

REPORT OF THE DIRECTOR OF AUDIT

GOVERNMENT RESPONSE TO MITIGATE BEACH EROSION

Ministry of Environment and Sustainable Development

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ABBREVIATIONS AND ACRONYMS

AFB	Adaptation Fund Board
BA	Beach Authority
EPA	Environment Protection Act
ICZM	Integrated Coastal Zone Management
JICA	Japan International Cooperation Agency
MoESD	Ministry of Environment and Sustainable Development
MoF	Ministry of Fisheries
MHL	Ministry of Housing and Land Development
MOI	Mauritius Oceanography Institute
MoT	Ministry of Tourism and Leisure
NAO	National Audit Office
NEAP	National Environment Action Plan
NEP	National Environment Policy
NES	National Environmental Strategy

CHAPTER ONE

INTRODUCTION

1.1 Overview of Coastal Area in Mauritius

Mauritius, a small island developing state, is endowed with a total land surface area of 1865 square kilometres. Its coastline of 322 km is almost completely surrounded by fringing coral reefs enclosing a lagoon area of around 300 square kilometres. The island is gifted with sandy beaches, protected bays and calm lagoons, factors that attract human settlement and permit the development of tourism and other associated economic activities.

1.2 Importance of Coast

Mauritius is predominantly a holiday destination for beach-resort tourists. It possesses a wide range of natural and man-made attractions, enjoys a sub-tropical climate with clear warm sea waters, attractive beaches, tropical fauna and flora complemented by a multi-ethnic and cultural population that is friendly and welcoming.

The coastal zone of Mauritius which includes beaches and lagoons is of vital importance for its socio-economic development. The coastal system protects the island from the natural forces of the ocean, provides income through tourism and fisheries, and is the focus of many leisure activities.

1.3 Coastal Degradation

Coastal areas in Mauritius are under stress. Coastal degradation occurs due to natural causes such as climate change, wave and wind action and unwarranted human activities that alter the natural coastal features and processes. One of the effects of coastal degradation is beach erosion.

1.3.1 Beach erosion is the removal of beach or dune sediments by wave action, tidal currents, wave currents, or human interactions with the environment. Waves generated by storms and wind cause beach erosion. This may take the form of long-term losses of sediment or merely the temporary redistribution of coastal sediments.

1.4 Audit Motivation

Tourism is one of the major pillars of the Mauritian economy. The tourism industry contributes around Rs 42 billion to the Mauritian economy in terms of revenue as well as direct job creation (28,187) and an estimated creation of 84,561 indirect jobs¹. The Report of the Integrated Coastal

¹ Source: *Economic Indicator September 2012*.

Zone Management (ICZM) Framework Study (2010) estimates the total annual revenue directly generated in the coastal zone, to be about Rs 74 billion. In 2004, hotels occupied about 48.6 km of the coastline of mainland Mauritius, while public beaches accounted for 28.9 km, together covering 24 percent of the coastline. It is estimated that about 35 percent of the coastline may be occupied by hotels in 2030.

It is Government's vision to further develop the tourism industry by welcoming two million tourists by 2015. The increase in tourist arrivals will bring considerable pressures on the coastal zone, with the construction of more hotels and increasing tourist related activities in the lagoon. If serious harm to the very resources on which tourism depends, is to be avoided, this growth must be managed.²

Given that the Mauritius product is predominantly sun, sand and sea and that the coast has a great socio-economic impact, the National Audit Office (NAO) decided to carry out a performance audit on the effectiveness of the measures taken by Government to mitigate beach erosion.

1.5 Audit Scope

Auditee

Issues of beach erosion fall under the remit of several Ministries and agencies. The Ministry of Environment and Sustainable Development (MoESD) is the Ministry that coordinates all environmental matters. The Ministry of Fisheries (MoF), Ministry of Housing and Land Development (MHL), Ministry of Tourism and Leisure (MoT), Beach Authority (BA) and Mauritius Oceanography Institute (MOI) are agencies that implement, inter alia, measures to mitigate beach erosion. The audit team reviewed the measures taken by MoESD and those agencies during the audit.

Audit Object

The audit focused on activities, programmes, policies, resources allocated and regulatory framework to mitigate beach erosion.

Time Coverage

The audit covered the period 2003 up to end of December 2012.

² Source: Mauritius Environment Outlook Report 2011

Geographical Area

This report examines beach erosion in the Republic of Mauritius. Rodrigues, Agalega and outer islands were excluded.

1.6 Audit Objective

The audit objective is to ascertain whether the measures taken by Government to mitigate beach erosion are providing the expected results.

1.7 Audit Methodology

The audit was conducted in accordance with International Organizations of Supreme Audit Institutions standards. Those standards require that performance audit should be planned, conducted and reported on, in a manner which ensures that an audit of high quality is carried out in an economic, efficient and effective way and in a timely manner. Different methodologies were used for the audit to understand the audit area along with obtaining sufficient, relevant and reliable audit evidence that support the conclusions and recommendations.

The team reviewed relevant documents and files relating to coastal zone. It also referred to relevant laws and regulations, reports and policies to identified assessment criteria. The team interviewed officers from the MoESD, MoF, MoT, BA and MOI. This method was used to get an insight of causes of erosion, the effects, measures taken to mitigate coastal erosion and the results of measures taken.

CHAPTER TWO

BACKGROUND

This chapter provides a background on the erosion of beaches in Mauritius. It describes the causes, effects, extent of beach erosion and types of coastal protection works recommended by the Study on Coastal Erosion which was commissioned by MoESD and was carried out by Baird and Associates Coastal Engineer Ltd. The chapter also describes different roles and responsibilities of key stakeholders involved in management of the coasts which impacts on preservation of beaches.

2.1 Causes of Beach Erosion

Baird Report in 2003 and National Environmental Strategy (NES) in 2008 identified two factors, namely, human and natural that is causing beach erosion. These are summarized below:

Human factors

➤ *Pollution*

- Recurring pollutants specially nutrient loads of sewage, fertilizer runoff, increased intensity of fresh water runoff and contaminants jeopardizing the reef-lagoon-beach system.

➤ *Exploitation of Coral & Sand*

- Previous harvest of corals for lime industry;
- Traditional exploitation of sand dunes for construction purposes (800,000 tonnes/year) till October 2001;
- Removal and dredging of coral for water ski lanes within lagoons;
- Coral rubble which is part of the natural system and provides natural protection are often removed after cyclones; and
- Trampling and compaction of sand dunes by machines and heavy pedestrian traffic, and levelling of dunes;

➤ *Others*

- Loss and infilling of wetlands, lack of soil conservation measures such as vegetative strips in agriculture threatens the lagoon health;
- Over-fishing led to reduction of fish species which were critical to protect reef from predators and maintaining the health of the coral;
- Encroachment of developments such as gabions walls, groynes, jetties and breakwaters which are the primary threat to the existence of beaches;
- Replacement of the native vegetation (creepers, shrubs and trees) largely by invasive filao (*Casuarina*) trees. These trees are not effective in trapping wind-blown sand, and maintaining the dunes; and
- Extent of Mangrove cover decreased in the past due to cutting for firewood and construction purposes.

Natural Factor

Another cause according to the NES 2008 is the global climate change.

2.2 Effects of Beach Erosion

The National Environment Action Plan (NEAP) in 1999 identified three main effects of beach erosion

- Loss of space to public and tourists resulting in loss of amenity and tourist income
- Escalation of costs in terms of coastal protection and/or remediation works
- Biological impacts through loss of habitat and changing currents

In 2010, the Adaptation Fund Board (AFB) identified that 11 percent of the tourist draws on the island of Mauritius will be lost, progressively over time, as alternative sites for beach tourists do not present themselves. Based on assumptions that there will be no increase in tourist numbers in 2010 and a constant rate of beach erosion over the years, AFB anticipated that the revenue loss per year will range from US\$ 2 million in 2011 to US\$ 100 million in 2060 (in 2010 terms). However, AFB acknowledged that more likely, the erosion rate will continue to accelerate and the beach losses will occur sooner, rather than later.

2.3 Identified Threats of Erosion over the Years

MoESD identified the problem of beach erosion in the early nineties and since then, the threat of further erosion and measures to combat it has been stated in several documents. In 1999, NES recognized that the problem of beach erosion exists and that a unitary management of the coastal zone is required to guide future development and to correct the environment mistakes of the past. NEAP 2 (1999) added that the coastal zone of Mauritius is a key resource. Intense pressure from sea and land based activities is degrading this environment and threatening to prevent its full economic potential from being realised. One of the main damaging effects of a degraded coastal zone is beach erosion. NEAP 2 established that to maximise the economic and social benefits obtained from the coastal region over the long term, holistic management of the often conflicting pressures on the coastal zone is essential.

In 2003, Baird Report assessed the extent of coastal erosion in 20 sites around the island of Mauritius; analysed the various causes of coastal erosion; assessed the performance of existing protection works along the beach and suggested remedial measures if any; and proposed abatement measures to arrest the erosion problem. Five sites were classified as high priority, ten as medium and five as low priority. Further, in 2007, the National Environment Policy (NEP) highlighted that there are intense pressure from sea and land based activities that threatens to prevent the coastal zone to exploit its full socio-economic potential. The main issue of concerns, amongst others, is inadequate management of coastal areas, absence of an ICZM plan, beach erosion, vulnerability of coastal resources to climate change and sea level rise. In 2008, NES confirmed that the coastal zone is under threat. There is a need for an integrated approach for management of the coastal zone to address the future developments and that some of the important subject areas that require extensive knowledge are coastal engineering (such as wave impacts, sand budgets) essential for development of beach erosion control measures.

2.4 Extent of Beach Erosion

The degradation of coastal zone is one of the major environmental problems facing Mauritius with beach erosion as the most acute and pressing one (National Climate Committee, MoESD). The Ministry took cognisance of the findings of Baird Report (2003) and AFB (2010) on the extent of beach erosion in different regions at different periods. These are summarised below:

➤ Baird Report 2003

At Flic en Flac there was 15 metres of retreat of the vegetation line between 1967 and 1997, most of it occurring between 1979 and 1995. This 15 metres retreat over approximately 500 metres of shoreline and 4 metres height (from the beach toe to the beach crest) amounts to approximately 30,000 cubic metre of sand lost from the beach.

➤ AFB Project Proposal for Mauritius (2010) highlighted the following:

- There are 21 public beaches (23 per cent of the beaches) currently experiencing erosion, many with accelerated rates in the last ten years. It can be assumed that over

the next 50 years half of these beaches will be lost to the point of not supporting visitors.

- The beach at Mon Choisy is eroding at a rate of about two metres/year, and risks disappearing within the next 15-20 years.

2.5 Types of Protection Works

Beaches need to be protected from erosion. Baird Report identified two approaches: prevention and intervention.

➤ *Prevention*

The “prevention” coastal management approach is the orderly planning of land use and the regulation of development in hazardous areas through the use of controls such as flood and erosion setbacks. There are two types of preventive coastal management approaches and they are as follows:

- *Setbacks*

A setback is a distance from the coastline to a house or other building that is intended to provide a safe separation between the coastal hazard and the development. Setback regulations will also include minimum elevation requirements to protect against flooding in low-lying areas. Setbacks have many benefits. They reduce hazards to development, protect the dune-beach-lagoon ecosystem, provide an environmental buffer for habitat and wildlife preserves natural vegetation and helps to preserve public access to beaches.

- *Relocation*

Relocation is the moving of a building or service to a different site further inland or to a more landward location within the existing site. Relocation, as a form of prevention, is an effective practice to mitigating flooding, erosion and dynamic beach hazards for existing buildings.

➤ **Intervention**

This is divided into non-structural and structural interventions.

▪ *Non-structural Intervention*

- Shore and beach management. Shore and beach management includes actions such as controlled access for vehicles and pedestrians, onshore grading, restoration of native coastal vegetation enhancement and dune protection and restoration.
- Beach nourishment. Beach nourishment, or beachfill, is the artificial placement of suitable, imported beach material from an inland or offshore source onto an eroding or sediment deficient beach area in order to replenish, maintain and/or enhance the beach width. It is considered a “soft” structural protection method because it attempts to replicate the natural processes. It is the only structural management tool, which serves the dual purpose of protecting the coastal lands and preserving beach resources.

▪ *Structural Intervention*

Structural intervention on a sandy shore is not recommended unless, as an absolute last resort, it is required to protect existing buildings at imminent risk. Structural interventions that extend into the water, such as groynes, gabions, detached breakwaters and artificial headlands, are complex structures with a high potential for adverse impacts on the downdrift shorelines. They require a comprehensive design effort and are relatively high cost.

2.6 Objectives, Roles and Responsibilities of Stakeholders in Mitigating Beach Erosion

Beach erosion is an issue that cuts across several Ministries and agencies. The objectives, roles and responsibilities of key players are described below:

2.6.1 Ministry of Environment and Sustainable Development (MoESD)

Beach management forms part of a wider area of coastal zone management. The responsibility of coastal zone management is entrusted to the ICZM Unit. The main duties of the ICZM unit, through the ICZM Committee, are:

- To develop an integrated coastal management plan
- To monitor coastal resources including wetlands
- To control beach erosion

- To protect marine flora and fauna
- To prepare guidelines for coastal construction
- To monitor coastal water quality

The ICZM Committee was established under the Environment Protection Act (EPA) 2002 and the members are the following:

- The Director of Environment as Chairman
- A representative of each of the Ministries, departments, public bodies, organisations and associations specified in the Seventh Schedule (22 representatives)
- Representatives of six non-governmental organisations, appointed by the Minister

2.6.2 Beach Authority (BA)

BA is a body corporate that falls under the aegis of the Ministry of Local Government and Outer Island. Its main objective is to ensure an integrated approach in the proper control and management of 97 proclaimed public beaches in Mauritius and 12 proclaimed public beaches in Rodrigues.

The duty is to implement projects in relation to:

- the conservation and protection of the environment of public beaches
- infrastructural development, including provision of amenities for the use of the public and their maintenance, on public beaches
- provision of leisure facilities on public beaches
- the enhancement of the quality of sea water

2.6.3 Ministry of Housing and Lands (MHL)

The vision of the MHL is to have a planned development of the territory of Mauritius where it will be pleasant to live and work where business can thrive and prosper and where the natural beauty of the country will be preserved for the enjoyment of generations to come.

It develops National Development Strategy, for the long term growth and physical development of the country, its city, towns and rural areas, areas of significant environment conservation or

restriction including coastal/lagoon areas and other significant land use opportunity and constraint areas.

MHL is responsible for the management of coastal beaches especially in relation to the leasing of Pas Geometriques lands.

2.6.4 Ministry of Tourism and Leisure (MoT)

MoT is responsible, amongst others, to institute a legal and operational framework to plan, monitor and regulate tourism activities in line with the defined tourism strategies and policies and to ensure the development of quality beach related tourism facilities and activities.

2.6.5 Ministry of Fisheries (MOF)

One of the objectives of this MoF is to promote and regulate the optimal long-term sustainable utilization of living marine resources.

CHAPTER THREE

FINDINGS

This chapter describes the initiatives taken by Government in relation to beach erosion, difficulties faced to implement certain measures, and the causes and possible effects of not implementing them.

Summary of Findings

Beach erosion problem and its causes have been identified since early nineties through several documents/reports as being one of the major threats on our coastal zone. The latest observation from AFB in 2010 showed that 23 percent of the public beaches on the island of Mauritius are at risk of erosion and many with accelerated rates in the last ten years. It is also assumed that over the next 50 years half of these beaches will be lost to the point of not supporting visitors.

The responsibility of coastal zone management is entrusted to the ICZM Unit and the ICZM Committee of MoESD. The main duties of these two bodies among others are to conduct and recommend studies on beach erosion, to develop an integrated coastal management plan, to control beach erosion, to protect marine flora and fauna, to prepare guidelines for coastal construction, and to monitor coastal water quality.

The ICZM Committee is responsible for the coordination of issues relating to beach erosion. However currently, the ICZM committee does not have any authority to enforce actions on the different stakeholders.

Both the recommendations of Baird Report and the ICZM Framework were not being executed with a proper action plan with budget and time frame. The actions taken by different stakeholders are not being monitored by MoESD on a systematic basis and there is no data sharing among stakeholders as data are scattered in several organizations. For instance, information relating to the state of beaches is at the MoESD while data regarding the state of coral reef and water are at the MoF. Aerial photographs of beaches are under the custody of MOH. The reason is that the ICZM Committee is not an enforcing agency. Consequently issues of beach erosion are not being tackled in a holistic manner.

3.1 Major Initiatives Taken by MoESD

The Ministry took several initiatives since 1991 to address the problem of beach erosion. Some of these are described below:

- With the enactment of the EPA in 1991, several actions were taken to address the problem of beach erosion. During the period 1995 to 2001, the Ministry conducted surveys of public beaches and identified the occurrence of beach erosion to an extent of 5,000 m along the shoreline of Mauritius. MoESD took initiative to redress some affected sites through the installation of gabions. Some 3,500 metres of gabions were installed at a cost of Rs 18.4 million in six sites (NAO Annual report 2002).
- An ICZM Unit was set up in 2000 with the aim of developing an ICZM plan and to control beach erosion.
- Sand mining was banned in 2001.
- Under the EPA 2002, an ICZM Committee having as major responsibility the coordination and monitoring of all issues pertaining to coastal zone management was set up.
- A study on Coastal Erosion in Mauritius (Baird Report) was completed in 2003 at a cost of some Rs 13 million.
- After request of MoESD, provision has been made by MHL in 2005 to respect a setback distance of 30 m from the high water mark for construction of hard structures.
- Following the setting up of the ICZM committee, a study on an ICZM Framework was carried out in 2010 at a total cost of some Rs19 million. The study was carried out in view of developing a framework with the main purpose of improving management of the coastal zone. Three sub-committees were set up as a follow up of the study to implement the recommendations therein. These are (1) Legislative Framework, (2) Pressure Zones, and (3) Strategy, Policy and Institutional Framework.
- In order to mitigate the erosion due to climate change, sea level rise and storm surges, coastal protection works are carried out by the MoESD. As from financial year 2008-09 to 31 December 2012, 15 sites were rehabilitated at a cost of Rs 58.8 million (excluding consultancy services).
- In 2012, Mauritius has secured funds from AFB in the context of the assistance to developing countries that are particularly vulnerable to the adverse effects of climate change and which are parties to the Kyoto Protocol under the United Nations Framework Convention on Climate Change .The grant to the Republic of Mauritius from the AFB, amounting to USD 9,119,240 is targeted to implement concrete adaptation projects with a view to increasing climate resilience of communities and livelihoods in coastal areas of the island. The project, currently, being executed by the Ministry, kick started in August 2012.
- As from May 2012, the Japan International Cooperation Agency (JICA) is carrying a study in coastal protection and rehabilitation work .The project will be of duration of some three and a

half years and its aim is to ensure that adaptation measures are taken in a holistic and sustainable manner to protect critical coastal sites around Mauritius.

3.2 Observations

In spite of several initiatives taken over the years, the Ministry was faced with several constraints that prevented it to address the problem of beach erosion in a comprehensive manner. Some of the causes and effects of not addressing this problem are as follows:

3.2.1 Functioning of the ICZM Committee

The issue of beach erosion cuts across different Ministries and departments. It involves the commitment of different stakeholders and this call for an effective coordination among them. The ICZM Committee is the only mechanism set up under EPA 2002 to ensure the coordination and monitoring of all issues pertaining to coastal zone management including beach erosion. However, this Committee which first met in September 2003 is not functioning properly. In a meeting held on 29 September 2003, the Committee agreed that meeting would be held as and when required but at least one meeting should be held every two months. However, the ICZM Committee met on only 20 occasions as from September 2003 to December 2011 (eight years) and has not met at all for the whole year of 2012 though there is urgency to address the problem of beach erosion.

I am given to understand that the Chairperson has been advised to henceforth hold meetings on a more regular basis.

3.2.2 Implementation of Baird Report

Following the Baird Report in 2003, an Implementation Committee (to look into the implementation of the recommendations of the report) was set up in 2003. The Committee met in nine occasions and the last meeting was held on 28 March 2006. However, the Implementation Committee did not develop a detailed action plan comprising of, amongst others, assignment of responsibilities, priority projects, time frames for implementing recommendations and financing strategies.

As a result, the Implementation Committee was not able to monitor the progress of recommendations to be implemented by other stakeholders. The latter were implementing recommendations at their own pace, depending upon their priorities and availability of resources. An example is the coral reef conservation measures (discussed in details in paragraph 3.2.9 below).

3.2.3 Delay in Implementing the ICZM Framework

The study on ICZM Framework, carried out in 2010 at a cost of some Rs 19 million and whose main purpose is to improve the management of the coastal zone is being implemented at a very slow pace. This is mainly due to the following factors:

- The activities and the delivery of expected outputs and outcomes in achieving the ICZM framework have not been time framed.
- The capacity building of stakeholders is critical to achieve coastal management and protection of coastal resources. The process of building capacity at MOESD and other enforcing agencies have been lacking.
- MoESD has experienced difficulties in securing sufficient funds for the implementation of the ICZM framework.

Also, the three sub-committees namely the Legislative Framework, Pressure Zones, and Strategy, Policy and Institutional Framework which were set up in April 2011 as a follow up of the study on ICZM Framework do not have a specific term of reference and have not met for the whole year of 2012.

We were made to understand that the ICZM committee would implement the recommendations of the ICZM framework study pending the setting up of an Institutional Framework .The main aim of the Institutional Framework is to integrate cross-sectoral policy.

3.2.4 Absence of Data Sharing Protocol among Stakeholders

In the absence of an established protocol for sharing of data, stakeholders fail to share information pertinent to the problem of beach erosion. As a result, this impairs the ability to work together in a holistic way. Information either not shared at all or not shared on a timely basis prevents MoESD to have a full picture of the problem. Some of these data have been requested by MoESD on behalf of Consultants engaged by the latter to assess the problem of beach erosion. However, these data could have been used regularly by the Ministry as they are readily available and MoESD, being the leading Ministry could have a better understanding of the state of lagoons and thus makes timely decision to address the problem.

Examples of data used by Consultants are given below.

- Aerial photographs were taken in 1967, 1975, 1991, 1998 and 2008 at 13 specific sites by MHL. MoESD does not readily use these data to understand beach erosion as these data need to be bought from the MHL. These photos have been used only by consultants engaged by the MoESD to analyse beach changes that have occurred over time.
- Data on state of corals and causes of degradation are not consistently being communicated to the MoESD. As of date, the Annual Report 2011 and 2012 of the MoF which are essential

documents to disseminate information on state of coral reef and quality of water are not yet published. All factors affecting the coral reefs which are mostly controllable could have been addressed by MoESD if information is disseminated on a timely basis.

The issue was raised by the sub-committee on Institutional Framework and it was recommended to set up GIS units in relevant Ministries with the Ministry of Housing and Lands as custodian of data and information.

3.2.5 Absence of Beach Profile Monitoring

The ICZM Framework 2010 stated that the key to a really successful beach management is ongoing monitoring. An established beach monitoring programme will provide an early warning of the onset of beach erosion. It will also give a measure of the rate and extent of such erosion and will enable timely corrective measures to be taken. The Baird Report also proposed to have a regular beach profile monitoring through annual surveys.

Actually, the Ministry conducts surveys after cyclones or after beach erosion becomes apparent in some sites. However, due to shortage of staff, the Ministry is not able to conduct beach profile monitoring. On the other hand, the rate and extent of erosion of non-public beaches also are not known.

Beach profiling monitoring has started in 2013 with the JICA project.

3.2.6 Absence of Assessment of Measures Taken

An assessment of completed coastal protection work ensures that measures taken are providing expected result and efficient use of resources is made. It also indicates whether protection works could-be replicated, improved or abandoned. Protection works were carried out since 1995 and an assessment of their effectiveness has never been carried out by MoESD as they do not have the technical expertise to do so.

3.2.7 Absence of Maintenance of Completed Works

Maintenance of completed protection works is of utmost importance for the protection works to give expected results. A regular maintenance will also ensure that repair costs are kept to the minimum. According to BA Act, the authority is responsible for the conservation and protection of the environment of public beaches. The law is ambiguous as to whose legal responsibility it is to carry out maintenance of coastal protection works. We are given to understand that there is a policy that requires BA to undertake the maintenance works. However, there is no formal legal document ascertaining its legal responsibility for maintenance. Consequently as of December 2012, maintenance has never been undertaken on previously completed protection works.

3.2.8 Effectiveness of Protection Works (Non Structural Intervention)

Following the Baird's Report in 2003, MoESD conducted coastal protection works at various public beaches around the island. The purpose of the protection works was to mitigate beach erosion due to climate change, sea level rise and storm surges. However, at many sites, it was observed that the beaches still suffered from erosion particularly after a cyclone or sea level rise.

The most recent example of beach erosion was observed in January 2013 after Dumile cyclone hit the country in December 2012. In a survey carried out at 64 public beaches on 4 January 2013, the Ministry observed that erosion occurred at sites where beach rehabilitation works were carried out in 2012. The sites are Von Molke, Roches Noires 'Debarcadere', Bras d'Eau, Palmar (near Surcouf Hotel), Trou d'Eau Douce (near Le Tropical Hotel), Bois des Amourettes, Blue Bay, Flic en Flac and Mon Choisy.

According to MoESD, the absence of sufficient coral reefs which act as natural breakwaters (reduce the strength of waves) along with inadequate maintenance of protection works are contributing towards the degradation of rehabilitated beach.

3.2.9 Inadequate Coral Reef Conservation Measures

Coral reefs are important as they act as a barrier against oceanic waves, thus preventing erosion of the coastline. They also contribute in the formation of sandy beaches and lagoons. According to Baird Report, absence of corals from lagoons as observed at Flic en Flac has caused beach erosion and this might be the case for other places such as Palmar in the long run.

An analysis of the percentage of live corals at some established sites (Appendix 1) shows that there is a constant degradation of live corals from 2003 to 2010. Coral degradation is even being observed in the two Marine Parks, namely Balaclava and Blue Bay. (Appendix 1)

The live coral cover decreased from 45 percent in 1998 to 40 percent in 2005. (Source: MoF Annual Report 2005). According to JICA, as of December 2012, there was less than 20 percent live coral cover in our lagoons. In a short span of seven years, the live coral cover has alarmingly decreased by more than 50 percent.

According to MoF, the causes of coral degradation are both natural and human induced. The natural cause is coral bleaching due to rise in sea surface water temperature. On the other hand, human activities such as overfishing, increased tourism activities and increased siltation are also exerting intense pressure on the corals.

MoF is taking measures to rehabilitate degraded sites through coral farming. However conservation measures to preserve the existing live corals is minimal in spite of a decline in percentage live corals over the years. The only concrete measures taken to conserve corals were a regulation made in 2006 for prohibition of removal of coral and sea shell from the maritime zone of Mauritius (unless someone holds a permit) and the declaration of two marine parks under proclamation of the Fisheries and Marine Resources Regulations 2001.

Conservation zone has been designed in the two marine parks, namely at Balaclava and Blue Bay for the conservation of important ecosystems and resources and in which a limited number of recreational activities will be permitted. No fishing is allowed to be practiced in the zone unless someone holds permits.

Limits were set for glass bottom, pleasure crafts and pole and line fishing in the Blue Bay Marine Park. As far as other activities such as big game fishing and catamaran are concerned, no limit has been set yet. As far as the Balaclava Marine Park is concerned, no limit has been set for any of these activities. MoF commissioned study on the carrying capacity of the two parks and it is under preparation. Recommendations of the study will be implemented accordingly.

MoESD will take up the matter with the Ministry of Fisheries.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

Coastal zones, especially beaches and lagoons are of great importance to Mauritius given that many economic and leisure activities take place therefrom. However, over and above the global climate change phenomenon and its consequences, considerable pressure is still being exerted on coastal zone ecosystems and its resources through human activities.

The problem of beach erosion has not been adequately addressed. The latest observation from AFB in 2010 showed that 23 percent of the public beaches around the island of Mauritius are at risk of erosion and many with accelerated rates in the last ten years.

Since 2000, Government has taken some initiatives towards addressing the problem of coastal erosion through an integrated approach. An ICZM Unit was set up in 2000 with the aim of developing an integrated coastal management plan and to control beach erosion. An ICZM Committee having as major responsibility the coordination and monitoring of all issues pertaining to coastal zone management was set up under the EPA 2002. Also, the MoESD developed in 2010 an ICZM Framework to address the problem in an integrated manner. However, to-date this approach to address the problem of erosion is still lacking. This is mainly due to insufficient coordination among different stakeholders and the slow implementation of the ICZM framework.

Data on coastal issues obtained through monitoring or studies are scattered in several organisations. There is no central mechanism for collection and dissemination of data. Stakeholders come to know about the problem only during ad hoc committees or during studies carried by foreign consultants.

Several documents and reports, namely, NES 1999, NEAP 2 1999, Baird Report 2003, NEP 2007, updated NES 2 and NEAP 2 and ICZM Framework 2010 stated the problem of beach erosion and its causes as well as pointed out the major threats affecting the coastal zone of Mauritius. However, except for some guidelines which have been issued, measures taken to combat the causes of the coastal erosion problem (controllable) are very minimal and slow. The coordination problem among all stakeholders coupled with inadequate prevention measures, expertise and maintenance is not providing solution to the problem of coastal erosion

4.2 Recommendations

Beach erosion being a natural process cannot be completely eliminated. However some measures could be taken to reduce the rate of degradation and that could allow beaches to regenerate naturally.

4.2.1 Main Recommendation

MoESD must have the mandate to take a leading role in controlling beach erosion. It must have a long term vision with proper target in terms of budget and achievement. This vision must be shared with other stakeholders. The role and responsibility of each stakeholder must be clearly set in the ICZM Committee. MoESD must be the central organisation for managing funds and set target for other stakeholders in relation to beach erosion. MoESD must also be responsible for providing financial resources to stakeholders to address the problem of erosion. As such, stakeholders will be accountable to the lead Ministry. MoESD must set up a monitoring mechanism to ensure that activities are carried out and targets are met accordingly.

MoESD must play a leading and active role in managing information system. The ICZM Unit and Committee are required to play the role as a focal point for coordination through reception and provision of information in relation to coastal zone. Aerial photographs taken, rate of degradation of coral reefs and other relevant data must be actively used to understand beach erosion. This will enable MoESD to be more up to date with the evolution of our beach thus; corrective actions will be taken on a timely basis.

All projects must be closely monitored by stakeholders and results communicated to the ICZM Committee which must meet on a more regular basis than it is currently.

4.2.2 Other Recommendations

➤ Conservation measures

More emphasis should be given on conservation measures to safeguard the endangered existing live corals and beaches at the earliest possible since our beaches are valuable assets for the tourism industry and the Mauritian economy.

Coral reefs play an important role in the supply of sediments or sands to beaches. Given its importance, a long term plan with budget and time frame for the coral farming must be established. MOF have an important role to play in prioritising the replication of the coral farming projects at different sites, especially where there are no live corals. In Mauritius, the percentage of live corals shows a declining trend and only 20 percent were alive at end of 2012.(Source: MoF and MoESD) .The AFB also anticipated that over the next 50 years many beaches will be lost to the point of not supporting visitors, if there is no intervention.

MoESD should also consider monitoring non-public beaches to have an insight of the number of beaches that have been affected by erosion and the causes of erosion.

➤ Beach Monitoring

Given the dynamics of beaches and the effect of climate change, regular monitoring of the beaches is recommended. This will:

- ensure that appropriate measures are taken based on causes of the erosion and dynamics of the beach.
- ensure that maintenance of coastal protection works is done without delay and the cost of repair will be kept to the minimum.
- allow stakeholders to ascertain whether coastal protection projects undertaken are bringing expected results. Consequently, the work could be replicated, improved or abandoned.

➤ *Conservation measures of affected sites*

Given the importance of our beach, drastic measures have to be taken to conserve affected sites. These are:

- Temporary closure of beaches where remedial works were effected could be considered during off-peak season, for instance in winter.
- Protected areas should be strictly controlled according to legislations.
- Affected areas must be protected through legislations such as preventing activities for a certain period of time until there is regeneration of affected sites.

➤ *Maintenance works by Beach Authority*

BA should keep the responsibility to carry out the maintenance of coastal protection works. In this respect, the BA act needs to be amended to clarify this responsibility and avoid any ambiguity.

Appendix 1

Percentage of Live Corals

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Baie du Tombeau										
Back Reef	55	58	64	ND	38	64	27	34	NM	32
Le Goulet										
Fore Reef	62	74	-	74	38	41	29	29	NM	NM
Ile aux Benitier										
Fore Reef	35	23	26	ND	20	19	13	17	NM	NM
Back Reef	49	22	7	ND	6	7	3	1	NM	NM
Shore Reef	24	18	15	ND	0.5	0	<1	1	NM	NM
Bel Ombre										
Back Reef	44	51	24	17	32	39	22	20	NM	NM
Shore Reef	64	52	48	45	52	42	41	18	NM	NM
Bambous Virieux										
Back Reef	61	56	48	ND	52	65	55	51	NM	NM
Shore Reef	33	35	35	ND	28	37	26	26	NM	NM
Trou D'Eau Douce										
Back Reef	45	37	32		30	38	10	20	NM	NM
Shore Reef	70	60	59		64	52	30	13	NM	NM
Anse la Raie										
Back Reef	67	59	37	70	38	30	20	18	0.3	NM
Shore Reef	77	71	75	74	67	77	<1	0	3	NM
Trou aux Biches										
Fore Reef	36	33	28	ND	24	26	NM	19	NM	NM
Back Reef	37	37	40	ND	45	32	31	21	NM	24

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Pointe aux Sables										
Fore Reef	15	15	11	20	-	14	12	7	NM	NM
Back Reef	32	39	-	47	-	8	2	1	1	1
Albion										
Fore Reef	30	30	27	20	20	20	18	NM	NM	NM
Back Reef	54	22	19	12	1	1	1	9	NM	NM
Poudre D'or										
SiteI - Back Reef	58	57	40		18	8	7	2	3	NM
Site II - Back Reef	56	30	29		54	56	<1	0	0	NM
Belle Mare (Started in 2004)										
Site I		53	50	60	75	82	52	56	NM	18
Site II		50	64	70	67	72	47	47	NM	47

Source: Annual Report MoF

ND – Not Done

NM – Not Monitored

Percentage of Live Corals

	2003	2004	2005	2006	2007	2008	2009	2010
Blue Bay Marine Park								
Station 1		94			*11.77	7.7	7.8	12
Station 2	90	87	90.2	90.7	93.95	91.9	96.8	61.9
Station 3	90		85.5	83.3	76.67	**31.2	35.8	38.1
Station 4					0	0	<0.1	<0.1
Station 5					0	0	<0.1	<0.1

Source: Annual Report MoF

* No explanation given in Annual Report regarding decrease in coral coverage

** Percentage of coral coverage considerably decreased due to the increased frequency of diving, snorkeling and anchor damage

Percentage of Live Corals

	<i>2003</i>	<i>2004</i>	<i>2005</i>	<i>2006</i>	<i>2007</i>	<i>2008</i>	<i>2009</i>	<i>**2010</i>
Balaclava Marine Park								
Station 1			32.3		37.1	35.1	49.5	51.8
Station 2			65.7	53	54.8	54.0	60.1	49.3
Station 3			59.9		36.2	39.4	47.2	42.7
Station 4			67.9	64.4	51.4	65.9	68.9	63.6
Station 5			16.5		21.0	NM	29.8	32.6
Station 6			26.0	45.6	25.3	NM	*5.5	7.2
Station 7			33.3		30.2	NM	28.3	24.9

Source: Annual Report MoF

NM – Not Monitored

* No explanation given in Annual Report regarding decrease in coral coverage

** Coral reef ecosystem at most of the stations were in a fair state except for station 6 (located in the narrow lagoon facing the fish landing station) which showed significant signs of coral degradation, most probably due to anthropogenic activities (anchoring, poling and trampling) by the lagoon users.