement for an area of about was  $0.0899 \text{ km}^2$ . The area is under the influence of the trade wind from if. The displacement seems to be the result of an accretion process.



**Plate 7.** Aerial photograph of Macaneta Peninsula, September 1965.



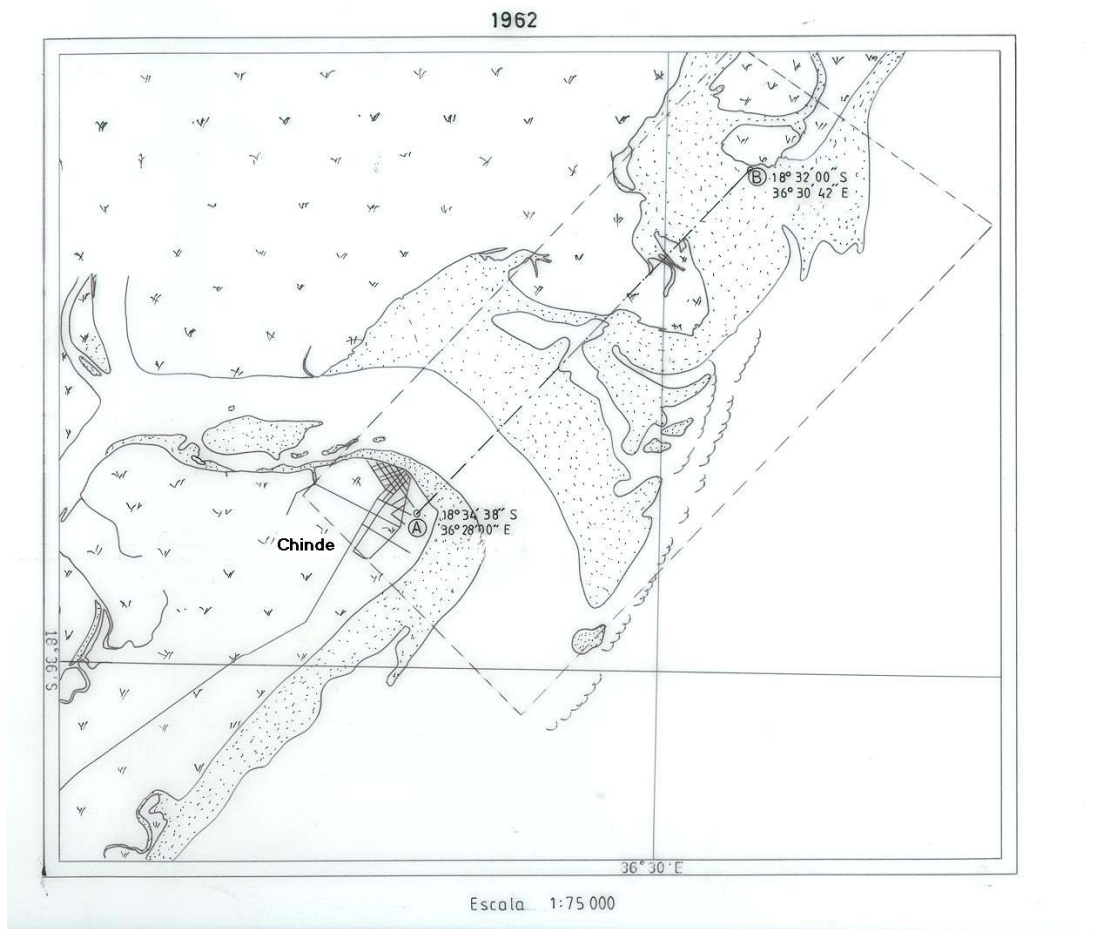
**Plate 8.** Aerial photograph of Macaneta Peninsula, September 1982.

### **Erosion in Chinde**

Chinde and Cuama (or Timbue) are the most important branches among the several that are part of the Zambezi delta. The delta is made by the last 100 km of Zambezi River and occupies an area of 8,000 km<sup>2</sup>. These branches are used for different purposes such as navigation for transportation of coal, sugar and diverse agricultural products from upstream regions Zimbabwe, Zambia, Malawi up to Zaire, with Mozambique and within the country. There used to be a regular ferry along the Zambezi River. Although some rivers are deep enough the navigation is, generally, difficult because of the morphological changes caused by the river dynamics in the structures of the channels. Chinde is faced with a problem of erosion that is becoming worse in the last two decades; the southern margin of the inlet is eroding steadily, with the risk of sweeping out the Chinde Village while the northern margin of the inlet has been accreting.

The driving forces for the erosion and accretion processes observed in the Chinde inlet are mostly related to the availability of sediments from Zambezi River and the combination of tidal currents and river flow. The river flow supplies the sediments to the inlet and adjacent coastal waters and also provides the dynamical force leading to the erosion process in the northern margin. The tidal currents provide the dynamical force that causes erosion in the southern margin.

The trend to erode and to accrete the southern and northern margins of the Chinde inlet maybe associated to regulation of Zambezi River through the Cahora Bassa dam. The dams are known by their environmental impacts in the sediment load. Probably, before 1974, while Zambezi River was flowing naturally the sediment loading in the delta was balanced after the deposition and removal during the different seasons, rainy and dry. So in both margins of Chinde inlet the deposited material in the dry season would compensate the deposited in the rainy season.



**Figure 1.** Location of Chinde.



The river damming changes the downstream morphology of riverbed and banks, delta and estuary and coastline due to the change of the sediment load. After the operation of the Cahora Bassa dam, in 1974, there was a slight reduction of the Zambezi River runoff, thus the decrease in the sediment availability. Consequently: (i) erosion in the northern margin ceased, hence, accretion dominated and (ii) the tidal currents dominated the river flow throughout the year, hence, the erosion of the southern margin.

Studies carried out in the area (Hoguane, 2002) estimated the rate of the sedimentation processes using historical hydrographic charts and reviewed the erosion and accretion driving physical processes. The southern coast of the Chinde inlet is retreating at rate of about 22 meters per year while the northern margin is advancing about 58 meters per year. **Table 5.** Rates of coastline changes at the mouth of Chinde inlet. Positive values indicate coastline retreat (erosion) and Negative values indicate coastline advance (accretion)

**Table 5.** Erosion rates in Chinde.

Period	Southern margin (Chinde)		Northern Margin (Ponta Liberal)	
	Advance/retreat (m)	Average (m yr <sup>-1</sup> )	Advance/retreat (m)	Average (m yr <sup>-1</sup> )
1927 -1941	1000	71	-2520	-180
1941 - 1951	200	20	-50	-5
1951 - 1962	-150	-14	500	45
1962 -1983	250	12	-	-
<b>Total/average</b>	<b>1300</b>	<b>22</b>	<b>-2020</b>	<b>-58</b>

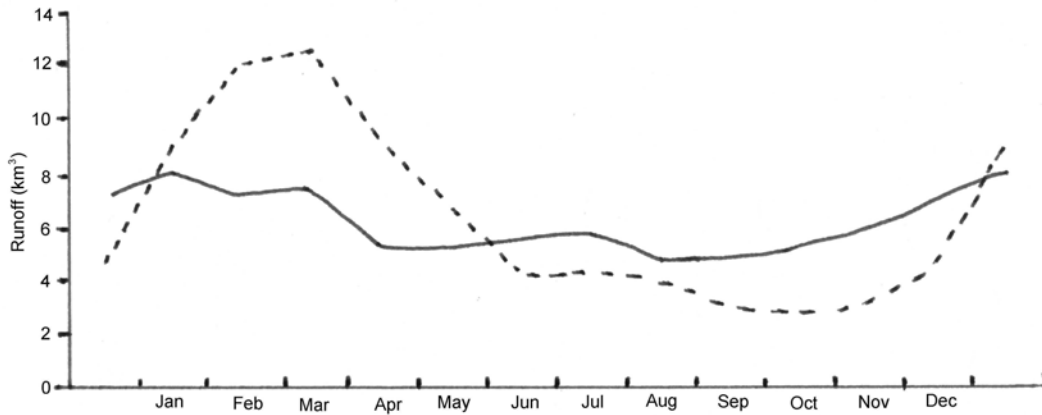
### **Damming of the rivers**

The changes of the river flow by human activities 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 cause imbalances in sediment fluxes that in turn cause either chronic erosion or sedimentation. In addition, the extension of wetland may change, and also change 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.

Zambezi River is the largest in East and Southern Africa. The average annual discharge is about 140 km<sup>3</sup>, 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, from November to March and relatively low flows in the dry season, from April to October. In average 60% to 80% of the mean annual flow occur in few months of the year. Zambezi has about 30 dams from which 2 large dams meant to produce electricity and these are: the Kariba and the Kahora Bassa dams. 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 Cahora Bassa dam initiated 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 Figure 2 (Hoguane, 1997). In addition to the changes in the seasonal cycle there was a reduction in the runoff. Before the operation of the Cahora Bassa dam (i.e. before 1974), the maximum flows were mostly over  $10,000 \text{ m}^3 \text{ s}^{-1}$ . After the regulation, the maximum flows were mostly below  $5,000 \text{ m}^3 \text{ s}^{-1}$  (Hoguane and Dove, 2000). This implies that the dam might have contributed to the reduction in flows by about 50%.



**Figure 2.** Seasonal runoff of Zambezi: Before de regulation (dotted line) and after the regulation (thick line).

## 5. Conclusion and recommendations

The degradation of the coastal environment is due to an inadequate development of the activities in the coastal areas. These activities are: fisheries, tourism, agriculture, erosion forestry, urbanization, and the coastal and marine resources in Mozambique leading to coastal erosion, land degradation, loss of biological diversity, destruction of coral, sea grass, mangroves, and deflection of fish stocks.

The Mozambican constitution takes into account the legislation on the environment, although there is no specific legislation concerning the protection of the coastal and marine environment. Many of the regulations and law in use are prior to Independence (1975) and they are still in valid and in force. There are several laws and legislations, and institutions dealing with the issues of exploitation of natural resources and conservation of environment.

Hence, there is a need to adopt an integrated approach to address successfully the management of the environment and the coastal and marine resources. The approach has to emphasize adequately on the institutional arrangements and involvement of all the stakeholders. The cooperation between government the institutions/ sectors would help to clearly define the roles

and the jurisdictional responsibilities, harmonization of programmes aiming at the management of the coastal and marine zones.

The sectoral laws and legislation regulate the exploitation of the resources and the associated activities, with the main goal of controlling the levels of exploitation, whereas the laws of environment focus on the conservation. These laws are enforced by different institutions, with different mandates. For instance, the sand mining activity is ruled by the Ministry of Natural Resources and Energy, whereas the ministry of environment observes the conservation of the habitats, through the enforcement of EIA. Often the EIA do not include the mitigation options neither the accumulative effects of the existing initiatives in the area nor of small initiatives.

Clearly, there is a need to harmonize the laws and set an effective institutional coordination mechanism for an optimum implementation of the law and benefit to the environment. Further, there is a need to review the laws and legislations regulating the exploitation and use of the natural resources, in order to include the mitigation options during the operation. For instance, for forestry exploration the law should require that be a reposition. Finally, there is a need to build capacity in the researchers, managers and law enforcement officials.

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