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## MAIN POINTS OF THIS ADVICE

The Netherlands Commission for Environmental Impact Assessment (EIA) has been asked to advise on the work plan which has to be drawn up as a first step in the planning process for the Integrated Coastal Zone Management plan in Beira Mozambique. The Commission considers the following points in this advice as crucial in the work plan.

For this project, a distinction should be made between the emergency works which have to be executed within a period of 6 months (short term) and the set up of an Integrated Coastal Zone Management (ICZM plan) plan which formulates activities on the longer run (long term). The term for preparing this plan also covers six months. These terms are the time limits of the project and are set by the Netherlands Minister for Development Cooperation.

Because of the tremendous complexity of the problems related to the coastal protection, the Commission tried to structure these problems and their possible solutions. For this, the Commission has drawn up a matrix in which activities are arranged according to their respective theme and ICZM plan zone (table 1). The suggested activities should be checked with the principles of the project.

### ***Emergency works***

Because of the limited time and budget, it is important to have a clear idea on the objectives of the emergency works. After review of the reports, the site visit and discussions with the consultants and the local authorities, the Commission suggests the following ranking of the emergency works in the work plan.

1. There is a serious problem concerning the sanitation situation due to poor drainage causing floods in parts of the city, particularly in the rainy season. This can be solved by repairing the sluice of the Palmeira outlet.  
The operation of the sluice should be optimized, taking into account its function in the drainage channel (run-off and water level), which is used both as waste water disposal and suburban sanitation channel. Moreover, sand deposition in the delta of the outlet should be reduced to a minimum. It is recommended to consult the public (stakeholders) for the operating regime and to establish a team that is responsible for the 24 hour operation of the sluice.
2. There is a serious and immediate inundation risk caused by the ongoing coastal erosion. This can be stopped by the execution of relatively simple engineering works, like the repair of the most deteriorated groynes on crucial places, restoration of the beach wall and sand suppletion on places with an insufficient sand reservoir (e.g. Miramar). Further studies are needed to prevent coastal erosion at Punta Gea. To influence the sand transport near the shore in the right direction it will be more effective to start with measures down drift.
3. There is serious erosion of dunes by wind and by over-trampling by people; this can be counteracted with simple small-scale measures. Alternative options for dune protection should be considered (windbreaks, concentrated guided entrances, planting with soil covers in stead of tree's). Public cooperation and awareness is important. To gain this commitment it is important to choose a location in the dunes for a pilot project, if necessary, stimulated with extra funds.

To execute the emergency activities the cooperation (labour, equipment and commitment) of the city of Beira is needed. A team or unit within the administration (consisting of all relevant departments) should be defined as responsible for coordination and communication. Public consultation is an important part of the decision making process. The Commission agrees with the suggestion to establish a Forum consisting of relevant stakeholders to act as a consultative and coordinative body. The stakeholders are still to be determined. The items to be discussed in

the Forum should be as clear and concise as possible. The experience obtained with the Forum can be used later as an input for the ICZM plan.

### ***Integrated Coastal Zone Management plan***

Because of the close interrelation of the problems in Beira, like coastal erosion, water supply, sanitation and drainage and their management, it will be necessary, in order to address the long term problems, to draw up an integrated plan. In this advice the Commission gives recommendations on the themes and a selection of activities which should be covered by the plan.

The plan should contain the elaboration of the problem definition and a description of objectives:

- ! Coastal protection through upgrading of the defence works and amelioration of the coastal ecosystem by dune rehabilitation.
- ! Solving the sanitation and inundation problems, through drainage and also by identifying other possible sources of pollution (e.g. waste water disposal and solid waste disposal).

The issues to be analysed in the plan are presented in table 1.

The Commission agrees with the distinction of coastal zones by the consultant: a primary, secondary and an extended zone. These zones are based on water related functions. Conflicts of interest within each zone and between different zones and mutual interests should be clearly defined.

An important alternative for the future is the restoration and upgrading of the Chiveve river as a drainage system again. This would enable to close the discharge sluice at Palmeiras and the channel so that the river course could be turned into an attractive green environment in the city. This option should be worked out.

To assess the impacts of the proposed activities, one has to describe the existing environment. The Commission assessed the existing information and gives recommendations for the gaps in this information. According to the Commission, the key elements in such a description are:

- ! the sediment transport system;
- ! the drainage system;
- ! the coastal ecosystem of the dunes.

For these key elements a monitoring programme should be developed in the near future.

It was already stated that Beira needs institutional strengthening to handle the emergency works and to establish the ICZM plan. To assess the deficiencies in the current situation it is necessary to describe the present administrative structure and responsibilities for the issues addressed. Attention should be paid to new developments regarding decentralisation of power and responsibilities to the local government. For the transparency of the decision making process and to obtain public commitment, it is necessary to find a mode for consulting the public. Two essential functions: consultation and coordination are elaborated in this advice.

Table 1

Beira emergency actions an ICZM plan issues

ICZM plan Zone	Theme	Emergency works	ICZM
P/S	Drainage	Palmeiras sluice door repairs	drainage subur
P	Coastal erosion	headland structure seawall repairs groyne rehabilitation	monitoring sand erosion sand mining
P	Dune habitats	coastal road wall repair construction of wind breaks/ fences exclusion of vehicles and public prohibition sand mining stabilize sands /nourish dunes /construct board walks	awareness development
P/S	Waste water disposal		wastewater
P/S	Drinking water supply		surface water
P/S/T	Pungue river basin management		river management
P	Harbour accessibility		dredging
P/S	Solid waste disposal		contamination
P/S/T	Ecosystem and biodiversity	restore dune habitat	conservation management integration
P/S/T	Institutional framework and capacity building	assessment of Forum composition and functions	training O&M ICZM
P/S/T	Monitoring	Monitoring of impacts	drawings

P = Primary ICZM plan zone, S = Secondary ICZM plan zone, T = Tertiary ICZM plan zone

## 1. INTRODUCTION

The city of Beira, Mozambique has sought support in order to address the problems related to coastal erosion. In August 1997, the Netherlands Minister for Development Cooperation decided to provide support for the preparation of an Integrated Coastal Zone Management plan (ICZM plan) for the city of Beira. Included in the ICZM-plan is the implementation of some of the identified emergency works. (See appendix 1 for the ToR). Arcadis Euroconsult -in association with Alkyon Hydraulic Consultancy & Research, the Netherlands, Profabril Group, Portugal, Arcadis Bouw Infra, the Netherlands and the International Union for Conservation of Nature (IUCN), Mozambique- was chosen to formulate the Integrated Coastal Zone Management plan in close collaboration with the city of Beira.

The first step in this planning procedure is the preparation of a work plan. This work plan should indicate the areas on which the project will concentrate but it should also specify the process and activities which will lead to the formulation of the coastal zone management plan and the implementation of the emergency works.

By letter dated 1 May 1998 (appendix 2) the Royal Netherlands Embassy, on behalf of the Minister for Development Cooperation of the Netherlands, has asked the Netherlands Commission for the Environmental Impact Assessment (EIA) to advise on the ICZM plan and the proposed emergency works.

A working group of the Commission, composed of a Mozambican expert (institutional and environmental matters), three Dutch experts (engineering, coastal ecology and water management), a chairman and a technical secretary (appendix 3), visited Mozambique from 8 – 12 May 1998.

### 1.1 Motive and mandate of this advice

The Commission has been asked to advise on the work plan, including the physical conditions of the coastline in Beira, the emergency works and on the coastal ecology. Furthermore the Commission was asked to advise on the composition, tasks and responsibilities of the Forum. Together this will give an assessment of the issues to be covered with regard to coastal zone management.

The advice is composed on the assessment of background documents (appendix 4) and the site visit. Information was gathered from discussions with the consultant and several governmental authorities and institutions. This has enabled the Commission to formulate a site specific advice for the work plan (selection of issues) as prepared by Arcadis/Euroconsult.

The work plan will be completed in May 1998 and will be discussed with the city of Beira and the Embassy. The ICZM plan will be finalized in October 1998. Prior to final decision-making, the Commission for EIA is requested to review the plan.

### 1.2 Project setting

The financial situation of the city of Beira is not sufficient to meet all costs of coastal protection. For drawing up the ICZM plan the Dutch government has a budget of Dfl 500.000,- and for implementation of the emergency works Dfl 1.000.000,- is available. Within this budget it is not possible to carry out all the coastal defence works. Choices have to be made between the emergency works. In order to compare the costs of certain measures these costs should be assessed in the working plan. Time constraints impose assessment of the feasibility of certain technical solutions and assessment of the feasibility of public participation..

According to the terms of reference the ICZM plan should be based on the following principles:

- ! environmentally sound;
- ! socially acceptable;
- ! technically simple;
- ! not capital intensive;
- ! be implementable with local expertise and technology.

These principles should be used as a framework for the suggested measures, and should, according to the Commission, be elaborated in the following requirements:

- ! environmentally sound;
    - contribution to the coastal protection in a most sustainable (natural) way;
  - ! socially acceptable;
    - consultation of the people through the Forum;
  - ! technically simple;
  - ! not capital intensive.
- these requirements are summarized in the next prerequisite:
- ! the work plan can only be implemented if local expertise and technology is used optimally.

The execution of the emergency works and the drawing up of the ICZM plan in Beira create a good opportunity for the local institutions to improve their capacities and to create a momentum of action dealing with coastal management problems of Beira. The project also provides an opportunity for an 'on the job' training of local people. Public involvement is crucial for the implementation of the measures.

### 1.3 Outline of the advice

In chapter 2 the problems to be solved are listed in order of priority. Chapter 3 gives the recommendations for the content of the various emergency works and activities which the Commission selected as important to handle in the ICZM plan. Suggestions for alternatives are given. The Commission recommends that the work plan of the consultant should elaborate this suggested approach.

Chapter 4 provides an assessment of the existing information on the natural and institutional environment. This chapter also gives recommendations on guidelines for monitoring of the emergency works and the ICZM plan. Institutional requirements to make the ICZM process successful are described.

## 2. PROBLEM DEFINITION

Because of the urgent need to solve the problem of sanitation- and inundation risks, some of the emergency works have to be carried out before the ICZM plan is completed. These emergency works have to be executed as soon as possible in order to avoid further erosion and consequently more costly measures on the longer run. The information gathered by previous missions gives sufficient support to identify these emergency works. Also from a psychological point of view, to stimulate the city and the people of Beira, and to show something practical after the several missions and studies, it is important to execute some of these works very soon.

The short term problems must be solved by means of implementing the emergency works (within 6 months) whereas the long term problems have to be addressed through the implementation of the Integrated Coastal Zone Management plan (long term). The term for preparing this plan also covers six months.

## 2.1 Problem definition for the emergency works

The Commission suggest the following priority-ranking of the existing problems.

Short term

1. there is a serious problem concerning the *sanitation situation* due to poor drainage causing floods in parts of the city, particularly in the rainy season;
2. there is a serious an immediate *inundation risk* caused by the ongoing coastal erosion;
3. there is serious *erosion of dunes* by wind and over trampling by people.

Another closely related problem to solve in the short term is the lack of institutional capacity for implementing the emergency measures. Public involvement is needed. In this frame the definition of the Forum's composition and functions is suggested.

## 2.2 Problem definition for the ICZM plan

In the tender report, the consultant stated: " *The ICZM planning involves the formulation of a combination of economic development options, environmental protection options, and coastal response options which can then be analysed to assess what may be the optimal development scenario for a given area.*

*At the heart of the ICZM process lies the understanding that i) all sectors, all levels of government and all actors (coastal communities, private sector) should be involved in the decision-making process; ii) preservation of entire ecosystems is required to sustain biodiversity and life-support functions; and iii) maintenance of the production and buffering function of coastal ecosystems is essential for long-term coastal development."*

This is a very broad definition of the ICZM plan. In this advice the scope of the ICZM plan is more specified. In the view of the Commission the ICZM plan should address the problems that require immediate action (as defined in the previous paragraph) and give a description of the long term objectives like:

- ! coastal protection through upgrading of the defence works and amelioration of the coastal ecosystem by rehabilitation of the entire dune area;
- ! solving the sanitation and inundation problems, through drainage and also by identifying other possible sources of pollution (e.g. waste water and solid waste disposal);
- ! strengthening of the institutional framework and capacity building in order to implement the ICZM plan.

It is important to define the boundaries of the coastal zones. The Commission agrees with the distinction of coastal zones proposed by the consultant: a primary, secondary and an extended zone. These zones are based on water related functions.

*The primary zone would include:*

- 1 *the area of the near shore sea (from 22 km distant into the MLW line)<sup>1</sup>];*
2. *The area of the beachfront (from MLW to the inner edge of the primary dune, often marked by the major coastal roadway) and including the dunes, beach, and any mangrove wetlands adjacent the shoreline;*
3. *The area of the immediate shore lands extending from the primary dune to the first major roadway*  
*This includes all the land uses in the area.*

*The secondary zone would include:*

*The interior lowlands, composed of all riparian areas, and all wetlands, rivers, creeks and their banks and other drainage of the urban area that flow to the sea.*

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<sup>1</sup> The Commission recommends to take a smaller area from the sea shore. The area should be as large as the influences on the sand transport by waves and currents.

*The extended zone would include:*

*The zone of influence, a more loosely defined zone that includes areas outside the Primary and Secondary zone, within and beyond the urban boundaries that affect the coastal environment; eg. agricultural lands, the Pungue river and water diversion sites, inland settlements etc.*

The lateral boundaries of the zones should be clearly described as well.

### 3. RECOMMENDATIONS FOR THE ORGANIZATION OF THE EMERGENCY WORKS AND FOR THE OPERATION OF THE INTEGRATED COASTAL ZONE MANAGEMENT PLAN AND ALTERNATIVES

This chapter contains recommendations for the work plan as the first step for the ICZM plan. In order to structure the emergency works and the activities to be considered in the work plan, the Commission has drawn up a matrix in which these works and activities are arranged according to their respective theme and ICZM plan zone (table 1). The suggested activities should be seen as guidelines for project formulation. All these activities, however, are also related to anticipated environmental effects of the plan. Therefore, they must be addressed in the environmental context as well. Also special attention is paid to the institutional framework.

It is obvious that not all alternatives can be worked out completely in the half year available, but they should be elaborated to such an extent that a preliminary judgement about their feasibility can be given. Moreover, it should be indicated and motivated along what lines a further study should be done in case the alternative is judged feasible.

#### 3.1 Work plan Emergency works

The Commission agrees with the following measures for solving the identified short term problems.

##### **Sluice repair**

To solve the sanitation situation due to poor drainage causing floods in parts of Beira, particularly in the rainy season, the sluice of the Palmeira outlet should be repaired as soon as possible.

The design could be adjusted to the current situation. An important issue to be studied is the range of options for operating the sluice. The operation of the sluice should be optimized, taking into account its function in the drainage channel (run-off and water level), which is used at the same time as waste water disposal- and suburban sanitation channel; sand deposition in the delta of the outlet should be reduced to a minimum. It is recommended to consult the public (stakeholders) for this operating regime. It is also recommended to establish a 24 hour guarding of the sluice.

Training of local officials for operation and maintenance jobs is also needed. Sufficient support (tools, employee's and time) should be available right from the start of the operation of the sluice.

##### **Measures to prevent coastal erosion**

The other selected emergency works (headland structure at Punta Gea, sand suppletion and sea wall repair at Miramar and groyne rehabilitation) should be studied in order to compare them and to identify the priorities within the limits of this project. The following aspects need to be described.



- ! Technical aspects:
  - current status of the groynes, sea wall;
  - design for repair;
  - costs;
  - location;
  - way of construction.
- ! Environmental aspects:
  - use of materials (what kind and where to find);
  - amount of sand deposition (the contribution of the measure in influencing the sand transport).
- ! Operational maintenance:
  - programme for maintenance which considers:
  - how and when maintenance should be carried out;
  - who is responsible for maintenance.

In order to influence as much as possible the sand transports the Commission suggests to start down drift with measures which could prevent further sand movements.

### **Dune rehabilitation**

To compare alternative options for dune rehabilitation the following aspects need to be described.

- ! Technical aspects:
  - design (new or restoration of the old constructions like the walls);
  - costs;
  - construction.
- ! Environmental aspects:
  - amount of sand transport;
  - use of materials to trap sand (e.g. fences);
  - use of indigenous vegetation to stabilize sand. The Commission suggests to study the impacts of stabilization with the indigenous pioneer species (creepers like *Scaevola*, *Imperata sporobolus*, *Ipomoea*, *Lannia*) and grasses with extensive root systems (*Helophyllum*, *Dactyloctenium*) and (*Cyperaceae*). Their grip on the sand dune is probably better and they need less water than trees do (more water left for reservoirs in underground of dunes).
- ! Operational maintenance:
  - measures to improve the awareness and the information (through public participation) of the people to keep them out of the dune area, because this is the main cause for dune destabilisation;
  - alternatives for entering the beach, guided entrances, board walks, create 'honey-pots': places where people like to go and concentrate;
  - alternatives for the shade of the tree's for example by planting tree's on the boulevards, or by providing 'umbrella's' on the beach itself (small scale businesses);
  - control of misuse.

Public cooperation and awareness is crucial. To gain this commitment the Commission suggests to choose a location in the dunes for a pilot project, if necessary stimulated with extra funds. The choice should be made in consultation with local people.

#### **3.1.1 Institutional requirements for the emergency works**

The proposed and prioritized emergency works regarding the drainage improvement, coastal protection and dune habitat restoration require the following institutional provisions:

- ! consensus within the Forum about priorities of emergency works and responsible authority body for management, operation and maintenance;
- ! sufficient capable and available staff, working with proper remuneration and incentives schemes;

- ! regular supply of equipment and materials for operation and maintenance by means of establishment of a proper budgeting system;
- ! exclusive transport and/or housing facilities for operation purposes of the sluices at Palmeiras;
- ! monitoring of effects of improved drainage inland and of delta growth at the coast; monitoring of effects of dune restoration.

As the emergency works are important for providing first actions on issues in Beira which for a long period could not be dealt with, it is necessary to have success in the execution of the emergency works and the operation and maintenance. This is in particular true for the drainage sluice at Palmeiras, which has been mentioned by the various parties as the first work to be executed. Immediately after the repair of the sluices and their inauguration, operational guidelines for opening and closing these sluices at low and high tides must be followed. This means that at that moment all required institutional capacities, as described above, must be available. The items for the Forum to discuss upon are simple and concrete. The emergency project should prepare proposals for Beira municipality to have these requirements ready at the right place and time.

### 3.1.2 **Alternative options**

After the repair of the discharge sluice of the Palmeiras drainage channel, scenarios for the operation must be determined which are most favourable for the development of the Delta.

For immediate action only repair of some essential groynes – to be determined by the study – is appropriate. The essential groynes could be chosen through their effectiveness to stop the sand transport.

Various options for dune rehabilitation could be considered. A pilot project could function as a positive example to gain future commitment of the inhabitants and further funding.

At this short notice, other options for coastal defence works like the construction of shore-parallel breakwaters and large scale sand nourishment to the beach are -as emergency measures- not possible. They can, when feasible, be considered in the ICZM plan.

## 3.2 ICZM plan

The plan should contain the elaboration of the problem definition and description of objectives:

- ! coastal protection through further repair of the groynes and small scale sand suppletion;
- ! amelioration of the coastal ecosystem by dune rehabilitation and improvement of mangroves and wetlands;
- ! improvement of the sanitation and inundation problems, through drainage and also by elimination of other possible sources of pollution (e.g. waste water disposal and solid waste disposal) and the taking of measures to counteract the widespread and uncontrolled defecation;
- ! strengthen the institutional framework and its capacity to implement the ICZM plan.

The issues to be analysed in the plan are summarized in table 1.

To address the importance of the plan and to compare the plan issues it is essential that the ICZM plan describes how these issues will contribute to the objectives (still to be defined) of the plan.

Drainage:

- improvement of the drainage system by the distinction of black (waste) and other waters;
- improvement of the water table and water quality;

- improvement of the low water level in the wet season in the areas along the channel;

Coastal erosion:

- upgrading of the defence system against high water level and storm surges.

Dune habitats:

- amount and quality of restored dune area;
- contribution to biodiversity including mangrove and wetland habitats;
- identification of bio-indicators for assessing environmental quality.

### 3.2.1

#### **Institutional requirements for developing the ICZM plan**

The distinction in coastal zones as made by the consultant is a practical delineation which will facilitate the assignment of the proper responsible institutions for the issue at hand in Beira.

The elaboration of the integrated coastal zone management plan requires the operation of two essential functions in an integrated plan development: consultation and institutional coordination.

The Forum which has recently been formed might have the role of performing the two functions mentioned above.

It is suggested that the Forum be composed of a nucleus of the most important institutions and selected stakeholders (still to be identified). The Forum is to be extended with all relevant stakeholders when exercising its consultative role. At important decisive moments in the ICZM plan development, the Forum should be consulted, (e.g. ranking of needs and options, selection of options, etc.).

The Forum's nucleus, furthermore, coordinates the activities of thematic working groups which need to be set up within the relevant institutions and which will be involved in the actual execution of the ICZM plan activities (e.g. data collection and analysis, option development and evaluation, etcetera). It is recommended that the Forum continues to exercise its coordinating role after the ICZM plan has been completed (after the 6 months project) to facilitate the plan implementation.

#### **Consultative role**

The coastal zone is in its essence a zone of interaction of several institutions and stakeholders. The Forum, in its consultative role, should function as a platform by which the civil society can manifest and defend its interests with the objective of obtaining a better organized society.

The institutions that should be part of the extended Forum are e.g. Maritime and Micoa, who each delegate one official representative. The Forum, however, should act as an independent institution and will invite other institutions and expertise whenever this is needed.

Also local NGO's should have access such as:

- ! organizations which work for the interest of the citizens of Beira;
- ! vital sectors, e.g. tourism. Any individual who tries to defend the interests of the operators in the tourist industry;
- ! single persons who work in the interest of the city of Beira;
- ! professional associations such as the Commercial Association of Beira (CAB);
- ! rotary Club - private clubs which work in the interest of the city of Beira;
- ! nature conservation organisations.

#### **Coordination role**

The Forum -in its basic composition- should play an important role in facilitating the coordination between the various institutions which exercise important functions in the coastal zone of Beira and the Beira municipality. The Forum in this composition coordinates the activities of the different thematic working groups which have to be established within the involved governmental bodies. As suggested by the consultant, these could be working groups in the fields of:

- ! institutional development (the Forum itself in its basic composition);
- ! physical planning (municipality);
- ! water and infrastructure (ARA centro, Aguas de Beira and municipality);

- ! ecology and biodiversity working group (municipality);
- ! beachfront management (municipality);
- ! emergency works (municipality);
- ! ICZM plan working and monitoring group (planning team within municipality).

The working groups report to the Forum about their progress and propose coordination issues to be solved within the Forum (e.g. supply of data, exchange of data, data collection and other planning activities).

### 3.2.2 **Alternative options within the ICZM plan**

For the long term, upgrading of the Chiveve river should be considered as an option for drainage of the area. In that case it would be possible to close the discharge sluice in the Palmeira drainage channel, which is an unnatural element in the coast. This would make it possible to turn the river course into an attractive green environment in the city. In the view of the Commission the re-opening of the Chiveve river outlet will not disturb the harbour.

Other alternatives for the coastal protection like large scale sand nourishments could be mentioned, indicating the problems of the required high degree of long term management associated with these solutions. Special attention must be paid to the management of the discharge of the material dredged from the entrance channel to the harbour. This material might remain in the system and could perhaps reach the coast again. The same holds for the application of other types of coastal defence structures like shore-parallel breakwaters.

These alternative options should be weighed in accordance with the key issues addressed in table 1 and with the criteria of chapter 2. When these alternatives are considered feasible than further detailed elaboration could be (not within the 6 months) necessary.

### 3.3 Most environmentally sound solution

One has to try and determine and weigh (attach scores to) all environmental aspects of the various solutions. By determining the final score it might be possible to find the most environmentally sound solution. This solution will be an optimisation of the themes mentioned in table 1. The description of the scores of the emergency measures will give insight in the process to an environmentally sound solution of coastal protection. This process could be scrutinized in the ICZM options.

### 3.4 Do-nothing option

This option will be used for further reference purposes: to compare the alternative options suggested above. This reference is based on the description of the current situation.

### 3.5 Autonomous developments

During the visit of the Commission it became clear that an advisory body (PROL) supported by foreign funds was busy in organizing, designing and planning a physical structure for Beira. The Commission considers this as an autonomous development. Depending on moment the results are available, the outcomes of PROL and the ICZM plan should be of mutual influence. For the long term PROL activity there was also an initiative to create an advisory body for coordinating and consulting the different interest groups in Beira. Duplication of effort with the Forum should be kept to a minimum by defining clear goals and authorisation of these initiatives.

## 4. DESCRIPTION OF THE EXISTING CONDITION OF THE ENVIRONMENT AND THE IMPACTS

The study area is defined according to the same boundaries as defined for the coastal zones.

### 4.1 Natural Environment

#### 4.1.1 Climate

In a paper<sup>2]</sup> on the vulnerability of coastal resources to climate change in Mozambique, it is stated that the country is extremely vulnerable to sea level rise and Beira was identified as one of the most vulnerable areas. Most of the town is below high water level: inundation and erosion being the main problems. Predictions for sea level rise strongly call for ICZM planning in Mozambique. Effect of hazards (like cyclones) should be considered. There are indications that such events could strongly influence the geomorphology of the coast for years to follow.

**# A description of the expected climate change, especially of those aspects which are important for the emergency works and the ICZM plan, must be given and analysed**

#### 4.1.2 Geomorphology

From the analysed and elaborated patterns of wave and currents, sediment transport over the shoals and along the coast must be calculated in order to understand the mechanism of the morphological changes. Description of these patterns can give information for the best place to supply sand in order to prevent coastal erosion. Two options are relevant:

- maintenance of the access channel to the Beira harbour;
- the dumping of the dredged material from this access channel.

**# The development of the coast and its features -like the delta at the outlet of Palmeira drainage channel- must be explained in order to understand the developments and predict future scenarios; retrospective sequential airphoto analysis is a useful tool for this.**

#### *Waves and currents*

The tidal movements in the estuary must also be described and analysed to gain understanding of the water movements around Beira. From old and recent hydrographic charts possible trends in the development of the bottom and coastline topography must be determined. Also the sediment according to type and grain size along the coast and on the shores of the river Pungue delta must be summarized, where necessary completed and analysed.

**# In order to understand the sand transportation, the off shore wave climate and current pattern must be analysed (most likely numerical models).**

#### 4.1.3 Hydrology ground water and surface water quantity and characteristics River Pungue and its estuary

The City of Beira is situated at the outlet of the Pungue river into the Indian Ocean. The Pungue river and estuary are important features for Beira: The harbour is located in the Pungue estuary and the river provides the city with drinking water by means of an intake about 40 km upstream. The estuarine area has possibilities for mangrove development, including the replanting of mangrove forests which have disappeared over the years.

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<sup>2</sup>"Vulnerability of coastal resources to climate changes in Mozambique" by David Chemane, Helma Motta and Mussa Achimo. Three scenarios for sea level rise are discussed: 0.2 metre by 2025, 0.5 metre by 2080, and 1 metre by 2100).

The tidal movement in the estuary twice a day creates a saline tongue intrusion in the Pungue river, which in the dry season advances tens of kilometres upstream, sometimes beyond the surface water intake for the Beira water supply.

The mission did not have the opportunity to review information about the hydrology of the Pungue river or depict in extenso the available information about the hydrology and hydrogeology of the Pungue river.

Information is available, however, at the Direcção Nacional de Aguas in Maputo and also in the offices of ARA Centro, the regional water management entity in Beira. It will be important to have the historic yield records of the Pungue river analysed and reviewed. Some data and studies are available about saline intrusion in the Pungue river.

**# It will be important to have information reviewed and analysed about the water uses in the Pungue river basin, to assess the volumes of Pungue runoff which are available or which should be secured in the dry season for:**

- ! drinking water supply for Beira;**
- ! irrigation;**
- ! reduction of saline intrusion;**
- ! sustainability of estuarine ecosystem (erosion and silt deposits).**

For a description of the presence of ground water, its quality and its development potential within a radius of at least 50 km of Beira, it is important to have a review of the available information on ground water. This information is also available at the Direcção Nacional de Aguas (DNA) in Maputo. A first step would be the consultation of the Hydrogeological map of Mozambique, a second step would be the consultation of specific reports and data on the Beira area. The consultation of the databank of DNA will be of help in this review.

**# A review of available information of ground water and its quality will help to determine future potential uses.**

#### *Urban water management in the city of Beira and adjacent agricultural lands*

The city of Beira is located partly on a narrow and low row of coastal dunes and partly in a low-lying area, which needs permanent drainage. Direct rainfall over Beira city creates considerable runoff which needs to be drained to the Indian Ocean. This is done through the Palmeiras drainage channel.

Waste water was collected in a waste water collection system (designed by DHV) This water was transported and discharged via a pressure pipe system into the Pungue estuary.

The system, however, has broken down and cross connections have been made of the waste water system to the Palmeiras drainage channel which now has a mixed purpose: drainage of waste water and rain water.

**# It will be important to have a clear description of the drainage problems in the city of Beira and the actual function of the Palmeiras drainage channel: What is the composition (in terms of volumes waste water and rainfall runoff) of the drainage; which areas of the city and agricultural lands drain rainfall runoff and/or waste water in the Palmeiras drainage channel? What are desired surface water and ground water levels in the city and the agricultural lands, considering the different land use functions?**

Because of insufficient supply of drinking water to the Macuti part of the city, it is said that wells have been constructed in the coastal dunes to extract ground water. This could cause salinisation of land behind the dunes.

When sufficient water can be made available for the city by means of surface water and ground water (regional resources), the wells in the dunes of the city of Beira can be removed, with possible positive effects on the biotope and salt-upcoming.

**# It will be important to have an inventory of these wells, their location, ownership, construction depth and phreatic water level, water quantity abstracted and water quality. Are there any confirmed signs of saltwater upcoming because of these**

groundwater extractions? A short description of the impacts should be given in the ICZM plan.

The improved drainage of Beira City through the rehabilitation and operation of the sluices at Palmeiras will have effects on the water tables in the city and the adjacent agricultural areas. A description is needed of how this will influence the water table. It is expected that the water table will drop. This might result in local land subsidence in swampy areas, such as was the case also in certain areas along the Chiveve river after the construction of the fishing harbour and the reduced entry of seawater.

**# An assessment on the impacts on the watertable is needed in the ICZM plan.**

It is not clear which function the Palmeiras channel and sluice has in the removal of waste water. During the dry season it might be necessary to have regular flushing of the channel with seawater to have waste removed.

Reduced infiltration of the area with salt water will reduce salinisation of the adjacent agricultural land.

Proper waste water and solid waste management and disposal facilities will have positive impacts on the water quality in the estuary of the river Pungue, which will have positive effects on the ecosystem and biodiversity in the area.

**# It is important to assess the impacts of these facilities in the ICZM plan.**

Strategic water resources management and water allocation in the Pungue river basin might create conditions with controlled saltwater intrusion into the river with positive effects on land salinisation.

**# These impacts should be studied in the ICZM plan.**

#### 4.1.4

#### **Ecology**

The Beira coastal environments are part of the “region of rivers”, the centre of the three broad coastal regions in Mozambique. Main characteristics are a flat topography, huge deltas (mud and sand flats), estuaries, marshes, beaches and low dune ridges and a highly dynamic mangroves, dunes and fresh water lakes.

The crucial challenge in such areas is to find a combination of socio-economic development (stabilize substratum) and nature development (allow destabilization and natural dynamics).

Beira and its surroundings are constituted of old beach ridges with low and narrow (up to several 100 metres) dunes, sand spits and fresh water marshes.

**# A description of the dune area in the city as a part of the ecology of the region is needed to understand its function in the large coastal system and the impacts of the required measures.**

#### *Mangroves*

Mangroves are extremely valuable as a coastal resource. They retain sediments, prevent erosion, have a high primary production and maintain a variety of wildlife; they also serve as nurseries for fish, prawns et cetera. Mangroves should be kept as a green belt. Assessment of the role of mangroves in order to establish a proper sustainable management is at stake and that is beyond the cope of this project.

**# The description by the consultant of the mangroves in Beira is sufficient.**

Some information on wildlife is needed. Important and correct is the conclusion that the present quality of mangroves in Beira is very low, both because of their limited extent and their ecological status.

**# Because of this, it is not opportune to spend much time and effort in restoring the mangroves within Beira. It is better to attend to the mangroves south and north of the town, which are more extensive and of a better quality**

What should be done however is to preserve/restore some mangroves in the Chiveve river as part of an alternative drainage solution see paragraph 3.2.2 and as little 'green lungs'. The outcomes of the mangrove study done by the universities of Groningen and Maputo can be helpful for the ICZM plan in the long run to assess the ecological and economical values of mangroves.

#### *Dunes*

The dune habitat is small but potentially important in Beira. It deserves immediate attention because of its protective function.

**# Restoring the dunes between Macuti lighthouse and Palmeiras outlet is important. Restoring dunes is technically simple and not expensive but cannot be accomplished without involvement and cooperation of the local people (see aspects for consideration in this matter in paragraph 3.1.2 and 3.2.1). The stabilization of the dunes with ground covers should be studied, trees should be avoided. The description of the plant species of dunes and mangroves by the consultant has errors and should be checked/corrected by a local biologist.**

## 4.2 Legal and institutional environment

Various governmental institutions have a mandate by law to operate in coastal zone management issues. Among these are:

1. Maritime, 100 metre measured from the High Water Line, with exception of:
  - ! Management of the forest resources. Maritime competes here with the Ministry of Agriculture and Fishing through the National Directorate of Forest and Wildlife;
  - ! Management of the harbour area remains under the responsibility of the Mozambican Railways;
  - ! River basin management is the responsibility of the Regional Water Administration (ARA Centro).
2. This zone of 100 metres is considered as public area. The whole area is to be considered under the Land Law. By this law, it is not permitted to have the right of use and exploitation of the land. In any case the law defines the competent authorities for obtaining special licenses for exploitation of certain activities. Among the competent authorities can be distinguished:
  - ! Council of Ministers;
  - ! Ministry of Agriculture and Fisheries;
  - ! Provincial Government.

With the approval of the set of laws which prescribes the decentralization process, autonomy is created at the local level.

It is important that the consultant analyses the legal and institutional environment because:

- ! this year the municipality elections are being held for the first time in Mozambique;
- ! it is possible that there will be a change of political parties;
- ! all these changes will occur during the time of the emergency works.

Certain unclarity can be identified in the package of laws that accompany the decentralization:

- ! which institutions will be represented in the municipality?
- ! Which levels of decisions will be delegated to the municipality, particularly in the coastal zone?
- ! Which institution will issue special authorizations for projects of small size, which will be established in the coastal strip?



# Developments of this kind, taking place during the six months of research should be described by the consultant.

## 5. COMPARISON OF ALTERNATIVES

Alternatives must be compared on their environmental impacts. It is recommended to present the comparison in the form of tables and diagrams. In the comparison the current environmental situation and the alternative most friendly to the environment must be given. All alternatives must be compared to international and commonly accepted standards as much as possible.

The various aspects need to be discussed with the responsible authorities. The prediction of impacts can be described in different ways according to the available information: qualitative and quantitative.

If necessary, stakeholder groups can attach values (weights) to the impacts of various options. Impacts that are not distinctive can better be left out of the comparison. It is recommended to use Multi Criteria Analysis as a tool for comparison.

## 6. IDENTIFYING INFORMATION NEEDS, EVALUATION AND MONITORING

The lack of information must be identified. The importance of this information for decision making must be noted.

In the ICZM plan a monitoring plan must be presented. This plan includes the monitoring of:

- ! changes in coastal morphology;
- ! effectiveness of mitigating measures for coastal erosion;
- ! effectiveness of coastal zone management measures on ecological quality of the environment;
- ! effectiveness of capacity building and training.

## 7. SUMMARY, FORMAT AND PRESENTATION OF THE ICZM PLAN

A non-technical summary must be included in the plan. This summary must address the major subjects of the plan, using comprehensive maps, tables and diagrams, and be written in such a way that it provides non-technicians and decision makers with a clear insight in the issues treated.