

**AN ENVIRONMENTAL OVERVIEW OF THE
WALVIS BAY 'BAY AREA',
NAMIBIA**



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**Submitted in partial fulfillment of the Masters of Philosophy
in Environmental and Geographical Science,
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EXECUTIVE SUMMARY

This dissertation forms part of a process which began when DANCED initiated the first stages of a project aimed at aiding the Namibian Government in the development of an Integrated Coastal Zone Management Plan for the coastline of the Erongo Region. DANCED requested the assistance of the MPhil students, from the Department of Environmental and Geographical Science of the University of Cape Town, in the compilation of a baseline report for the region. The first step involved the collection and synthesis of baseline data on all environmental factors (natural and social) pertaining to the Erongo Region. This was followed by individual research dissertations by each member of the class.

After review of the Baseline Report, the greater Walvis Bay 'bay area' was identified as a priority area in terms of coastal zone management of the Erongo Region. The aim of this dissertation is thus to provide an environmental overview of the Walvis Bay 'bay area' that can assist planners and relevant authorities in the effective management the area. Firstly, the importance of the study area as a conservation area is established. It is noted that the Walvis Bay wetland is one of the top five most important wetland areas in Africa. Secondly, there is little co-ordination and communication between the authorities that have jurisdiction over portions of the study area and this has led to ineffective management of the area. Thirdly, the study area is defined and the major human activities operating within the study area are identified and described.

The broad principles of Integrated Environmental Management guided the approaches and methods used in this report. The basic approach of description, analysis and evaluation was used. Seven major human activities, operating within the study area, were selected from the Baseline Report for analysis. These included the commercial and fishing harbours, salt recovery, mariculture, tourism and recreation, urban developments and guano collection. Relevant literature was consulted in the analysis of the impacts of these human activities on the environmental factors while two methods are employed for the evaluation of the impacts.

The first, an adapted Framework Approach (Summary Matrix), is used to present the impacts of each activity on a number of important environmental factors. The environmental factors include birds, large marine animals, small marine organisms, natural habitats, natural processes, water quality and socio-economic conditions. The matrix consists of Human Activities versus Environmental Factors (see Table 3). The impacts as described in each cell are then evaluated using an adapted Fuggle Matrix and the important (significant) impacts highlighted on Table 3. It is also important to analyse and evaluate the impacts of the natural processes on the human activities within the study area. It was found that the sedimentation processes within the study area were the major natural processes impacting on human activities.

It is concluded that the lack of effective management of the study area combined with the impacts (as summarised in Table 3) pose a major threat to the functioning of the natural environment of the study area. This in turn threatens the sustainability of bay-dependant human activities in the bay area. It is also concluded that before any management actions could be recommended the co-ordination between all the authorities and parties that have an interest in the study area needed to be addressed. Thus the following general recommendation is made:

- A Joint Management Committee be set up to administer and co-ordinate the various authorities and organisations that have an interest in, or jurisdiction over, portions of the study area. This committee should be as inclusive as possible and should as a minimum have representatives from the Ministry of Environment and Tourism, Ministry of Fisheries and Marine Resources, Walvis Bay Municipality, Namport, Pelagic Fishing Association and The Namibian Hake Fishing Association, Round Table of Walvis Bay, Salt & Chemical Co. Pty. Ltd., members representing Tourism and Recreation and at least one member representing other NGO's that may have an interest in the management of the study area. It may also be important to include several other Ministerial Departments such as: Ministry of Water Affairs and Ministry of Transport.

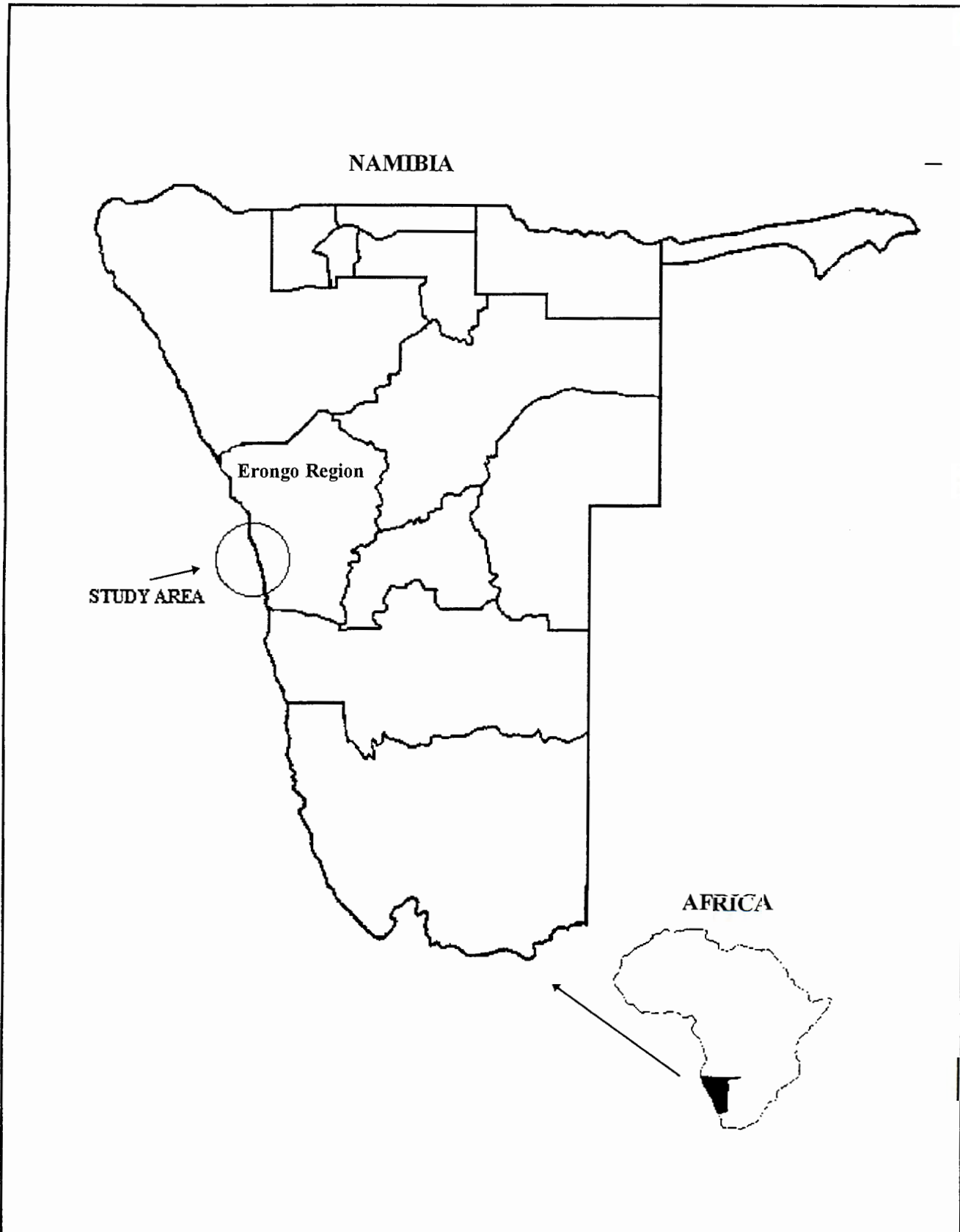
- The Joint Committee have formal (national) recognition and direct communication with Ministries at national level. This should ensure that management plans and recommendations initiated by the Committee be enforceable and contribute towards national planning strategies.

More specific management actions that should be initiated and co-ordinated by the Joint Committee are as follows:

- Initiate and co-ordinate a pollution monitoring programme that will monitor all forms of pollution in the bay including: oil spills, heavy metal concentrations, effluents from the fish processing factories, litter and any other sources of toxins that may be entering the bay. Adopt an appropriate set of standards for pollution levels.
- Set up policy on mariculture in the open water of the bay, including: spatial requirements, species of shellfish to be farmed, total carrying capacity of the bay area and requirements of impact assessments before farming commences.
- Promote the Walvis Bay wetland as a Ramsar site with emphasis on the extreme sensitivity of the area. The ultimate aim should be to proclaim the Walvis Bay Lagoon as a marine park.
- Monitor proposed and existing infrastructural developments within the study area (especially the proposed construction of the desalination plant at Paaltjies).
- Reconsider the quotas for recreational fishermen (The Sea Fisheries Act No. 29 of 1992). There is an increasing number of fishermen and a limited number of personnel to monitor quotas. These two aspects render the quota system for recreational fishermen ineffectual. Consider declaring portions of the coastline as marine reserves where no fishing may take place and thus where fish stocks can rejuvenate.
- Maintain and improve the present management actions to limit the influx of sediments into the lagoon.

More general guidelines referring to environmental management in Namibia as a whole recommended as follows:

- Legal enforcement of Environmental Impact Assessment, according to the Integrated Environmental Management Guidelines, for all development proposals.
- Improve and consolidate all environmental legislation.
- Legal requirement for conservation authorities to comment on development proposals.
- Increase budget for environmental departments of all relevant Ministries so that the appropriate personpower can be employed to effectively manage Namibia's environment.
- Control urban expansion and population growth.



MAP 1: LOCALITY MAP

TABLE 3: Summary Matrix of Impacts of Human Activities on Environmental Factors

	COMMERCIAL HARBOUR	FISHING HARBOUR (Fishing Industry)	SALT RECOVERY	MARICULTURE	TOURISM AND RECREATION	INFRASTRUCTURE (excluding harbour)
BIRDS	1. Oil may collect on the birds feathers (and eggs) resulting in death or disability. (5.3,52)	1. Overfishing has contributed to the reduction in bird numbers as birds depend on fish as a food source. (5.3,55)	1. Destruction of natural tidal flooding areas (bird habitat) during construction. (5.4,58)	1. Conflicts may arise between mussel farmers and birds that intend feeding on the mussels. (5.5,61)	1. Low flying aircraft over lagoon area frightens and disrupts flamingoes and other birds. 4 x 4 vehicles disrupt bird breeding colonies and may destroy nests and eggs. (5.6,63)	1. Developments at Langstrand and Dolphin beach may pose a threat to the breeding colonies of Damara Terns due to the increased number of people. (5.7,64)
	2. Plastics, plastic containers and other wastes dumped by ships may result in death or disability of birds. (5.3,54)	2. Longlining is detrimental to seabirds taking the baited hooks. (5.3,55)	2. Now provides permanently flooded shallow waters with extensive shore-lines for birds to inhabit and feed in. (5.4,58)	2. Surface area taken up by the mussel rafts reduces the area for birds to use. (5.5,61)	2. Plastics, plastic containers and fishing line left behind by visitors may result in death or disability for birds that get caught up in them. (5.6,62)	2. The possible construction of power-lines to the desalination plant at Paaltjies could negatively impact on the wetland bird population. (5.7,65)
LARGE MARINE ANIMALS	1. Oil, heavy metals and other toxins may cause mortality, growth inhibition, reduced reproduction, shift in species importance and tainted flesh in fish and shellfish. (5.3,52)	1. Over-fishing has resulted in the collapse of fish stock. (5.3,55)	1. The salt pans create an ideal habitat for the cultivation of oysters. (5.4,58)	1. Introduction of invasive alien species may pose as a potential threat to indigenous shellfish species. (5.5,61)	1. Overfishing (recreational) and overcollection of bait species may result in profound changes in the community structure of fish and other marine organisms. (5.6,62)	1. Increased numbers of people at Langstrand may result in increased exploitation of mussels and crayfish along the rocky shoreline. (5.7,64)
Seals, fish, mussels, oysters, etc.	2. Sewage from ships results in enrichment of the water causing anoxic conditions which may be detrimental to marine animals. (5.3,53)	2. Over-fishing has contributed to the decrease of seal numbers as seals depend on fish as a food source. (5.3,55)		2. Competition for food required by the surrounding natural organisms. (5.5,61)	2. Plastics, plastic containers and fishing line left behind by visitors may result in death or disability of seals and other marine animals. (5.6,62)	2. Increased numbers of people at Langstrand may result in increased litter which can impact on marine animals. (5.7,64)
	3. Plastics, plastic containers and other wastes dumped by ships may result in death or disability of seals and other marine animals. (5.3,54)	3. Effluents from the fish factories result in enrichment of the bay water and ultimately in anoxic conditions which may be detrimental to macro marine fauna. (5.3,53)		3. Wastes produced by the mussels results in enrichment which may ultimately result in anoxic conditions. (5.5,61)	3. Overexploitation of crayfish and mussels may result in the profound change in composition of these species. (5.6,62)	3. The abstraction of sea water and the release of hypersaline water back into the sea at Paaltjies, necessary for the desalination plant may impact on the white mussel and other marine communities in the surrounding area.
SMALL MARINE ORGANISMS (benthic fauna) (Phytoplankton)	1. Oil, heavy metals and toxins cause mortality, growth inhibition, reduced reproduction, and a decrease in diversity and density. (Sewage from ships results in enrichment-anoxic conditions. (5.3,52)	1. Effluents from the fish factories result in enrichment of the bay water and ultimately in anoxic conditions which may be detrimental to micro marine fauna. (5.3,53)	1. Destruction of natural tidal flooding areas (benthic fauna habitat) during construction. (5.4,58)	1. Competition for food required by the surrounding natural organisms. (5.5,61)	1. Walking on mudflats while birdwatching, or in general destroys burrows and layers of sediments. (5.6,63)	1. The abstraction of sea water necessary for the desalination plant and the release of hypersaline water back into the sea at Paaltjies, may impact on the marine organisms in the surrounding area. (5.7,65)
	2. Dredging destroys benthic communities. Disposal of dredge material results in the suspension and availability of toxic pollutants. (5.3,56)		2. Saltpans have created permanently flooded shallow waters where algae can grow. (5.4,58)	2. Wastes produced by the mussels results in enrichment which may ultimately effect micromarine fauna. (5.5,61)	2. Petrol and oil from ski boats is toxic to marine organisms and may result in death or disability. (5.6,63)	
NATURAL HABITATS Walvis Bay wetland and dune systems in the study area.	1. Oil spills destroy mud and sand flats by forming a layer that can not be penetrated by oxygen or sunlight. (5.3,53)	1. Effluents from the fish factories released into the bay water result in enrichment of the water ultimately leading to anoxic conditions and the deterioration of the bay water as a natural habitat. (5.3,53)	1. Initial destruction of natural bird habitat now provides permanently flooded shallow waters with extensive shorelines. (5.4,58)	1. Mussel rafts reduce the natural habitat of open water space. (5.5,61)	1. Walking on mudflats destroys burrows and layers of sediments. (5.6,63)	1. The construction of the road to Paaltjies resulted in the impoundment of intertidal flats ultimately resulting in them drying up. (5.7,64)
	2. Dredging destroys the habitat of benthic communities. Dredging operations will increase if harbour expansion proceeds. (5.3,56)		2. Resulted in an increased salinity that may have caused the total loss of vegetation from the Walvis Bay wetlands. (5.4,58)	2. Wastes produced by the mussels results in enrichment which may ultimately result in anoxic conditions. (5.5,61)	2. 4x4 vehicles damage dune vegetation which results in dune erosion. (5.6,63)	2. The development of Dolphin Beach and Langstrand resulted in the loss of dune and coastal habitat. (5.7,64)
NATURAL PROCESSES	1. The harbour structures and the implementation of a dredging programme has modified the longshore sediment transport within the bay. (5.3,56)	1. The harbour structures and the implementation of a dredging programme has modified the longshore sediment transport within the bay. (5.3,56)	1. Saltpan dykes have greatly retarded the rate of sedimentation of the lower reaches of the Walvis Bay lagoon. (5.4,59)	1. Mussel rafts may result in a change of the surface currents within the bay. (5.5,61)	1. 4x4 vehicles damage dune vegetation which results in dune erosion resulting. (5.6,63)	1. The construction of the road to the salt works has retarded the rate of sedimentation of the lower reaches of the Walvis Bay lagoon. (5.7,64)
WATER QUALITY	1. Oil pollution, heavy metals and toxins released into the bay will negatively affect the water quality. (5.3,52)	1. Effluents from the fish factories result in enrichment and anoxic conditions. (5.3,53)	1. Salt ponds result in increased salinity. (5.4,58)	1. Waste products produced by the mussels results in enrichment-anoxic conditions. (5.5,61)	1. Litter thrown into the water negatively impacts on water quality. (5.6,62)	
	2. Sewage from ships results in enrichment and anoxic conditions. (5.3,53)	2. Oil and fuel leakages from outdated fishing vessels affects water quality. (5.3,55)			2. Petrol and oil from ski-boat engines impact on water quality. (5.6,63)	
SOCIO-ECONOMIC FACTORS wealth generation, jobs, visual, noise	1. The activities within the harbour promote job opportunities for a substantial number of people. (5.3,55)	1. The fishing industry is the largest employer, employing approximately 10 000 people. (5.3,55)	1. Employs 90 people. (5.4,59)	1. Creates employment opportunities. (5.5,61)	1. Tourism creates job opportunities. (5.6,64)	1. Dolphin Beach and Langstrand have a visual impact on the surrounding area. (5.7,64)
	2. People migrate to WB to find work - results in unemployment, housing shortages, increased crime and TB and AIDS reported cases. (5.3,56)	2. Some jobs in the fishing industry are seasonal resulting in high unemployment during the off season. (5.3,55)	2. Salt pans and heaps of salt can be seen from a far distance and may distract from the visual quality of the area. (5.4,59)	2. Mussel rafts will have a visual impact. (5.5,61)	2. Tourism generates foreign currency and income for the Walvis Bay area. (5.6,64)	2. The construction of a desalination plant at Paaltjies and the power-lines (if above ground) will have a visual impact and an impact on the sense of place of the surroundings. (5.7,65)
	3. Imports and exports moving through generate money for Namibia. (5.3,55)	3. Odours from fish processing affects tourism potential. (5.3,54)			3. Litter and waste left behind by visitors is visually obtrusive. (5.6,63)	
	4. Visual impact, noise, polluted water causes health problems and affects tourism and recreation, coal dust from stock piles. (5.3,55)	4. The fishing industry contributes 3% to the Gross Domestic Product of Namibia. (5.3,55)				

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LIST OF ABBREVIATIONS

ICZMP	Integrated Coastal Zone Management Plan
IEM	Integrated Environmental Management
EIA	Environmental Impact Assessment
DANCED	Danish Cooperation for Environment and Development
UNCED	United Nations Conference on Environment and Development
MW	Mega Watt
M.Phil.	Masters of Philosophy
NGO	Non-Governmental Organisation
Pers.Com.	Personal Communication
LSDB	Langstrand-Dolphin Beach
GDP	Gross Domestic Product
TAC	Total Allowable Catches
MFMR	Ministry of Fisheries and Marine Resources
MET	Ministry of Environment and Tourism

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

Coastal zones, throughout the world, are one of the most valuable resources, being especially important for trade, residence, tourism, and recreation (Department of Environmental Affairs, 1996). However, over the past 50 years these zones have come under increasing pressure brought about by mismanagement and over-exploitation (*ibid.*). Land-use pressures have intensified and in many cases the carrying capacity of these coastal zones have been overloaded resulting in rapid degradation (*ibid.*). The seriousness of coastal zone problems and other global environmental issues resulted in the United Nations Conference on Environment and Development (UNCED) adopting Agenda 21 in June 1992. One of Agenda 21's main concerns was the future of coastal zones and coastal zone management was highlighted as a need (Goldberg, 1994).

The Danish Co-operation for Environment and Development (DANCED) aims to contribute to the restoration of the global environment, in accordance with the recommendations outlined in Agenda 21 (Baseline Report, 1996). DANCED has identified Integrated Coastal Zone Management as one of its key areas of interests. In keeping with this commitment it offered assistance in the formulation of and Integrated Coastal Zone Management Plan for the coastal zone of Namibia's Erongo Region (Map 1).

The first stage of DANCED's involvement entailed a visit to the study area (23 October 1995 to 17 November 1995), with the purpose of identifying prevalent issues which needed to be addressed. Thereafter, the MPhil. students from the Department of Environmental and Geographical Science at the University of Cape Town were commissioned to investigate these issues further and to draw up a baseline report which would ultimately aid in the compilation of an Integrated Coastal Zone Management Plan for the area.

Once the baseline report was completed, each Masters student was required to prepared an individual dissertation, relating to environmental issues as identified and elaborated on in the report. This document is one such dissertation and although is has relied on the information presented in the baseline report it should, nevertheless, be viewed as a stand-alone document.

1.2. AIMS AND OBJECTIVES

The aim of this dissertation is to give an overview of the environmental status of the Walvis Bay 'bay area'. This will be achieved by considering the present and potential human impacts on the natural and social environment of the bay area. To that end this dissertation must:

- define the study area to be considered.
- describe the biophysical components of the study area.
- define the major human activities taking place within the study area.
- identify and analyse environmental impacts and influences, of the various human activities, on the natural and social environment of the study area.
- identify the influences of the natural processes on the human activities within the study area.
- evaluate the impacts of the human activities on the social and natural environment of the study area.
- make recommendations on how to improve the overall management of the study area.
- be academically rigorous and make references to the relevant theoretical underpinnings of the various philosophies, approaches and methods employed.

1.3. RATIONAL FOR CHOOSING THE WALVIS BAY 'BAY AREA' AS THE STUDY AREA

This section will briefly discuss why the Walvis Bay 'bay area', as defined in section 3.2, was chosen from the extensive coastline of the Erongo Region, Namibia, as the study area for this dissertation.

Economic development, rapid population growth, migration from inland to the coastal area and increasing tourism are exerting increased pressure on coastal areas throughout the world (Pappas *et al*, 1994 and Goldberg, 1994). The coastal area of the Erongo Region, Namibia, is no exception and improved environmental and natural resource management and better integration with overall development planning from all levels (national, local and project) are needed to effectively manage this areas (*ibid.*). However, effective management of the coastal area of the Erongo Region is made difficult because of the extent of the coastline. These difficulties are further exasperated by the limited personpower and funds and inadequate legislation.

Coastal zone management involves the management of both natural processes and human activities operating within the coastal zone. Management of natural processes, such as beach erosion and sedimentation are essential to maintain human quality of life and extended human use of the natural environment. The management of human activities requires the mitigation of negative impacts and the enhancement of the positive effects that these activities have on the natural environment. This is ultimately also for the maintenance of human quality of life which is integrally linked to the quality of the surrounding natural environment.

In general human impact on the environment is accentuated in areas where human activities are concentrated (Goldberg, 1994). This is due to the variety of human activities impacting on the environment in complex ways which may be resulting in cumulative effects. Walvis Bay lagoon and bay area is not only one of the top five most important wetlands in Africa that plays host to a number of important bird and animal species but it is also an area of concentrated human activity. These activities

include the commercial and fishing harbours and associated industries, salt recovery, mariculture, tourism and recreation, nature conservation and guano harvesting. The concentration of these human activities is impacting on the natural and social environment of Walvis Bay in complex ways and it is important that we attempt to understand and mitigate these negative impacts as best as possible. It is for this reason that I have specifically chosen the Walvis Bay 'bay area', as defined in section 3.2, as the study area for this dissertation. It is my belief that effective management of this geographical area is a priority, a challenge that must be addressed before excessive funds and personpower are spent on areas of the Erongo Region's coastline where human activities are less concentrated.

1.4. APPROACH AND METHODS

The broad principles of Integrated Environmental Management (IEM) as discussed in section 2.2 have guided the approach and methods utilised in the compilation of this dissertation. Although the IEM procedure (Department of Environmental affairs, 1992) seems to apply to the development of a new project proposal, this dissertation has used the principles and the associated tools of environmental impact assessment to give an overview of the impacts of the existing and ongoing human activities on the natural and social environment of the study area. This dissertation uses a three phased approach of description, analysis and evaluation to reach conclusions and propose recommendations.

Seven human activities were identified from the Baseline Report as major activities impacting on the study area. These activities were firstly described and then their impacts on the natural and social environment analysed by referring to relevant literature. It was considered necessary to analyse the impacts of some of the major natural processes on the functioning of the human activities. This was also achieved by consulting the relevant literature.

The primary methods of evaluation used in this dissertation were adapted from the Framework Approach (The Standing Advisory Committee on Trunk Road

Assessment, 1979) and the Fuggle Matrix (as used by Fuggle in the Environmental Impact Assessment of the construction of the Constantia Hypermarket, 1979). The Framework Approach of presenting and evaluating information was adapted to form a Summary Matrix of Human Activities versus Environmental Factors. Each cell of the matrix summarises the analysis of the impacts of the each human activity on a specific environmental factor. The importance of the impacts were then evaluated using an adapted Fuggle Matrix. Impacts with a high importance rating (4 or 5) were then highlighted on the Summary Matrix.

The Summary Matrix was used to draw valid conclusions after which recommendation on the improvement of the overall management of the study area were made. General guidelines relating to environmental management in Namibia as a whole were then proposed.

This report has attempted to remain within the more practical domain that environmental impact assessment today finds itself. Thus emphasis has been placed on the final presentation of the major impacts in a simple form, so as to aid decision makers in the process of policy and management strategy formulation.

1.5. ASSUMPTIONS AND LIMITATIONS

There are a number of assumptions and limitations that are inherent in the compilation of this dissertation. The basic assumption is that the information used from the Baseline Report: Coastal Zone Management Plan for the Erongo Region, Namibia is accurate. All future references made from the Baseline Report will be referred to as Baseline Report, 1996.

The limitations experienced in the compilation of this dissertation include the following:

- Interested and affected parties were interviewed as part of information gathering process for the compilation of the Baseline Report, however, they were not interviewed with specific reference to this dissertation.
- The obvious lack of public participation in the identification of 'human activities' to be assessed is another limiting factor. The choice of environmental factors to be used in the framework matrix for evaluation also excluded public participation.
- The lack of quantitative data such as the levels of pollution in the bay water, amount and type of effluents being released into the bay and tourist statistics for the study area limited the extent of the analysis that was carried out.
- No specialist input was used for the analysis of impacts of the various economic activities on the surrounding social and natural environment of the study area. The analysis was done by consulting relevant literature and records of interviews carried out during the compilation of the Baseline Report.
- No in-depth analysis of the relevant policies was carried out and as a result several impacts may, to a certain extent, be mitigated if appropriate policies do exist and are being implemented.

1.6. REPORT STRUCTURE

After the introductory section, section 2 starts with a discussion of the philosophy and underpinning principles under which the baseline report and this dissertation were compiled (i.e. Integrated Environmental Management). The definition of sustainable development is briefly discussed and a definition of Integrated Coastal Zone Management as defined by DANCED is given.

Section 3 commences with a description of the boundaries and biophysical characteristics of the study area. The importance of the study area as a conservation area and some of the problems being experienced in the administration of this area are then discussed. Included in this section is a description of the various government departments and organisations that are interested in or have jurisdiction over portions of the study area. It concludes with a discussion of the co-ordination, administration and legal problems that are being experienced in the management of the study area.

Section 4 describes the main human activities presently operating in the study area while an analysis of their impacts on the natural and social environment of the study area are undertaken in section 5. Section 6 analyses the impacts of the natural processes on the functioning of the human activities within the study area.

Evaluation methodologies are then discussed in section 7. These include an adapted Framework Approach which is used to form a summary matrix of human activities versus environmental factors. Each cell of the matrix summarises the impact of the human activity on the relevant environmental factor. An adapted Fuggle Matrix is then discussed and used in section 8 to evaluate the importance of each impacts as summarised in the summary matrix. Each cell is given an importance score between -5 and +5. All impacts with importance scores of -4 or -5 and +4 or +5 are shaded on the summary matrix.

Finally section 9 refers to the summary matrix in drawing conclusions and makes broad recommendations on how to improve the general management of the study area. More general guidelines relating to environmental management in Namibia as a whole are finally proposed.

SECTION 2

INTEGRATED ENVIRONMENTAL MANAGEMENT, SUSTAINABLE DEVELOPMENT AND INTEGRATED COASTAL ZONE MANAGEMENT

2.1. INTRODUCTION

This dissertation and the accompanying Baseline Report have both been compiled under the broad philosophy of Integrated Environmental Management (IEM). In this section Integrated Environmental Management philosophies and underpinning principles will be explored together with the ultimate aims of this philosophy, namely sustainable development. In attempting to achieve Sustainability, tools such as environmental impact assessments (EIA) are used to identify critical issues that need to be analysed and evaluated. Once analysis and evaluation are complete valid conclusions can be drawn and recommendations made. These recommendation can then form the basis of management plans, or in the context of this dissertation an Integrated Coastal Zone Management Plan (ICZMP). Sustainable development as a concept and ICZMP's as management plans will also be discusses in this section, but first the IEM philosophies and principles.

2.2. INTEGRATED ENVIRONMENTAL MANAGEMENT (IEM)

Integrated Environmental Management has been described many times by many people (Hall, 1992). Fuggle (1990, p 1) states that IEM is a *systematic approach* for ensuring the structured inclusion of environmental considerations in decision-making at all stages of the development process. Hall (1990, p 1) suggests that IEM is a *concept* that is essentially one of holistic planning to ensure proper management of the environment. Avis (1994, p 228) describes IEM as a *procedure* with the primary objective to promote environmentally sound development and to marry the opposing concepts of development and conservation. Furthermore, IEM is also defined in the

official IEM guidelines as: “A *philosophy* which prescribes a code of practise for ensuring that environmental considerations are fully integrated into all stages of the development process in order to achieve a desirable balance between conservation and development” (Nel, 1993). IEM is all of the above as it aims at finding the optimum balance in the inevitable compromise (Hall, 1992). “It is variously described as a concept, an approach or a philosophy. It is all three. What it is not, is simply a procedure to be mindlessly followed (Hall, 1992, p 2).”

Several criticisms have been levelled against the IEM procedure as set out in Document 1 of the Integrated Environmental Management Guideline Series (Department of Environmental Affairs). Hall (1992, p 3) states the following: “The document produced by the Council for the Environment seeks to outline procedures by which the necessary evaluation of consequences of the action can be achieved. These procedures are currently palpably inadequate and almost crude”. This may be the case, but if the procedures are followed with a full understanding of the underpinning principles and philosophies of IEM, they may be of greater use. Nel (1993, 7) criticises IEM by saying that it is not a comprehensive environmentalist management system and that IEM is not regarded as a suitable tool to implement the principles of sustainable development to the operational phase of the project life cycle. However, once again, if the IEM procedures are followed and the underpinning principles and philosophies employed and fully understood, they form a comprehensive environmentalist management system that can be used as a tool to implement the principles of sustainable development to the operational phase of the project life cycle. Some of these underpinning principles and philosophies will now be discussed.

The concept or philosophy of IEM is based on the principle of acceptance of the reality that we live and operate in a ‘total’ environment (Hall, 1992 and Dept. of Environmental Affairs, 1992). ‘Environment’ in IEM intrinsically includes the physical, biological, social, economic, cultural, historical and political components (Dept. of Environmental Affairs, 1992). Hall 1992 classifies the elements of the total environment in the following way:

Total Environment:	Physical	Natural	living and non living
		Manmade	urban, rural, cultural and built
	Systems	Natural	planetary and eco-systems
		Manmade	economic, social and political
	Perceptions		hearing smell and visual

There are several other underpinning principles that must be understood to comprehend the full extent of the IEM philosophy. Another being that the starting point of IEM is not environmental protection *per se* but to regulate environmental use to meet set goals (Fuggle, 1995). "IEM requires the acceptance of the philosophical supposition that development and conservation are not irreconcilable, and that a balance which represents the best interests of society can be found. (Avis, 1994: 228)". IEM does not aim to stop development but aims, through the use of Environmental Impact Assessments (EIA), to suggest ways of mitigating negative impacts of development proposals and ongoing activities (Fuggle, 1995). IEM takes the process a step further and aims also to enhance the positive aspects of development proposals and activities (Fuggle, 1995 and Dept. of Environmental Affairs, 1992). Enhancement combined with mitigation must ensure that no person or group is worse off after completion of a plan or development than they were before it was initiated (Fuggle, 1995). The latter can only be achieved if environmental concerns are addressed from conception to exhumation: from before birth to after death of a project or plan (*ibid.*).

IEM also strives to inform and include all people and organisations, that are interested in and affected by a proposal, at the very earliest stages (Department of Environmental Affairs, 1992). It seeks to include as many participants as possible and to empower the less privileged in our society (Fuggle, 1995). IEM is thus as much concerned with the development of people as it is with the protection of nature(*ibid.*).

Informed decision-making coupled with environmental accountability is also an underpinning principle (Dept. of Environmental Affairs, 1992). This is achieved by

using an open, participatory approach of public and specialist input during all stages of the process, with due consideration of alternatives. The input by the public and the specialist during the various stages of a proposal may fluctuate depending on the expertise and information needed (see Figure 1). IEM also calls for an interdisciplinary approach to solving problems thus allowing all disciplines and professions to play a role (Fuggle, 1995).

With the above in mind it is important to note that IEM's central concern is with problem solving and not simply problem identification (Fuggle, 1995). In IEM, it is insufficient for an impact assessment practitioner to stop after impacts have been identified and described: one must go further and suggest realistic proactive management actions to mitigate the negative impacts and enhance the positive effects thus ensuring sustainability of all projects and human activities (*ibid.*). In attempting to achieve sustainability it is also important to note that the IEM procedures and philosophies should be employed in such a way so as to compliment - rather than duplicate - existing planning and other procedures (Department of Environmental Affairs, 1992).

It can be argued that the philosophy of IEM is all encompassing. The basic philosophy and underpinning principles allow practitioners and organisations the latitude to include all tools, methods and ways of thinking in their efforts to plan sound, sustainable and environmentally friendly developments. Based on this viewpoint, the IEM process is only as limited as the person or organisation that is employing it. Noting, therefore, that sound environmental planning is directly related to the amount of commitment (time, money, and thought) that a person or organisation is prepared to give, it appears that one cannot claim that the IEM process is inadequate. With the combination of the substantive and procedural EIA elements together with a fresh philosophical framework, IEM offers significant opportunities towards the achievement of the objectives of sustainable development before, during and after the development process (Nel, 1993).

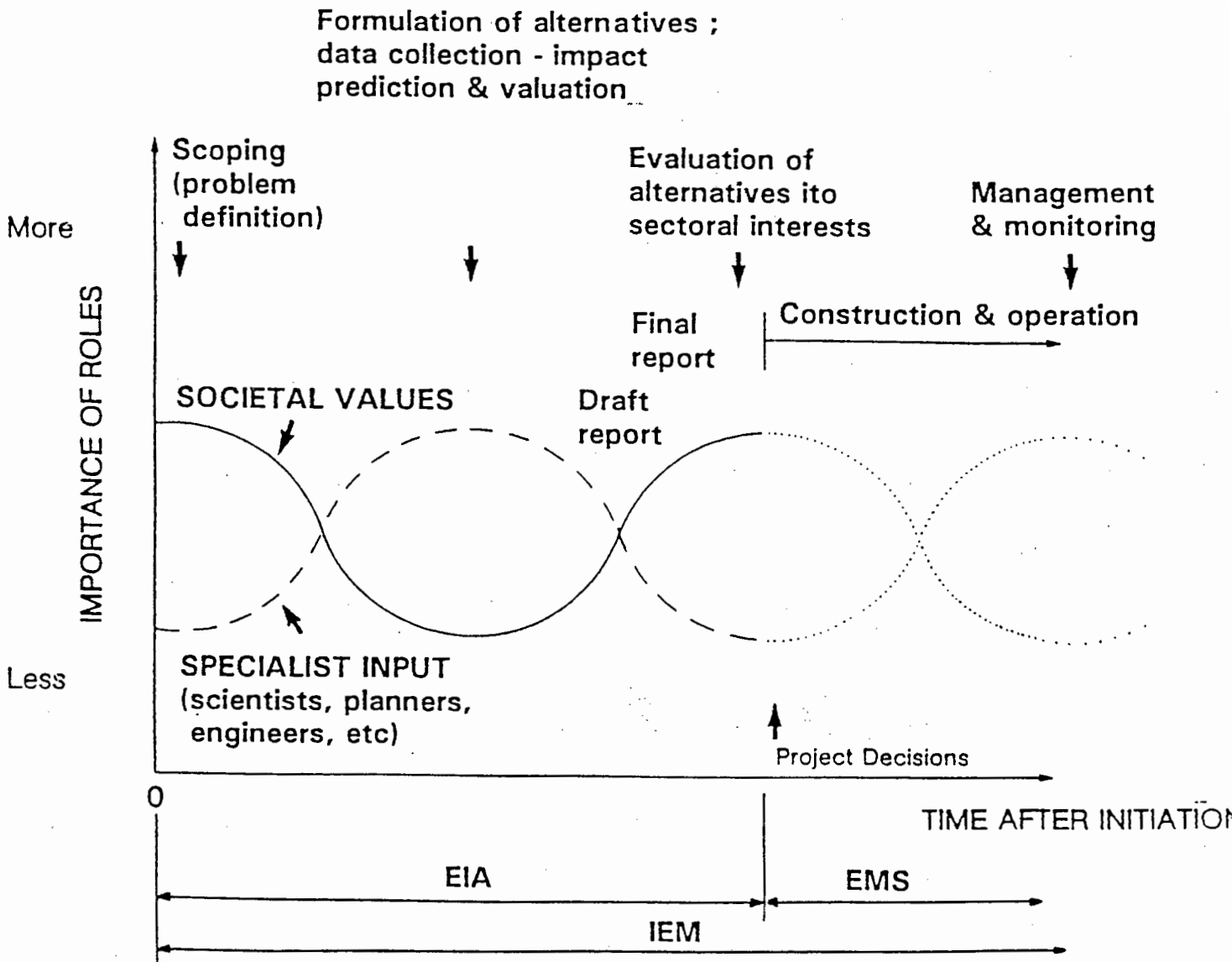


FIGURE 1 THE RELATIVE IMPORTANCE OF THE ROLES OF SPECIALISTS AND SOCIETAL VALUES IN IEM (after Beanlands, 1988)

2.3. SUSTAINABLE DEVELOPMENT

The meaning of 'sustainability' and 'sustainable development' have been extensively debated by academics and practitioners alike (Redclift, 1992, Goodland, 1995 and Audouin, 1995). It is not my intention to further that debate but rather to briefly discuss some definitions that have been proposed. This, however, may be limiting as any definition on sustainability or sustainable development may ultimately lead to further debate.

The concept or definition of sustainable development received much attention after the Bruntland Commission emphasised the need for world-wide sustainability and defined sustainable development as "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (Goodland, 1995). Unfortunately this definition does not distinguish between the different concepts of 'growth' and 'development' (*ibid.*) Pierce *et al* (1990) define 'development' as improvement or progress or the increase in satisfaction and well-being of individuals in society, while 'growth' generally refers to the increase over time in the level of Gross National Product per capita. "While development can and should go on indefinitely for all nations, throughput growth cannot. Sustainability will be achieved only when development supplants growth; when the scale of the human economy is kept within the capacity of the overall ecosystem on which it depends (Goodland, 1995, 4)".

The World Wildlife Fund defines sustainable development as: "Improvement of the quality of human life within the carrying capacity of the supporting ecosystem." (Goodland, 1995). The International Council for Local Environment Initiatives defines sustainable development as: "Development that delivers basic environmental, social and economic services to all, without threatening the viability of natural, built and social systems upon which these services depend." (Audouin and du Preez, 1995). Furthermore, Goodland (1995, p 4) distinguishes between three types of sustainability, namely environmental, social and economic sustainability. He assumes sustainable development to be socially, economically and environmentally sustainable

and he supports Daly's (1988, 1990, 1992) notion that sustainable development is "development without throughput growth beyond environmental carrying capacity and which is socially sustainable" (Goodland, 1995).

I have attempted not to be drawn into the debate on the meaning of sustainable development and have by no means expressed the views of all academics and practitioners involved. However, from the literature reviewed, Goodland appears to have defined sustainable development in the most comprehensive way. Although, not discussed in this paper, a full understanding of the definition of sustainable development requires the understanding of the three forms of sustainability as mentioned above, namely: social, economic and environmental sustainability. These concepts will not be discussed in this dissertation and reference can be made to Goodland (1995): "The Concept of Environmental Sustainability."

To achieve the sustainable development of a project proposal, or sustainability of human activities already commenced, management plans are drawn up based on research, data collection and impact assessments that have been carried out. In the context of this dissertation such a management plan would be in the form of an Integrated Coastal Zone Management Plan.

2.4. INTEGRATED COASTAL ZONE MANAGEMENT (ICZM)

The Danish Co-operation for Environment and Development have defined ICZM for the purposes of their participation in the drawing up of an Integrated Coastal Zone Management Plan for the Erongo Region in Namibia. ICZM is defined as "Co-ordinated management of the coastal zone as a whole in relation to local, regional, national and international goals, with particular focus on the interactions between the various activities and resource demands that occur within the coastal zone and between coastal activities and activities that occur in neighbouring regions. It implies the integration of environmental protection goals into economic and technical decision making processes with the objectives of achieving sustainable development. ICZM intends to offer alternatives to conventional planning approaches by;

formulating holistic coastal area development scenarios; more actively involving inhabitants of the area as well as relevant national and local authorities; having proactive as well as reactive potential and by considering the needs and interests of all major groups in the coastal zone which should participate in the process.” (Ramboll, 1995, p 1).

2.5 CONCLUSION

This section has discussed the underpinning principles and philosophies of IEM that have been broadly employed in the compilation of this document. The ultimate aim of IEM, namely sustainable development has also been explored with various definitions of the concept being discussed. The definition of ICZM as defined by DANCED was then given. Now that there is a better understanding of the philosophy, underpinning principles and definitions used to compile this dissertation, the of study area as referred to in this dissertation will be described.

SECTION 3

DESCRIPTION AND JURISDICTION OF THE STUDY AREA

3.1. INTRODUCTION

The study area for this dissertation was specifically chosen because of the concentration of human activities operating within an ecological sensitive area which includes an internationally important wetland. The boundaries, biophysical characteristics and jurisdiction of the study area will be discussed in this section. The conservation importance of specific areas within the study area and some of the difficulties being experienced in trying to conserve these areas will also be discussed. Firstly, the description of the study area.

3.2. DESCRIPTION OF THE STUDY AREA

Walvis Bay is situated on the coast of Namibia at the northern extreme of the Namib Desert and at the mouth of the Kuiseb River. The bay is bounded to the west by Pelican Point, which is a dynamic sand spit extending from the shore in a north-westerly direction (CSIR, 1989). The study area in particular will consist of the following geographical areas:

- The Walvis Bay wetlands which consist of the natural areas of the Walvis Bay lagoon, "Second Lagoon" and the eastern half of Pelican Point and its adjacent intertidal areas, the salt works and the naturally flooded areas to the south of the salt works.
- Walvis Bay itself i.e. the deeper water enclosed between Pelican Point and Langstrand.
- The beach area starting from Paaltjies Beach through to Pelican Point.
- The coastal strip from Langstrand down the coast to the sand dunes north of Lover's Hill. The eastern boundary (north of the harbour) is the main road between

Swakopmund and Walvis Bay. While the eastern boundary (south of the harbour) is the road alongside the lagoon.

- The harbour area and all facilities under the control of Namport and the fishing industries.

The above comprises the total study area and is illustrated in Map 1 and Map 2.

3.3. BIOPHYSICAL ENVIRONMENT OF THE STUDY AREA

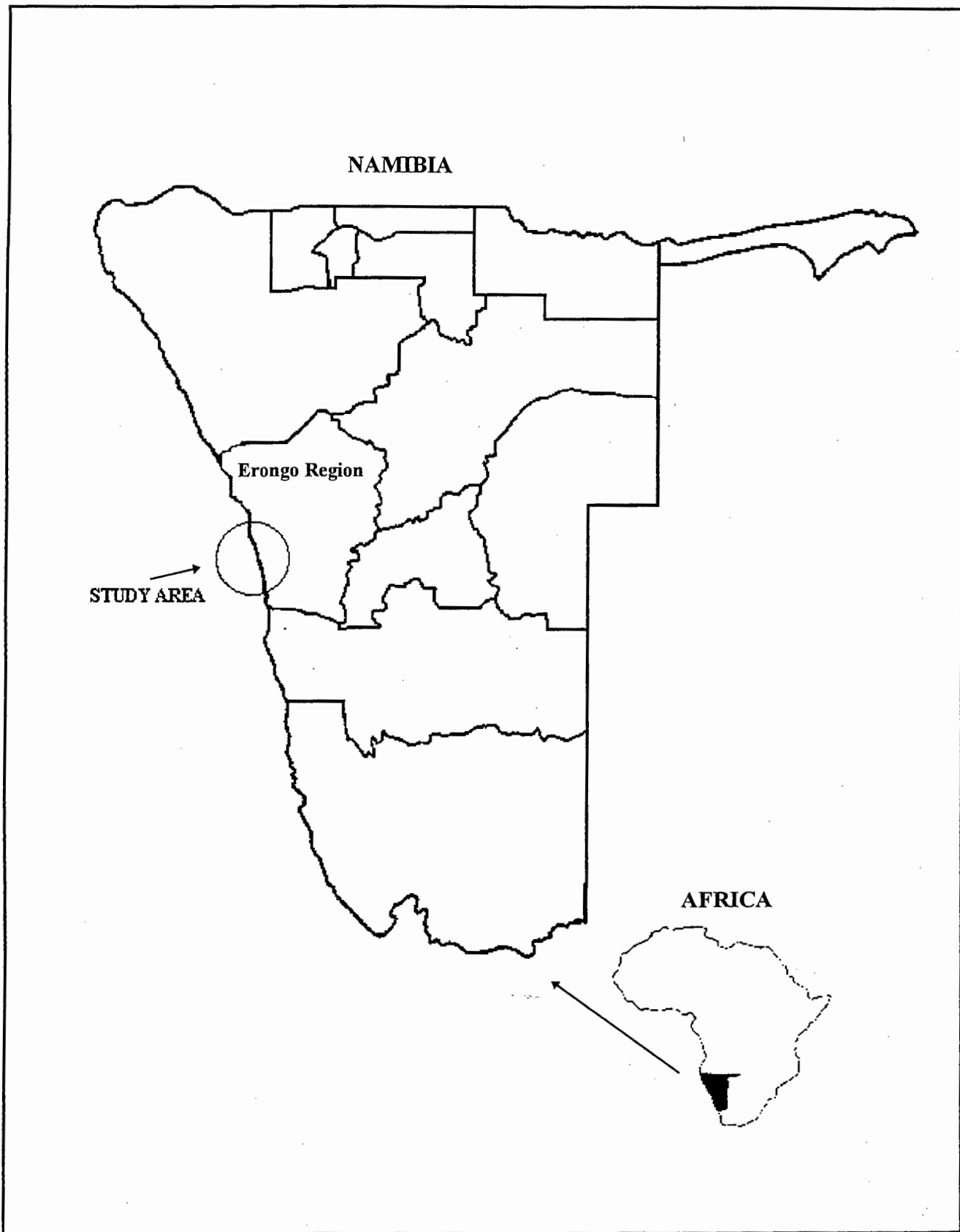
A brief overview of the fauna of the study area and some of the most important ecological characteristics of the Walvis Bay lagoon are included in this section. Terrestrial flora within the study area is extremely limited and is non-existent in the Walvis Bay wetland area and will thus not be discussed in this dissertation. The climate of the study area will be briefly discussed.

3.3.1 FAUNA OF THE STUDY AREA

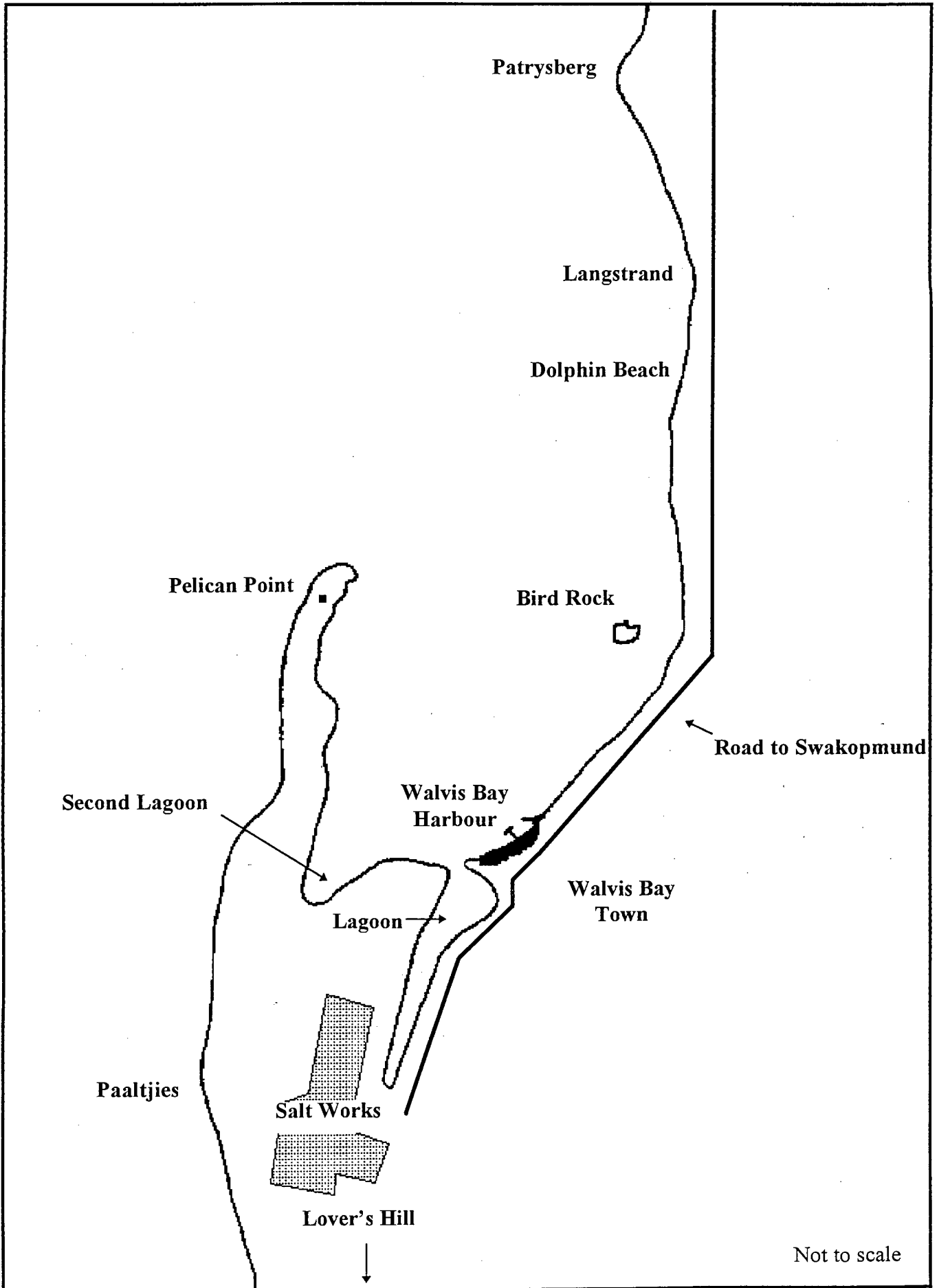
There are a variety animal species that have adapted to the harsh desert and coastal environment of the study area. However, only describe some of the animals whose survival are closely linked to ecological state of the study area will be discussed here. Reference can be made to the Baseline Report (1996) for a more comprehensive overview.

Avifauna

Walvis Bay wetland supports more coastal birds than any other locality in southern Africa and is one of the top five most important coastal wetlands in Africa (Williams, 1988). The upwelling of the nutrient rich-waters offshore of Walvis Bay supports a prolific fish population which in turn supports a rich seabird community (*ibid.*). The bay and lagoon area also form a sheltered environment where fine sediments and organic matter can settle and accumulate (*ibid.*). These areas are exploited by a proliferation of invertebrate animals and small fish which also act as a food source to the thousands of birds that the wetland supports (*ibid.*).



MAP 1: LOCALITY MAP



MAP 2: STUDY AREA

Walvis Bay wetland together with Sandwich Harbour and Cape Cross Lagoon supports over 60% of the world's populations of the Chestnut-banded Plover, and supports between 50-70% of the world's population of Black-necked Grebe during their non-breeding season (Baseline Report, 1996). These wetlands also support 66% of all the greater flamingos in southern Africa and 82% of the lesser flamingos (Williams, 1988). The majority of birds using the Namibian Coastal wetland areas are migrant and upwards of 120 000 shore-birds migrate from Siberia to these wetlands to use them as feeding areas during the Northern Hemisphere winter (*ibid.*).

Apart from the Walvis Bay wetland the 30 km of mixed shoreline between Walvis Bay and Swakopmund is also an important area as it supports large colonies of wading birds (Baseline Report, 1996). It has a summer average of 407 birds per square kilometre compared to an average of 78.5 birds on similar shores on the Cape West Coast of South Africa (*ibid.*). Furthermore, bird breeding colonies between the Swakop River and Langstrand have the highest concentration of Damara Terns along the Namibian coast (*ibid.*).

Apart from the conservation significance, coastal birds such as flamingos, pelicans, and especially penguins have considerable potential as tourist attractions (Williams, 1991a). However, it appears that these birds are usually as side-attraction, which makes their value difficult to assess (*ibid.*) Nevertheless, indications are that coastal birds, directly through guano collection and reserve entrance fees, and indirectly through added tourist expenditure on food, transport and accommodation, could contribute up to N\$5 Million to the economy of Walvis Bay and other areas in Namibia where bird colonies are located (*ibid.*).

Marine and Terrestrial Mammals

The main marine and terrestrial mammals found in the study area are seals, dolphins and black-backed jackals (Baseline Report, 1996). There is a small seal colony at Pelican Point and two species of dolphin commonly occur along the coast, namely the Atlantic form of the Bottlenose Dolphin and the Heavyside Dolphin (O'Toole,

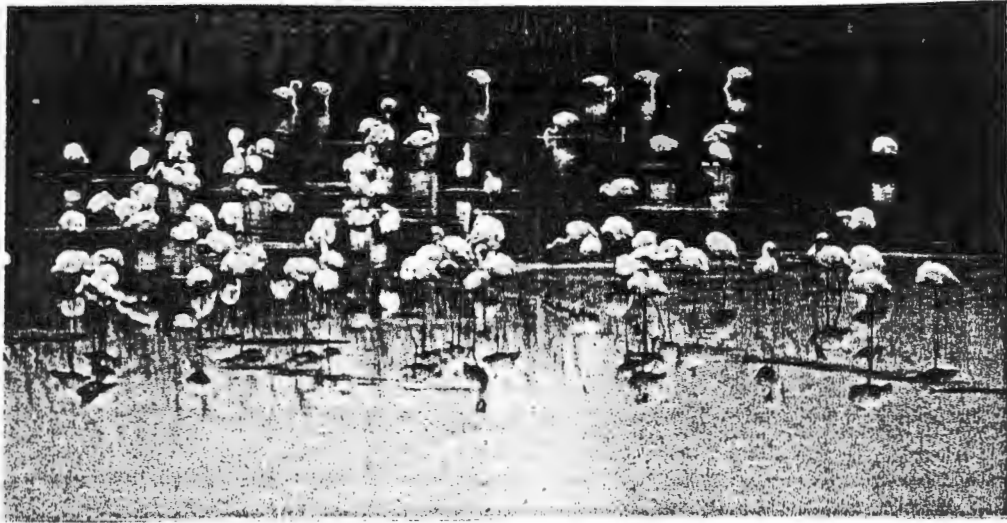
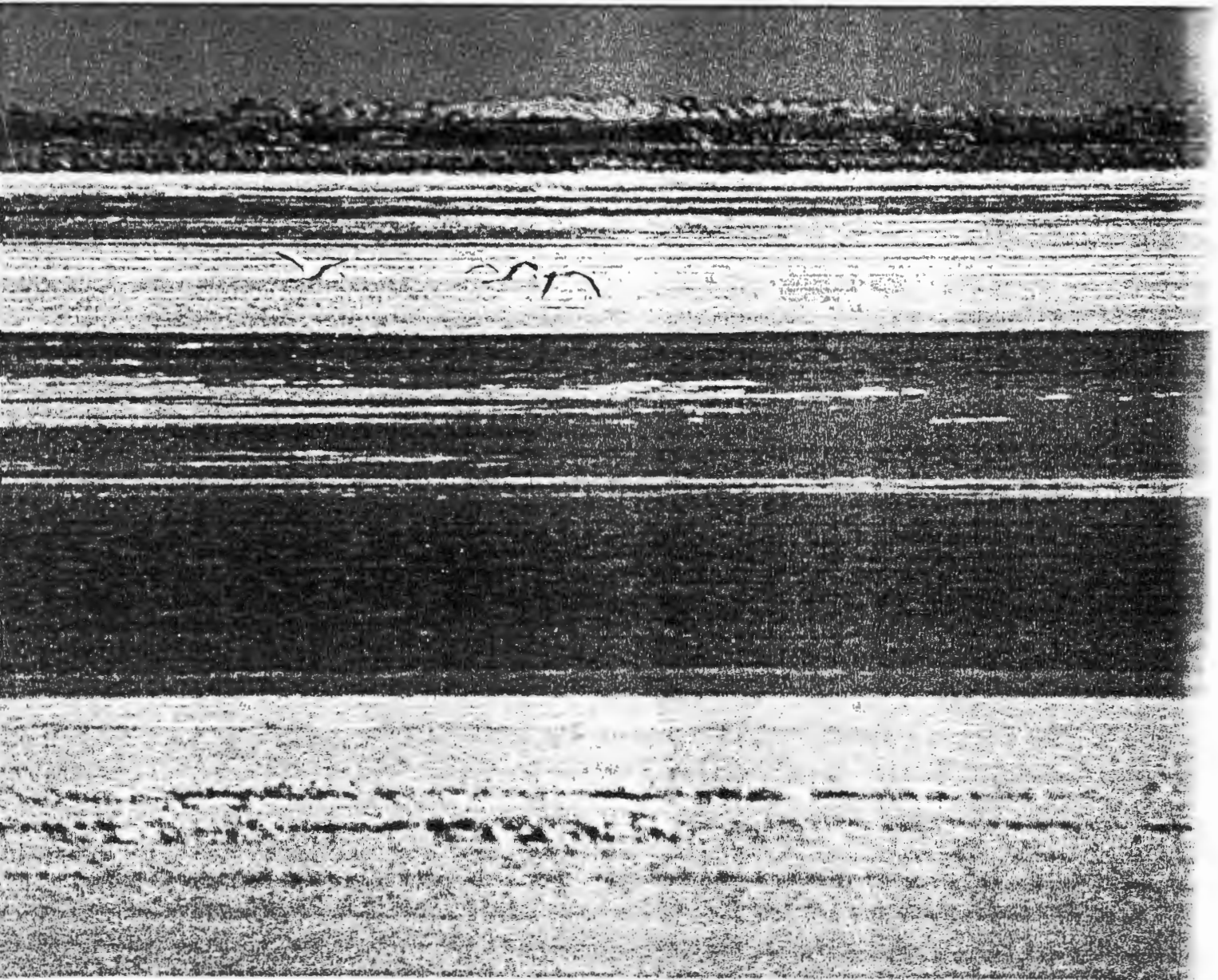


PLATE 1

Top: Flamingos

Bottom: Flamingos flying over salt evaporation ponds to the south of the lagoon.



1993). Blackbacked jackals mainly occur on the coastline where they scavenge off dead seals, nesting birds and smaller rodents (Baseline Report, 1996).

Fish

The large area of the bay and lagoon offers a calm, protected and nutrient-rich environment for a variety of fish species. Even though most fish do not breed in the lagoon, many juvenile fish return to develop until they are mature enough to breed (Baseline Report, 1996). Many predatory fish, such as shark and Garrick also inhabit these waters and feed on other fish (*ibid.*).

Within and beyond the surf-zone, several species of larger fish occur. Some of these include Cob, Steenbras, Blacktail and Galjoen all of which are fished by recreational fisherman visiting the area (*ibid.*). Deep sea species that are commercially harvested include Hake, Horse Mackerel, Pilchard, Anchovy and Kingklip (*ibid.*).

Intertidal Fauna

Intertidal faunal investigations along the Erongo coastline have been limited (Baseline Report, 1996). Studies that have been done, however, indicate that the white mussel dominate the biomass of intertidal fauna along the sandy beaches (White mussels are used by fisherman for bait and their reduction in numbers has been attributed to over collection) (*ibid.*).

The rocky stretch of beach between Walvis Bay and Swakopmund is important because it supports crayfish and mussels that are principally limited to this area (*ibid.*). Crayfish, due to this limited distribution, are highly sensitive to disturbance (*ibid.*). Brown Mussel populations are similarly sensitive to disturbance, and are currently threatened by the invasion of the European Mussel, an alien species (*ibid.*). The species are competing for limited space along the shoreline, and the alien species is outcompeting the Brown Mussel (*ibid.*).

Benthic Fauna

The different reaches of the lagoon as discussed in section 3.3.2. are significant in terms of the benthic fauna (bottom-dwelling animals) that they support (CSIR, 1989). The main benthic communities found in the lagoon are mud prawns, tube worms and burrowing bivalves (*ibid.*). The 1989 CSIR study of the lagoon noted that the middle (deeper) reaches of the lagoon contain the highest species diversity and densities of individual species. This is a result of the biogenic sludge that collects in these sections. The mouth area of the lagoon appears to be dominated by the crown crab (*ibid.*). The shallows and middle reaches of the lagoon support populations of large tube-worm, the colonial Paper Mussel and sea-anemones (*ibid.*). The intertidal fringes appear to be dominated by small polychaete and mud prawns (*ibid.*).

3.3.2. WATER COLUMN AND SEDIMENTARY CHARACTERISTICS

The Walvis Bay coastal waters appear to be a major "sink" of organic material generated by primary production (the conversion through photosynthesis of carbon dioxide to organic carbon by plants) in the Benguela upwelling system offshore (CSIR, 1994). The upwelling of nutrient rich waters off-shore supports a prolific fish population which are an important food source that supports the large number of birds that inhabit the area (*ibid.*). Periodically eruptions of hydrogen sulphide gas occur within the bay reflecting the anoxic conditions created by the high organic loading of the sheltered waters of the bay (*ibid.*).

The lagoon, by contrast, is well-oxygenated since a large portion of its volume is exchanged during each tidal cycle and the surface waters are subject to a high wind stress (*ibid.*). The lagoon exhibits a reverse salinity gradient: being hypersaline at the water surface and less saline near the bottom (*ibid.*). Similarly the water in the shallow upper reaches is warmer than at the mouth (*ibid.*).

The distribution of sediment on the surface of the lagoon bed follows a clear pattern of zonation which is of particular significance to the benthic macrofauna (See section 3.3.1 *Benthic Fauna*) (*ibid.*). In the mouth and lower reaches of the lagoon coarse and

medium-grained sediments predominate, reflecting the influences of ebb and flood tides (*ibid.*). The middle reaches are characterised by the distribution of fine sediments with a relatively large fraction of clay and organic matter (*ibid.*). The upper reaches are clearly differentiated by sediments predominantly consisting of clay and organic fractions (*ibid.*).

Sedimentation processes within the lagoon and bay and the longshore transport of sediments in and around the bay are discussed in sections 6.2 and 6.3 respectively.

3.3.3 CLIMATIC CONDITIONS

The study area is located within a harsh desert environment that is characterised by low summer rainfall (approximately 8,6 mm/year) and by temperatures that are moderated by the influence of the cold Benguela Current (CSIR, 1989). Generally the area is also characterised by high cloud cover and high atmospheric humidity due to the formation of fog. Fog occurs regularly throughout the and can extend inland for about 112 km. It contributes 35-45 mm of precipitation per year to the coastal area (Baseline Report, 1996). The wind regime, of the study area, is a major environmental control that influences most biotic and abiotic processes affecting the lagoon, including the flux of upwelling nutrients into the system, primary production and sedimentation (CSIR, 1989).

In the absence of convection, stable air conditions result in temperature inversions in the lower atmosphere (Baseline Report, 1996). Pollution particles are hydrophilic and attract the water particles that comprises fog (*ibid.*). As a result, the fog accumulates pollutants and together with atmospheric inversions, pollution dispersion is limited (*ibid.*). Although the dominant winds in the region are typically strong, and disperse air pollution, sea breezes, which tend to result in the lower atmosphere, result in pollution being blown back to land (*ibid.*).

3.4. NATURE CONSERVATION AND THE IMPORTANCE OF THE WALVIS BAY WETLAND AND OTHER CONSERVATION WORTHY AREAS

Nature conservation falls under the Namibian Ministry of Environment and Tourism. The policy of the Ministry of Environment and Tourism regarding the conservation of biotic diversity and habitat protection is to ensure adequate protection of all species and subspecies, of ecosystems and of natural life support processes (Baseline Report, 1996). This is implemented by means of:

- inventories, monitoring and appropriate research;
- education;
- managing, and assisting and advising in the management of, land and natural resources in Namibia;
- legislation
- co-operation with local, national, regional and international organisations working for biotic diversity and habitat protection.

(Baseline Report, 1996)

The study area has several areas that are worthy of conservation and although they are not specifically designated as conservation areas they are of extreme importance. Many problems are also being experienced in trying to manage and conserve these areas. Possibly the most important area is that of the Walvis Bay wetland.

Walvis Bay wetland

The Walvis Bay wetlands consist of the natural areas of the Walvis Bay lagoon, the eastern half of Pelican Point and its adjacent intertidal areas, the salt works and the naturally flooded areas to the south of the salt works (See Map 1). No terrestrial vegetation occurs in these wetlands and the total area of the wetland is approximately 35-40 square kilometres (Noli-Peard & Williams, 1991).

In terms of the number and variety of coastal birds which it supports, the Walvis Bay lagoon is regarded as the most important coastal wetland in southern Africa, and is

probably one of the five most important wetlands in Africa (Williams, 1988). As a result the wetland was registered as a Ramsar Site under the Ramsar Convention (Baseline Report, 1996). Namibia acceded to the Ramsar Convention in 1995, but has not yet ratified it (*ibid.*).

The Walvis Bay wetland should be conserved, amongst others, for the following reasons:

- high diversity and abundance of birds, including rare and endangered species;
- international importance - high percentage of intra-African and Palearctic migrant birds;
- local importance - supports many resident bird species;
- nursery area for several fish species;
- high concentration of estuarine invertebrates.

(Baseline Report, 1996)

It is generally agreed that this area is of high conservation value and should, as such, be declared and managed as a protected natural area.

Coastal Areas

The 30 kilometres of rocky shoreline between the Swakop River and Walvis Bay as referred to in section 3.3.1 *Avifauna* is also worthy of conservation status. Patchy and limited rocky outcrops on the Namibian coastline make these areas important habitats for invertebrates, and as a consequence, popular feeding areas for birds. This fact, together with the high bird populations and important breeding habitats adds to the conservation significance of the rocky stretch of coastline.

Management Problems

There are several issues that adversely affect the potential positive input of Nature Conservation administrators towards the protection of endangered species and sensitive environments. These together with a number of other problems have existed for some time without receiving satisfactory attention and are as follows:

- outdated and inadequate environmental legislation;

- conservation authorities not legally required to comment on development proposals;
- limited power of conservation authorities outside of formally protected areas;
- interministerial conflicts;
- shortage of staff and facilities;
- haphazard development, uncontrolled urban expansion and high population growth;
- little consideration for environmental concerns by developers;
- uncontrolled tourism; and,
- inadequate funds to maintain planning, monitoring, research and management services to ensure sustainable and appropriate levels of natural resource management, both within and outside of protected areas.

(Baseline Report, 1996)

A number of the abovementioned problems are linked to the conflicting and overlapping jurisdiction that exist in the study area. It is thus important to discuss the jurisdictions and interests of the various stakeholders involved in the study area.

3.5. JURISDICTION AND ADMINISTRATION OF THE STUDY AREA

There are a number of Government Departments and other organisations that have varying degrees of jurisdiction over the study area. The exact boundaries of these jurisdiction are in many cases not well defined and are resulting in some major management problems. The various departments and organisations that have jurisdiction over portions of the study area will be discussed. Some of the administrative and legal issues that make the overall management of the study area extremely difficult will also be discussed.

Namibian Ports Authorities (Namport)

The port is controlled by the Namibia Ports Authority (Namport). Their role is to exercise general infrastructural and regulatory functions (dredging and customs), together with navigational and other commercial facilities (Dierks, 1994). Namport is

also responsible for the control of maritime pollution, oil spill containment within the harbour area, the maintenance of maritime safety and the provision of search-and-rescue services in territorial waters (*ibid.*).

Ministry of Environment and Tourism

The Ministry of Environment and Tourism is the statutory responsible for the protection of the natural environment in Namibia. The Ministry is divided into four Directorates, namely, that of Forestry, Resource Management, Tourism and Resorts and Environmental Affairs. The Directorate for Environmental Affairs is responsible, at a national level, for environmental planning, co-ordination and protection.

The Directorate of Resource Management is primarily responsible for the management of National Parks and various other declared conservation areas with their jurisdiction ending at the low water mark along the coastal areas. Although the Walvis Bay wetland is not a declared National Park, it has been registered as a Ramsar site under the Ramsar Convention and the landward areas are policed by the Directorate of Resource Management. They are also responsible, along with the Ministry of Sea Fisheries and Marine Resources for the cleaning of the beaches that fall within State owned land. The stabilisation of dunes (using low wooden fences to trap the sand) on the south side of the lagoon is undertaken by the MET's Directorate of Forestry

The Ministry of Sea Fisheries and Marine Resources (MFMR)

The Ministry of Sea Fisheries and Marine Resources has two Directorates, the Directorate of Resource Management, and the Directorate of Operations. The Directorate of Operations is responsible for the monitoring and controlling of catches and landings, as well as for surveillance and enforcement operations. Directorate of Operations inspectors do patrol the coast to enforce regulations on the number of different species of fish that may be caught daily by recreational fishermen and the numbers of bait and shellfish species that may be collected per person. However, limited personpower limits the effectiveness of these patrols. In Walvis Bay there are

200 inspectors (observers) that go out on fishing vessels to monitor quotas and 55 onshore inspectors that monitor the fish factories.

The jurisdiction of the MFMR, as far as the study area is concerned, covers the ocean and lagoon areas up to the high-water mark. MFMR is also responsible for the cleaning of the beaches that fall within State owned land.

Fishing Industry

There are two organisations representing the fishing industry in Walvis Bay. These are The Pelagic Fishing Association and The Namibian Hake Fishing Association (Ramboll, 1995). Although the berthing facilities in the fishing harbour are owned by the individual fishing companies the berths are maintained by Namport using their own internal standards.

Walvis Bay Municipality

The state land between Swakopmund and Walvis Bay (former area of the Walvis Bay Enclave) is under the jurisdiction of Walvis Bay Municipality. It is the responsibility of the Walvis Bay Municipality to clean the beaches within its boundaries. The Municipality also controls dune/sand encroachment into the town by various means of dune stabilisation (e.g. levelling dunes and spreading gravel over the area).

Non-Governmental Organisations (NGO) and other Stakeholders

There are a number of NGO's that have an interest in the status of the Walvis Bay wetland and bay area. The main NGO is the Walvis Bay Round Table, who have commissioned several studies to be undertaken on the bird populations of the Walvis Bay wetland and have sponsored several educational boards around the wetland. The tourist industry as a whole also has an interest in the maintenance of the wetland as a conservation area.

The salt and Chemical Company that is mining salt in the salt ponds to the south of the lagoon also has an obvious interest in the status of the lagoon and bay area.

Discussion

The above are some of the major stakeholder that have some jurisdiction and interests over the study area. In the absence of an overall authority of the study area there is little or no communication and co-ordination between the various government departments, organisations and NGO's that administer or have an interest in the management of the area (Press release, 1993). This is a major problem as a lack of co-ordination and defined jurisdictions often lead to no management actions being taken at all. This is often the case in the cleaning of the beaches within state owned land. It is the responsibility of both the MET and the MFMR (Ramboll, 1995). The consequence of the overlap in responsibilities on state owned land between the two ministries is that effective cleaning of the beaches is not undertaken. (*ibid.*) This, however, is also partly due to the insufficient funding of MET as well as a lack of personpower within the coastal region (*ibid.*). The lack of personpower and funding within the MFMR also results in the ineffectual monitoring of fish catches by recreational fisherman. There is a further conflict in jurisdiction between these two departments in that the MET's jurisdiction ends at the low-water mark while the MFMR's jurisdiction ends at the high water-mark. This overlap also results in a lack of management of this area.

The lack of co-ordination between Namport, MET, MFMR and the fishing industries and the lack of monitoring and quality standards makes it extremely difficult, if not impossible, to monitor and control pollutant and effluent release into the bay. This is a major problem and must be addressed before any meaningful contribution can be made to the effective management of the study area.

Another problem contributing to the difficulties experienced in managing this area is that environmental monitoring is not been carried out. As a result there is little knowledge about the effects, if any, that the pollutants are having on the water quality and marine organisms. Furthermore, Environmental Impact Assessment (EIA) procedure only has policy status and can thus be bypassed (Ramboll, 1995). It is optional for municipalities to request that EIA's be carried out when a new

development is proposed in the study area and it is not compulsory to follow the subsequent recommendations of the EIA.

3.6. CONCLUSION

This section has described the boundaries of the study area and has discussed some of its important biophysical characteristics. These included the fauna, water column and sedimentary characteristics and climatic conditions of the study area. Furthermore the importance of the Walvis Bay wetland and the coastal strip between Walvis Bay and Swakopmund, as conservation areas, was also discussed. Included were some of the problems that are presently being experienced with the administration of these areas. The various government departments and organisations that have jurisdiction over and an interest in portions of the study area were also discussed. It was emphasised that the lack of co-ordination between the departments and organisations is resulting in many difficulties being experienced in the overall management of the study area. Now that there is a better understanding of the natural characteristics and administrative problems being experienced within the study area, the human activities operating within it will be discussed.

SECTION 4

DESCRIPTION OF THE MAIN HUMAN ACTIVITIES OPERATING WITHIN THE STUDY AREA

4.1. INTRODUCTION

The main human activities operating within the study area are discussed in this section. These activities were identified in the Baseline Report as major activities impacting on the study area and were thus chosen to be analysed and evaluated. They include: the commercial harbour, fishing industry, salt recovery, mariculture, tourism and recreation, urban infrastructure and guano harvesting.

4.2. COMMERCIAL HARBOUR

The Port of Walvis Bay is Namibia's most vital piece of infrastructure. It is primarily divided into two sections: the fishing harbour to the north (110 hectares) and the commercial harbour to the south (129 hectares) (Ramboll, 1995). The commercial harbour handles the bulk of Namibia's import and export trade (Dierks, 1994). Examples of such exported goods are minerals such as uranium, copper, lead, feldspar and salt, as well as other cargo such as beef and canned fish. Imports of generalised container cargo, plant and machinery, petroleum and bitumen also pass through the port facilities (Dierks, 1994).

Pollution

Marine pollution that results from the day-to-day functioning of the harbour is a major concern. In terms of the control of this pollution, it has been stressed that the plans dealing with emergency situations, in the Walvis Bay harbour, are insufficient and rehearsal procedures are not carried out on a regular basis (Ramboll, 1995). Currently Namport is also unable to adequately cope with large oil spills. However, an Environmental Data Workshop for Oil Spill Contingency Planning was

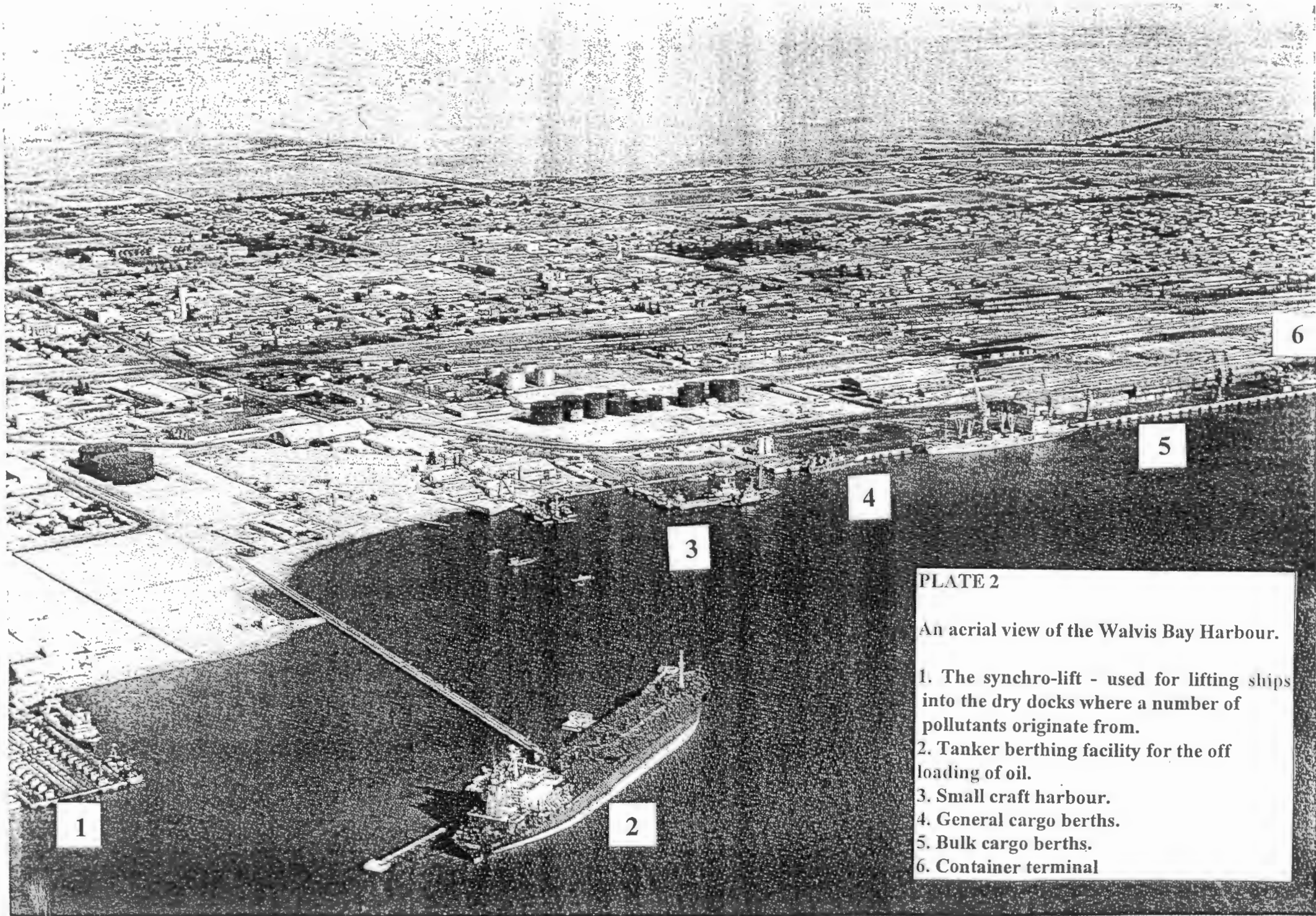


PLATE 2
An aerial view of the Walvis Bay Harbour.

1. The synchro-lift - used for lifting ships into the dry docks where a number of pollutants originate from.
2. Tanker berthing facility for the off loading of oil.
3. Small craft harbour.
4. General cargo berths.
5. Bulk cargo berths.
6. Container terminal

held in Walvis Bay in 1993 and a consignment of equipment to aid in the training of oil spill containment is due to arrive in Namibia in 1996 (van der Meer, pers.com., 1996).

Commercial activities in the harbour occasionally cause minor oil spills and heavy metal pollution of the Bay water (Ramboll, 1995). Moreover, Walvis Bay does not have adequate facilities for the storage and processing of bunker oil. This in turn causes a major problem, as ships visiting the Namibian coastline tend to dump their bunker oil out to sea (Van der Meer, pers.com., 08/02/96). Another source of maritime pollution is the waste and sewage that is dumped from ships anchoring in the harbour and bay area. Namport does, however, supply a waste collection service for all these ships and they are charged for this service irrespective of whether they use it or not. Unfortunately, substantial amounts of waste are still thrown over board, resulting in waste being washed ashore on the beaches between Walvis Bay and Swakopmund (Ramboll, 1995).

Anti-fouling paint and other toxic substances used during ship maintenance at the dry docks are another source of pollution. Moreover, bilge water released by ships from foreign waters results in the release and distribution of alien marine organisms that invade the natural environment of indigenous marine organisms.

Dredging

The construction of the harbour and the implementation of a dredging programme has significantly impacted on the Bay Area. Approximately 200 000 cubic meters (dredged volume) of material is dredged from the turning circle, tanker basin and the channel every year (CSIR, 1994). Namport possesses dredging equipment to undertake annual dredging of the harbour area, but employs Portnet (South African Ports Authority) once every 5 to 6 years to undertake major dredging (Van der Meer, pers.com., 1996.). Major dredges can dredge up to 761 000 cubic meters of material which was the case in 1988 (CSIR, 1994).

Disposal of dredge material is a matter of concern and 3 dump sites, within the Bay area, are presently being used. Dump site C (see Map 2) is undesirable as it is located at the mouth of the lagoon and may be having a major impacts on the marine fauna of the lagoon. Apart from the concern for the dumping of dredge material, dredging also costs Namport a substantial amount of money. The last major dredging of the harbour in May, June and July of 1995 cost Namport a total of N\$5,92 million (Van der Meer, pers.com., 1996).

Off-Shore Oil and Gas

Five companies are presently involved in oil explorations off the Namibian coast. In April 1992, a Norwegian consortium, led by Norsk Hydro, was the first to finalise a license for block 1911, off the northern Namibian coast. They pledged to spend 45 million US dollars on work, including 3 test wells, and 1 million US dollars on training. Further exploration licenses, granted by the Directorate of Energy, were given to the following companies:

- Ranger Oil
- Sasol
- Chevron
- Shell

In all, commitments were received to drill (eight) wells at widely spaced points along the coast, with all findings to be shared with the Namibian Government on a confidential basis (Anon, 1993).

To date, no oil has been discovered. Gas, however, was discovered in 1974 by Chevron at the giant Kudu 1 field, situated 150 km off-shore from the southern tip of Namibia. Between 1985 and 1988 further gas was discovered by South Africa at Kudu 2 and 3 gas fields. The exploration licenses mentioned earlier have, as yet, failed to produce any further gas discoveries. However, the new information which has been gathered has generated data which will aid the preparation and siting of new wells (Baseline Report, 1996).

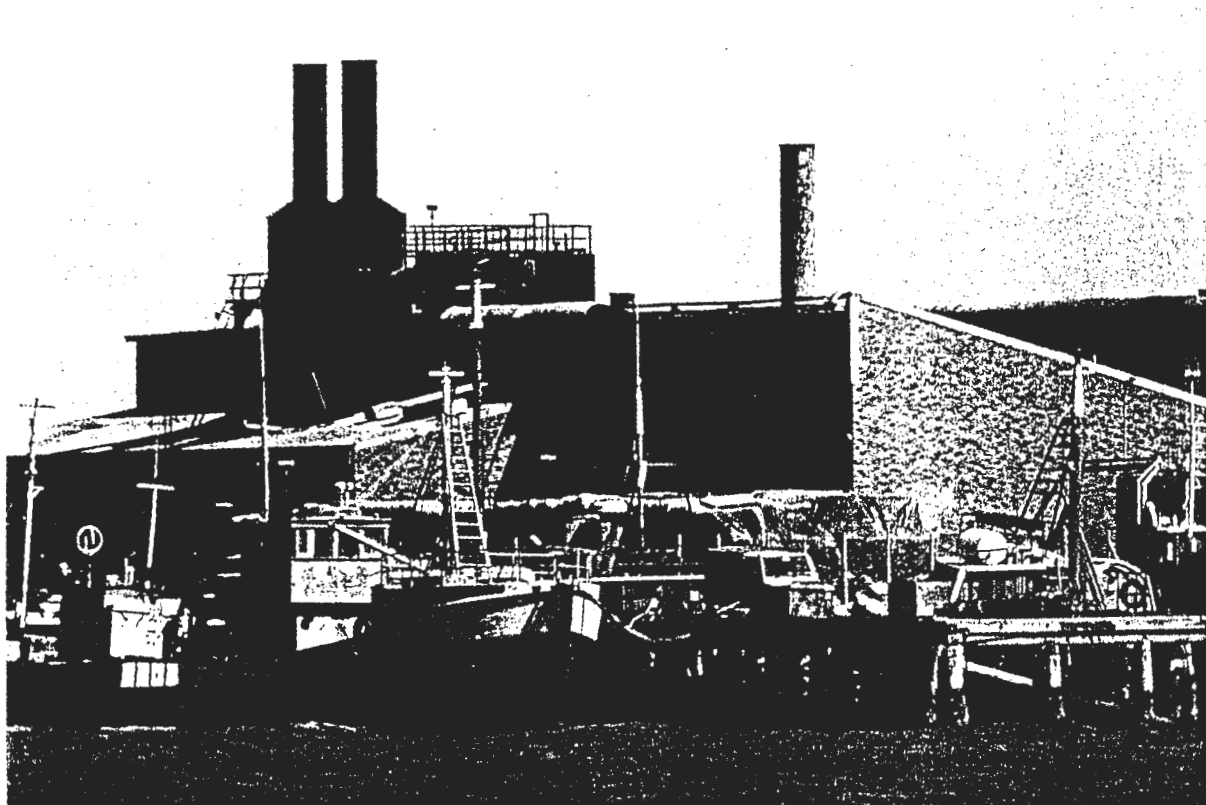
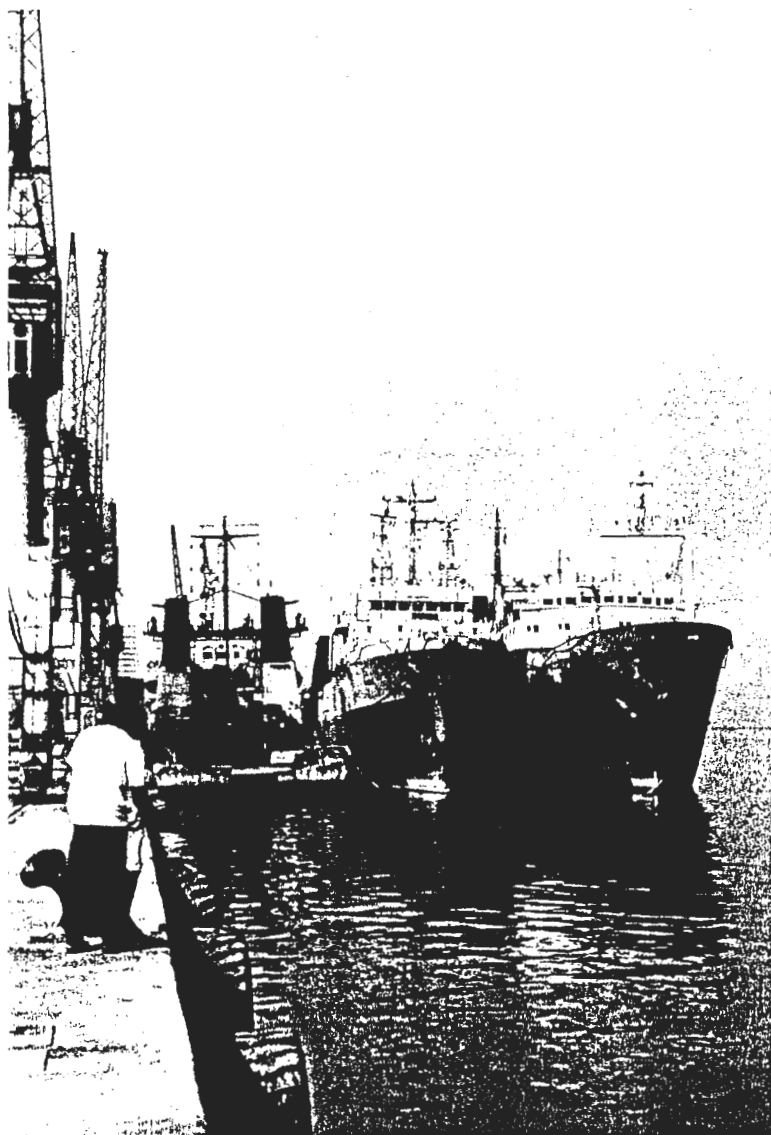


PLATE 3

Top: Fishing trawlers berthed in front of the fish processing factories.

Left: Cargo ships berthed alongside the general cargo quays of the commercial harbour.



Namibia has ensured that its citizens benefit from oil exploration, regardless of whether or not oil is eventually discovered. This is done through encouraging exploration companies to make training pledges as part of their application for an exploration license (Baseline Report, 1996).

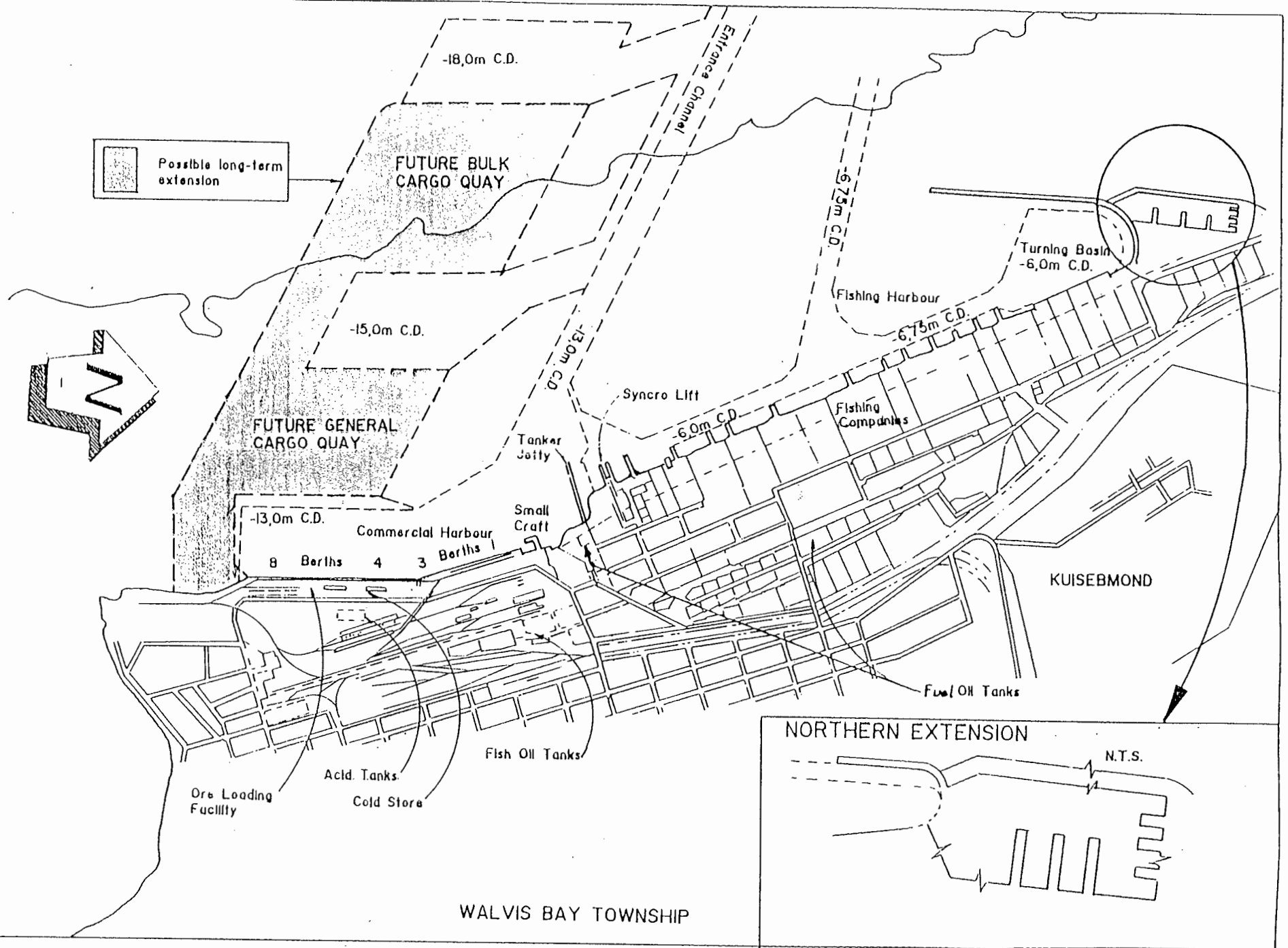
Expansion

Namport is looking at expanding the general cargo quays on the south-west extremity of the port (see Map 3). The impacts resulting from this port expansion into the bay area can be divided into those which are permanent and those which may exist in the short- or medium-term (CSIR, 1994). Permanent damage will be caused by the actual construction of additional quays. Short- and medium-term impacts will result from extensive dredging to provide access channels to the quays and sufficient under-keel clearance for ships alongside (*ibid.*). During construction minor oil spills may occur and flotsam and other harmful materials may enter the water and be spread around the lagoon and bay area impacting on the marine environment.

4.3. FISHING INDUSTRY

The fishing industry is generally regarded as the backbone industry of Walvis Bay and Namibia and employs approximately 10 000 people. The industry contributes up to 3 % of Namibia's Gross Domestic Product with the potential to increase this contribution to 10 % (Baseline Report, 1996). The fishing industry is overwhelmingly dependent on export markets. Fish and fish products are exported to South Africa, England, Maritius, Mozambique, Angola, Canada, Zimbabwe, Egypt and Russia. As a result of the size and importance of the fishing industry, definite policies have been developed to ensure the sustainable management of the natural resource.

MAP 3 LAYOUT OF EXISTING AND PROPOSED HARBOUR
EXTENSIONS TO WALVIS BAY HARBOUR



WALVIS BAY TOWNSHIP

Policy

In 1991 a new fisheries policy was set down in a White Paper titled 'Towards Responsible Development of the Fishing Sector'. The Policy encompasses three main features, namely:

- promoting stock recovery
- ensuring increased Namibian participation and benefits, especially through increasing onshore processing; and
- securing a productive industry based on a vessel quota system.

The policy appears to target commercial fisheries which take place outside of the Bay Area. Policy concerning line fishing (or recreational fishing) and mariculture, both of which occur within the Bay Area, does not seem to be clearly defined (*ibid.*). Regarding recreational fishing the policy only states its aim to maintain high abundance of fish stocks. However, the Sea Fisheries Act (Act No.29 of 1992) does manage recreational fishing to a certain extent, in that it sets out regulations for the numbers of different species of fish that may be caught daily or transported per vehicle. It also stipulates the number of species of bait organisms that may be harvested from the sea. These regulations are enforced by 12 Sea Fisheries inspectors that patrol the coast and commercial fishing boats to enforce the regulations, however, this limited manpower limits the effectiveness of these patrols (*ibid.*).

Fish Factories

The fishing harbour forms a large part of the total harbour area, with fish processing factories running the length of the quay side. Although these factories are well maintained and in apparent good condition, most of the equipment and structures are old and less efficient than new equipment (Baseline Report, 1996). However, to remain in the export market and to comply with European Union standards, about N\$ 200 million was invested in the factories during the two years from 1992 to 1994 and about N\$ 200 million in boats (*ibid.*).

Pollution

Nevertheless, the fishing industry remains one of the major odour and water polluters of the bay. Effluents from the fish processing factories are released directly into the Bay Area impacting on the water quality, bird populations and the marine fauna (Ramboll, 1995). These effluents are currently not being monitored and no formulated quality standards to reduce pollution release into the Bay are in place (Baseline Report, 1996). Odour resulting from fish processing can be smelt throughout Walvis Bay and have resulted in several public objections being received by the municipality and local news papers.

Social Factors

Over 50% of the fishing fleet are older than 20 years and the technology used is less efficient than modern technology (Baseline Report, 1996). The impact of this outdated fleet on the natural environment is not monitored. However, the condition of the fishing vessels does have an impact on the fishermen living and working on the ships during the fishing season. A positive aspect of the industry is that it is a major in the Walvis Bay area, employing approximately 10 000 people. The availability of work attracts a substantial number of migrants, creating a number of social issues within the Walvis Bay area.

Over fishing, demersal fishing and longlinning are some of the fishing practises that have had severe impacts on not only the industry itself, but also on local bird population that depend on fish as a source of food.

Expansion

As mentioned in section 4.2, the total area of the fishing harbour is at present 110 ha. According to research done by the Walvis Bay Development Advisory Committee, the growth in the fishing industry is expected to be 5% up to 1998, and 7-10% for a few years thereafter (Dennis Moss, 1994). Based on these growth rates, the expected demand for land, both seaward and landward, for the fishing harbour could double within the next 10-15 years. This implies that approximately a 100 ha of



PLATE 4

Above: Fish processing factories in the background emitting “fishy” smelling smoke causing odour problems.

Below: Pollution in the harbour area.



land is required for the future physical expansion of this sector (*ibid.*).

4.4. SALT RECOVERY

The windy, arid coastal climate of Namibia is highly favourable for the cheap production of salt. Salt and Chemicals (PTY) LTD is producing 320 000 tons of industrial quality salt per annum, by solar evaporation of sea water in ponds that have been established on the sandflats of the Walvis Bay lagoon (see Map 2). The solar ponds, to the south and west of the lagoon, cover a total area of 4 000 hectares.

Future Expansion

Salt and Chemicals (PTY) LTD, although producing 320 000 tons of salt per annum, has the capacity to produce over 450 000 tons (Baseline Report, 1996). The current output from Namibian-owned salt recovery companies is well below potential capacity, and it is estimated that production from existing coastal pans could be increased at least four-fold (*ibid.*). Future expansion depends on the securing of exports and other markets. Furthermore, the establishment of a local salt-based chemical industry would also increase domestic demand.

4.5. MARICULTURE

The commercial farming of oysters is being undertaken by Salt and Chemicals (PTY) LTD in the evaporation ponds in the Walvis Bay Lagoon. The oysters take about nine months to grow to a marketable size - at least six months faster than elsewhere, making this mariculture industry one of the most productive in the world (Baseline Report, 1996). Presently the industry farms only oysters and produces approximately 12 000 oysters annually, most of which are exported to South Africa (*ibid.*). Oyster spats are being imported from Chile and Europe, however, the Salt Company in Swakopmund has started to produce their own spats, which are exported throughout southern Africa.

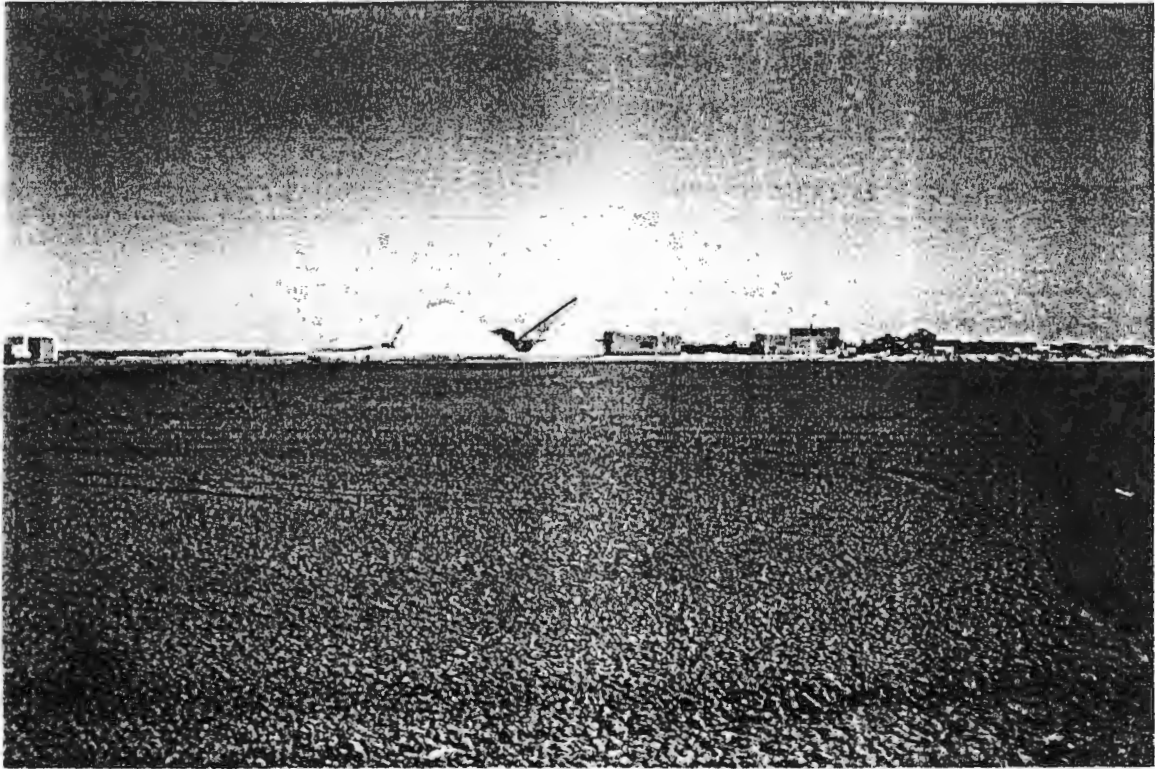


PLATE 5

Top: Salt & Chemical Company south of the Walvis Bay lagoon. Note the contrast in colour between the salt piles and the intertidal mudflats.

Left: Salt crystallising in the evaporation ponds.

Expansion

The central region of the Namibian coast is a special upwelling area, which results in nutrient rich water for much of the year. These conditions are ideal for the commercial farming of filter-feeders, such as oysters and mussels and have proven to promote the fastest rate of shellfish growth in the world (*ibid.*). As a result a mussel farm is presently being planned for near Pelican Point in Walvis Bay Lagoon. It is expected to start production in 1996 (*ibid.*).

4.6. TOURISM AND RECREATION

Tourism was declared a priority sector by Parliament in 1991 as it presented a high potential for economic development and diversification within Namibia (Baseline Report, 1996). As a result a White Paper on Tourism was drawn up and approved by Cabinet on the 29 of March 1994 (*ibid.*). The White Paper sets out the framework under which the tourist industry will operate. It endeavours to promote the full utilisation of the tourism potential in order to realise tourism's role in economic development of Namibia as a whole (*ibid.*).

As tourism is a major growing industry in the Walvis Bay area, the Walvis Bay Municipality have decided to draw up a tourism management plan in order to increase its tourism potential and attract more visitors to the area. The main limiting factor to tourism is infrastructure as the town does not have adequate accommodation to cope with the demand. However, with the implementation of the tourist management plan, the Walvis Bay municipality hopes to build additional accommodation units to cater for tourists.

Tourist Attractions

The Walvis Bay Lagoon and surrounding areas offer a variety of activities that attract tourists. The main tourist activities occurring in the Bay Area are recreational line fishing and shell fishing (crayfish and mussels), bait collecting, bird watching and recreational water activities. Recreational fishing attracts more tourists than any other tourist related activity in Namibia (Baseline Report, 1996).

4.7. DEVELOPMENT OF URBAN INFRASTRUCTURE

There are a number of developments taking place within the study area. These together with existing and proposed infrastructure are described in this section.

Langstrand - Dolphin Beach

Langstrand-Dolphin Beach (LSDB) is situated between Walvis Bay and Swakopmund (see Map 2). LSDB falls within the Walvis Bay municipality's jurisdiction and is subject to the town's laws and development procedure. LSDB was developed in 1984 with the initial idea of creating a holiday resort area. This resort area was to include limited permanent residential accommodation (Stubenrauch, 1994). The development of LSDB was seen to be the first step towards the promotion of tourism and recreation in the Walvis Bay area.

The location of resort areas at Langstrand and Dolphin Beach were motivated by the lack of appropriate tourism facilities in Walvis Bay. LSDB, with its wide beaches and easy access to Walvis Bay, presented an ideal location for a resort development. Furthermore, the LSDB area lies in close proximity to various tourist destinations, such as the large desert sand dunes, the Naukluft Game Reserve and the Walvis Bay lagoon, to mention but a few.

A Structure Plan has been developed for the LSDB area. The main objectives of this Structure Plan are to:

- prevent development sprawl along the coastline;
- protect the aesthetic character of the developments;
- strengthen the connections between recreational and residential areas;
- developing Langstrand with permanent holiday developments;
- ensure the protection of the natural environment between Langstrand and Dolphin Beach. Such measures include the prohibition of raw sewerage being pumped directly into the sea; controlled 4x4 vehicle activity on the beach, and the enforcement of a 90m wide building restriction from the high water mark (Stubenrauch, 1994).

To date, Langstrand has developed its resort, with expansion in residential erven to be expected to the south of Langstrand. Dolphin Beach, however, is still at its initial phase of development, and only has a few day-visit facilities and a couple of overnight facilities incorporated into Dolphin Park. Although it is uncertain whether residential developments are to take place at Dolphin Beach, approximately 200 units (2,7 hectares) are expected to be developed. The development of tourist and residential accommodation along these areas may have severe implications for the natural environment.

Access Road to Paaltjies

The construction of the road around the southern tip of the Walvis Bay making the salt works and the popular fishing spot at Paaltjies beach easier to access has resulted in some impacts on the lagoon system as it has cut-off some of the intertidal flats.

Proposed Desalination Plant

A feasibility study, compiled by the Department of Water Affairs, on alternative water supplies to the study area identified desalination as a viable option. The study recommended that the desalination plant be constructed at the popular fishing beach of Paaltjies (Baseline Report, 1996). The choice of this site has raised objections from local environmental groups, who are concerned about the impacts of the construction of the desalination plant in this ecological sensitive environment. Powerlines will have to be constructed and routed through the sensitive sand and mudflats of the lagoon (*ibid.*). Despite objections by environmental groups, it appears as though the construction is to go ahead with commissioning commencing in 1997 (*ibid.*).

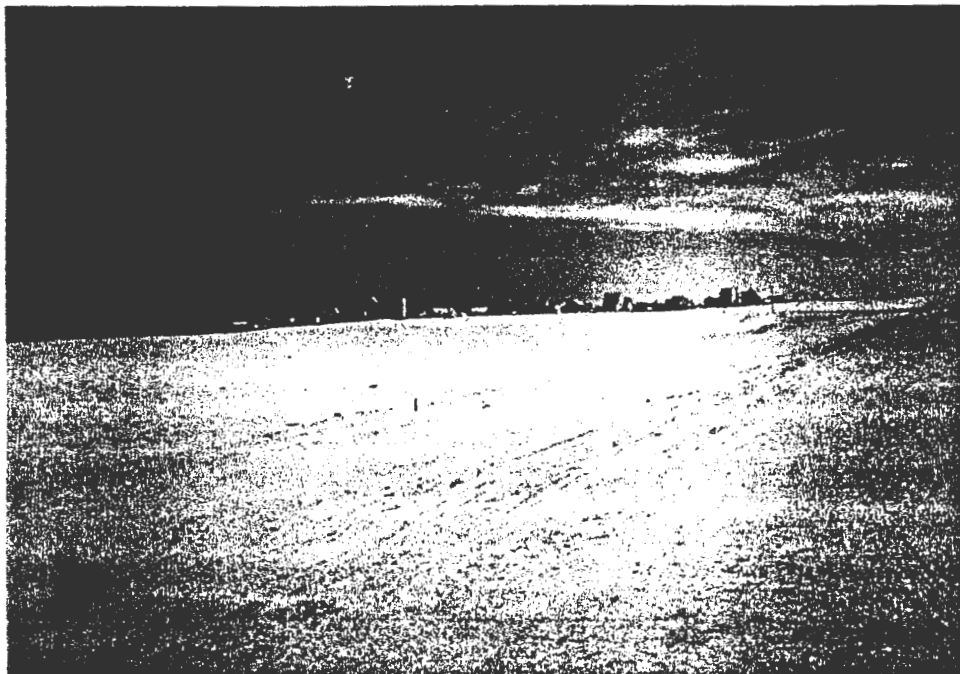
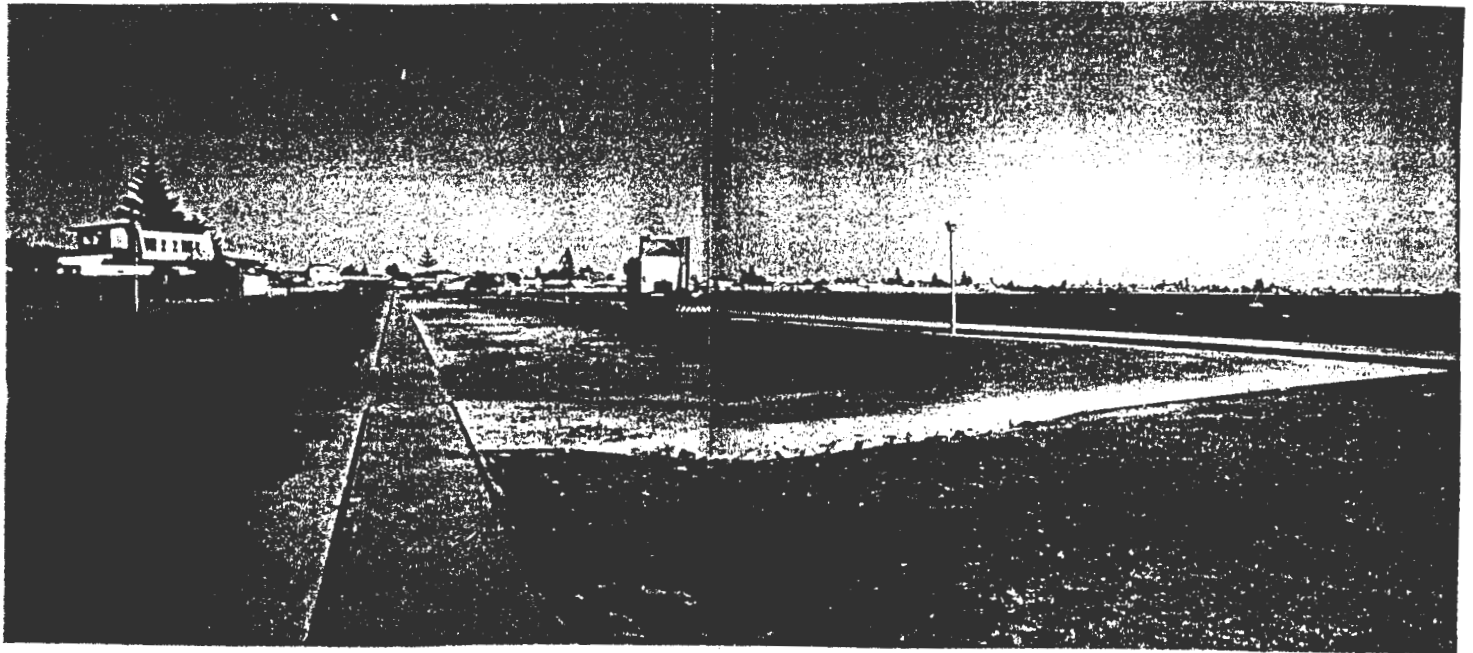
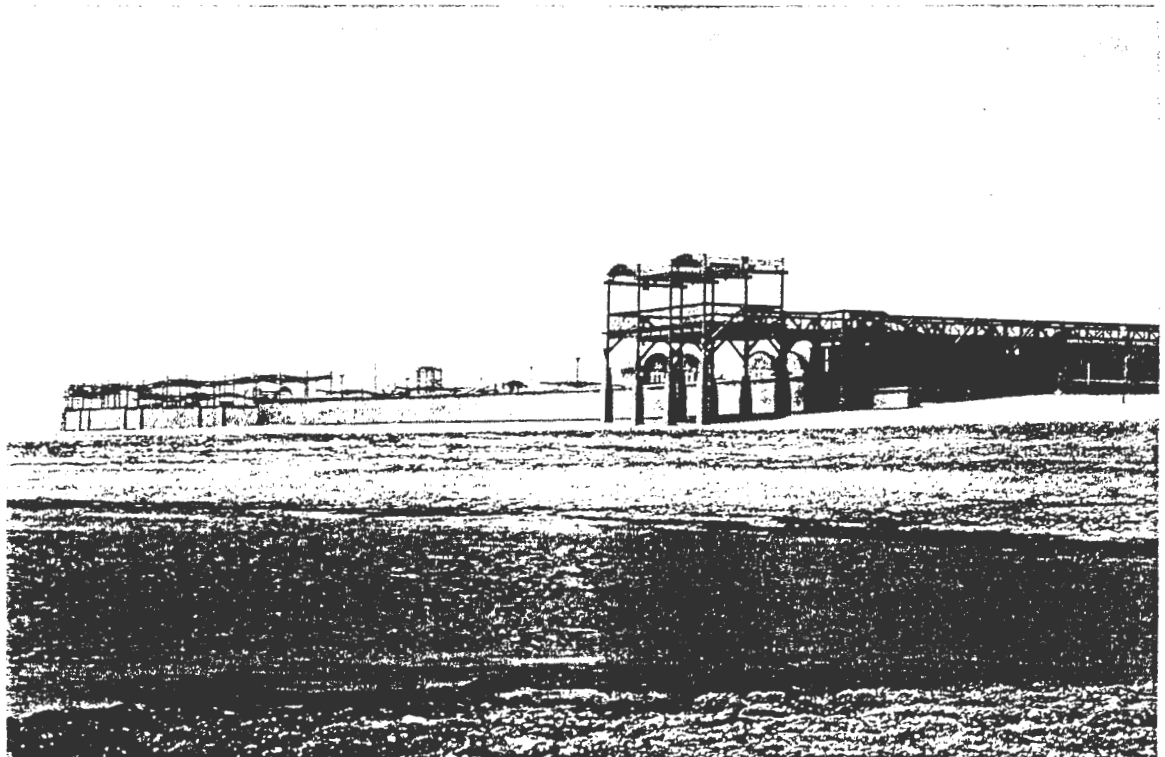


PLATE 6

Top: Development south of the Walvis Bay lagoon.

Left: A view of the Langstrand development showing the contrast between the surroundings and the houses.

Bottom: Dolphin Beach Holiday Resort development.



4.8. GUANO HARVESTING

Guano is harvested within the Bay Area from an artificial, 10 hectare, platform situated on the coast between Swakopmund and Walvis Bay (Baseline Report, 1996). "Gudewant" owns the platform and harvests guano once a year out of breeding season, when bird numbers are at their lowest.

Limitations

The quantity of production is primarily dependent on the amount of birds in the region, which in turn is dependent upon the amount of inshore fish stocks. With a notable decrease in the amount of fish in these waters over recent years, guano production has been limited.

4.9. CONCLUSION

This section has attempted to briefly describe the main human activities operating within the study area. These activities are all interacting with the social and natural environment of the study area in various ways. Specific environmental impacts will be identified and analysed in section 5.

SECTION 5

ANALYSIS OF THE IMPACTS OF THE HUMAN ACTIVITIES ON THE NATURAL AND SOCIAL ENVIRONMENT OF THE STUDY AREA

5.1 INTRODUCTION

The impacts of human activity on the natural and social environment of the study area will identify and analysed in this section. This will be done with reference to the four general impacts as described below.

5.2. GENERAL IMPACTS OF HUMAN ACTIVITIES ON COASTAL MARINE ENVIRONMENTS

There are four general categories of impacts that human activities have on coastal marine environments. These are:

- *enrichment* - this is the general introduction of natural occurring substances that are not toxic but that lead to changes in the structure and metabolism of the ecosystem (Day *et al*, 1989). Eutrophication is a type of enrichment which occurs as a result of the addition of high levels of inorganic nutrients (for example sewage and effluent from the fish factories, both of which have high concentrations of nitrates and phosphates) (*ibid.*). This can lead to excessive algal growth brought about by the increase in metabolism, resulting in the increased consumption of dissolved oxygen (*ibid.*). A decrease in dissolved oxygen in the bottom waters thus results from the decomposition of both sinking algal cells and organic matter from sewage inputs and other sources, ultimately leading to anoxic conditions (*ibid.*). Algal blooms are aesthetically unpleasant and when anoxic conditions are reached unpleasant odours may result (Botes *et al*, 1991). Furthermore, the reduction in dissolved oxygen leading to anoxic conditions may have detrimental effects on both the fish and shellfish within the bay. The structure of the benthic communities

may also change dramatically as organisms that burrow into anaerobic sediments have to be able to oxygenate their burrows by pumping oxygenated water through (*ibid.*). With increasing organic loading of an area, from sewage pollution for example, the burrowing organisms are eliminated as the anaerobic zone moves closer to the surface (*ibid.*).

- *physical alterations* - direct changes in the physical structure or dynamics of the estuary i.e. hydrological changes brought about by the construction of quay sides and the implementation of dredging programs.

toxic materials - toxins can be naturally occurring materials such as heavy metals (which are in concentrations much higher than that which naturally occurs) or exotic organic compounds such as pesticides, oil and petroleum (*ibid.*). These materials can be acutely toxic, or more commonly, they can cause chronic or sublethal effects as well as bioaccumulate in food chains (*ibid.*). These toxins may also accumulate in the bottom sediments and when disturbed may be resuspended in the water column causing detrimental effects. Oil and petroleum products may have profound effects on marine and land organisms. These include mortality, growth inhibition, reduced reproduction, shift in species importance, tainted flesh in fish and shellfish, and a decrease in the abundance and diversity of benthic communities (*ibid.*).

- *harvest or introduction of exotic species* - these usually lead to changes in the relative abundance of different species, but if harvest pressure is great enough for a sustained period, species may be driven to extinction in a local area.

The Marine and ecological effects of different types of contaminants and activities are summarised in Table 1A.

More specific impacts of each activity operating within the study area will now be analysed in relation to the above mentioned impacts.

Table 1A: Marine Environmental and Ecological Effects and Different Types of Contaminants and Activities

Contaminants or Activities	Bacterial/Viral Contamination	Oxygen Depletion	Toxicity	Bioaccumulation	Habitat Degradation	Depletion of Biota	Aesthetics
Sewage	X	X		X	X		X
Urban and Agriculture run-off	X	X		X	X		
Minning Waste			X	X	X	X	X
Ocean Dumping	X	X	X	X	X		
Coastal Developments	X				X	X	X
Petroleum Hydrocarbon expolration and exploitation		X	X	X	X		X
Chemical Spills and Leaks		X	X	X			X
Atmospheric Emmissions	X		X	X			
Food and Beverage Processing		X			X		X
Litter					X	X	X

Source: Cote, R.P.(1989) Science Council of Canada, 1989

5.3. IMPACTS RESULTING FROM COMMERCIAL AND FISHING HARBOURS ACTIVITIES

There are a number of potential impacts associated with the commercial and fishing harbour activities. Several of these impacts are related to the pollutants that originate from the commercial harbour activities and effluents that are released by the fishing industry. Other potential impacts may result from the day to day functioning of the harbour and the possible expansion of the harbour.

Impacts of Pollution from Commercial harbour and Fishing Industry

One of the major sources of marine pollution in the Walvis Bay harbour is from both minor and major oil spills. There have been 27 minor oil spills and 1 major oil spill in the Walvis Bay harbour between 1993 and 1995 (van der Meer, pers.com., 1996). Oil may have profound impacts on marine environments as the most important links in marine food chains run the greatest risk of being impacted on by oil pollution. Primary producers (phytoplankton) and first order consumers (microcrustaceans) lack the motile power to leave an area which has been contaminated (Kontogiannis, 1973). Oil not only impacts on marine microfauna such as phytoplankton and microcrustaceans by also on the macrofauna such as birds, seals and penguins, fish and mussels. It may have profound effects on all marine organisms including mortality, growth inhibition, reduced reproduction, shift in species importance, tainted flesh in fish and shellfish, and a decrease and abundance in benthic communities' (Day *et al*, 1989). More specifically, oil harms birds by destroying the waterproof layer on the feathers needed to keep them warm (Bourne *et al*, 1976). During preening, birds also ingest quantities of oil resulting in death. Further, a layer of oil over bird eggs may prevent them from hatching (*ibid.*). Oil can also destroy habitat areas by covering them with an impermeable layer thus preventing oxygen from reaching living organisms beneath and blocking out the light necessary for photosynthesis (Kontogiannis, 1973).

Heavy metal pollution of the harbour and bay waters is another form of pollution that results from the on and off-loading of iron ore, coal and other minerals. Heavy metals (of certain concentrations) may be toxic to filter feeders and other marine organisms and may also result in mortality, growth inhibition, reduced reproduction, shift in species importance, tainted flesh in fish and shellfish, and a decrease and abundance in benthic communities (Day *et al*, 1989). These metals can accumulate within the flesh of filter feeders, such as mussels and oysters, rendering them unfit for human consumption (see section 5.5 Limitations to and Impacts Resulting from Mariculture). Heavy metals accumulate in the surface sediments of the bay and may be resuspended during dredging operations, resulting in detrimental effects on the marine organisms (see sub-section on *Impacts due to Harbour Dredging Programme*).

Anti-fouling paints, originating from the dry docks in the harbour, are among the most toxic anthropogenic compounds introduced into the bay (Ramboll, 1996). These toxins together with the run-off from the urban areas of Walvis Bay may be having severe impacts on the marine organisms as discussed in section 5.1 *toxic material*. These toxins may also pose a health risk to recreational users of the Bay water.

Effluent from the fish processing factories and sewage from ships visiting the harbour are a further two forms of pollution being discharged into the bay. However, these forms of pollution are not toxic and impact on the marine environment in a different way to that of oil, heavy metals and anti-fouling substances. These effluents and the sewage results in enrichment of coastal waters which impacts on the natural environment as discussed in section 5.1. In social terms they pose a health risk to recreational users of the bay water.

At present the breakwater at the north end of the fishing harbour (see Map 3) is considered to be responsible for an area of 'dead' water on its south side. Effluents discharged into this area by the fish factories do not disperse readily and prolonged stress may have cause localised detrimental impact on the benthic community (as discussed in section 5.1.) (CSIR, 1994). This is directly impacting on the fish processing factories as they rely on clean water for processing fish. These factories

are required to adhere to European Community Standards for the production and placing in the market of fishery products (Baseline Report, 1996). They were in danger of not being allowed to export to European countries due to the bad quality of sea water used to clean the fish. Furthermore it is believed that all the mussels in the harbour area have died due to a combination of oil spills, discharge of wastes containing traces of anti-fouling paints from the dry-docks and the high content of organic pollutants in the sea water caused by the discharge of effluents from the fish processing factories (Ramboll, 1995).

Litter dumped from ships anchored in the bay pollute the water and beaches of the study area. This waste on the beaches is not only aesthetically unpleasant but it also poses a health risk to beach users (Baseline Report, 1996). Plastics and plastic containers disposed of by the ships may also have detrimental effects on birds and mammals living and breeding within the study area. Birds and seals often get caught up in plastic bags and containers and this may ultimately result in death or disability.

Odour pollution, resulting from the processing of fish, is also a major problem. The odours largely originate from catches used for fishmeal as well as from the actual processing of fishmeal (Baseline Report, 1996). In 1993 the CSIR-Watertek identified several reasons for the offensive odours, the main one being that of odours from rotten fish. Fishing trawlers do not have refrigeration facilities and have to travel far distances to catch fish, resulting in the rotting of the catch before it is off-loaded at the harbour. An added problem is the use of oil-free direct-flame dryers for the production of fishmeal (Baseline Report, 1996). These are less expensive than the indirectly heated steam units. Steam units are more efficient in the recovery of the condensables that add to the odour problem (*ibid.*). The odour problem is further aggravated by sea breezes that carry the emissions from the factories into town (*ibid.*). These emissions may in turn not be dispersed as a result of the atmospheric inversions that often develop along the coast (see section 3.2.3)(*ibid.*). Several interested parties in Walvis Bay maintain that the odour problem is so bad that it is affecting the town's prospects of developing as a tourist attraction (*ibid.*). There have

also been many letters of complaints by residents of Walvis Bay to local newspapers and the Municipality as a result of the offensive smells (*ibid.*).

The introduction of alien organisms brought in by foreign ships is also a form of pollution. These organisms may effect the ecological balance of the bay. Invasive organisms compete for habitat and food that is usually available to indigenous species only.

Impacts due to fishing practices of the Fishing Industry

The collapse of the fish stock due to over-fishing was the primary cause for the major decrease in gannet and penguin populations off the Namibian coast. Demersal trawling, however, benefited several species of seabirds by discarding of by-catches (unwanted species) and fish waste (Baseline Report, 1996). This practice, however, has been stopped. Longlining is also detrimental to seabirds which may take baited hooks - Cape gannets, white petrels and albatrosses are at risk. Since longlining is a fairly new development in Namibia, there is not yet evidence of large scale seabird mortalities (Baseline Report, 1996). Over-fishing has also reduced the fish available as food source for the seal populations ultimately resulting in a decline in the seal population along the coast of Namibia.

Socio-economic Impacts

The economic benefits of the commercial and fishing harbours to Walvis Bay, and Namibia in general, are substantial. The commercial harbour is Namibia's most vital piece of infrastructure. Foreign exchange generated by the import and export of goods through the harbour contributes to the GDP of the country as a whole (Baseline Report, 1996). The fishing industry is regarded as the backbone industry in Namibia and contributes 3 % to the GDP with the potential to increase this contribution to 10 % (*ibid.*). The fishing industry is also the largest employer in the Walvis Bay area employing approximately 10,000 people.

However, several social problems are associated with the employment opportunities in the area, as many people migrate to Walvis Bay from the north of the country in

search of work. These social problems include an increase in unemployment, housing shortages, escalation of crime, and an increase in the reporting of TB and HIV cases. Further social problems are experienced within the fishing industry. These include conditions such as cramped and uncomfortable eating and sleeping quarters and unsanitary ablution facilities resulting in unhealthy living conditions (Baseline Report, 1996).

Impacts due to Harbour Dredging Program

The construction of the harbour and the implementation of a dredging programme has significantly modified the southward longshore transport of sediment along the east shore of the bay area (CSIR, 1989). Dredging of harbour channels also impacts on the natural system in that the benthic fauna are disturbed and the toxic pollutants bound in the surface layers of the bed are released (*ibid.*). Disposal of dredge material can also a major impact. Disposal of dredge material at dump site C (see Map 3) is undesirable as it is located at the mouth of the lagoon. During dumping the heavy metal, toxic pollutants and fine sediments that are contained in the dredged material remain suspended in the water column and move into the lagoon, impacting on the organisms as explained in section 5.1.

Impacts that may occur due to Harbour Expansion

Extensive dredging to provide access channels to the quays and sufficient under-keel clearance for ships alongside, is the major proposed action for the harbour expansion that will result in short- and medium-term effects (CSIR, 1994). The major threat is presented by the compounds that are bound in the bottom material being re-suspended in the water column (*ibid.*). These compounds include nutrients, toxins, organic matter, hydrogen sulphide and fine sediment (for example, clay) particles (*ibid.*). If transported into the lagoon severe short-term impacts may be experienced, as discussed in section 5.1 *toxic materials* (*ibid.*). Annual dredging rates will also increase dramatically for the new proposed expansion. This is mainly due to the increased surface area of the basins and channel and due to the increased channel depth. An estimated 720 000 cubic meters (dredged volume) will have to be dredged annually if the proposed expansion goes ahead (*ibid.*). In addition the benthic fauna of

the dredged areas will be destroyed. However, in the latter case re-colonisation may occur, if no further dredging occurs, but not necessarily with the same suite of species (*ibid.*).

During construction, minor oil spills may occur and flotsam and other harmful materials that may enter the water of the Bay will impact on the environment in the same way as oil spills and litter from ships.

Most obvious long-term effect of the construction of the additional quays is the loss of benthic areas (*ibid.*). However, the most critical aspect of any harbour expansion will be the effect on the water circulation in the bay and upon tidal flow in and out of the lagoon (*ibid.*). Assuming that the future general cargo quays on the south-west extremity of the port will be reclaimed, and therefore solid structures, two effects are anticipated:

- wave action and therefore wave-driven longshore sediment transport (which is southbound in this vicinity) will be drastically reduced.
- the quays will trap this longshore transport and will severely limit the influx of the finer sediments carried by the clockwise circulation to the mouth of the lagoon. In fact, the circulation pattern will be altered.

(CSIR, 1994)

As a result of the above, less sediment will be available at the lagoon mouth to be transported into the lagoon. This is seen as a benefit to the lagoon (See section 6.1 Sediment Transport in and around the 'Bay Area'). The proposed port extensions will probably not affect the water exchange at the lagoon (which is an important ecological consideration) significantly, because the currents in and out through the mouth are tidally driven, (*ibid.*).

Additional impacts, that are difficult to quantify, are the potential increase in the dumping of litter and the occurrence of oil spills resulting from an increase in the number of ships visiting the harbour. Increased activity in the on- and off-loading of

cargo such as coal, lead and uranium will also increase the potential for spillage, resulting heavy metal pollution of the bay water.

Potential Impacts due to Off-shore Oil and Gas Exploration

In the event that oil is discovered, Walvis Bay will be used as the main supply base for all off-shore drilling, mainly because of its advanced cargo handling and berthing facilities (Baseline Report, 1996). However, although the berthing facilities at Walvis Bay Harbour are advanced, it is limited, and the increased traffic would put a great deal of pressure on the harbour, and port expansion would need to be considered, resulting in the impacts as discussed above.

5.4. IMPACTS RESULTING FROM SALT RECOVERY OPERATIONS

The establishment of solar ponds alongside the Walvis Bay lagoon destroyed extensive areas of natural tidal flooding during their development and significantly affected the natural functioning of the lagoon system (CSIR, 1992). The establishment of these saltpans resulted in an increased salinity and may also have caused a total loss of vegetation from the Walvis Bay wetland (Noli-Peard & Williams, 1991). However, they now provide large areas of permanently flooded, shallow water with extensive shorelines which provide a habitat for a large number of birds. In fact, half of the birds occurring in the Walvis Bay lagoon are regularly recorded in the salt works area (Baseline Report, 1996).

Algae that grows in the hypersaline water of the saltpans is a major food source for the flamingos that inhabit the area (Morant, 1996, pers.com.). The saltpans also form an ideal habitat for farming oysters as they protect the oysters from red tides and sulphur eruptions (see section 6.3). During sulphur eruptions the pumping of water from the bay into the saltpans can be stopped thus preventing the toxic hydrogen-sulphide and red tide from entering the pans and killing the oysters.

Another *positive* effect of the salt works is that it has effectively cut off any significant wind-blown sand supply to the southern part of the lagoon thus limiting

sedimentation of this area (see section 6.1)(CSIR, 1992). However, the extent of the salt pans does have an impact on the aesthetic quality of the surrounding area and detracts from the sense of "wildness" of the lagoon. The piles of salt at the salt works are also visually obtrusive. The salt works, Salt and Chemical (Pty) Ltd, presently employs 90 people and with regards to its intentions of expansion, extensive environmental studies, on the impact of salt pan expansion around the Walvis Bay lagoon, will have to be undertaken before further pans are created.

5.5. LIMITATIONS TO AND IMPACTS RESULTING FROM MARICULTURE

There are several factors that may limit the expansion of the mariculture into the open water of the Walvis Bay lagoon. These limitations together with the possible impacts that may result from the expansion of mariculture into the lagoon are discussed and analysed in this section.

Limitations to the Expansion

One of the major limiting factors to the expansion of the mariculture industry in the Bay Area is that of pollution. Although the present state of the bay water quality is unknown, the amounts of pollutants entering the water from the harbour area are a cause for concern. Mussels and oysters are filter feeders, which means that they filter large volumes of water to extract the plankton from it, which they consume as food (Cook, 1995). Unfortunately during this filtering process chemical pollutants such as metals, hydrocarbons and organometallic compounds are also consumed thereby affecting the marketability and even the survival of the mussels and oysters (*ibid.*). Furthermore it is believed that all the mussels in the harbour area have died due to a combination of oil spills, discharge of wastes containing traces of anti-fouling paints from the dry-docks and the high content of organic pollutants in the sea water caused by the outlet of effluents from the fish processing factories (Ramboll, 1995).

Chemical pollutants, such as metals, accumulate within the bodies of the organisms and, even where levels of metals in the water in which these organisms grow are low,

accumulations of the metals soon reach levels where they become toxic to the organism or render them unfit for human consumption (*ibid.*). The above procedure has an amplifying affect wherein accumulated levels of such metals exceed the level of such metals in surrounding water by what is referred to as an "enrichment factor" which varies from metal to metal and organism to organism (*ibid.*). Thus for example the "enrichment" factor in the respect of the metal cadmium is 318 700 for oysters and 100 000 for mussels. Thus relatively minute increases in the level of cadmium in the surrounding water are amplified in the tissue of the oysters and mussels to significant levels by virtue of the above mentioned "enrichment factor" (*ibid.*). It has been shown in numerous areas of the world (Goldberg, 1994) that accumulation of such metals is devastating to populations of mussels and oysters. Even if they themselves are not killed - they are, once contaminated, not fit for human consumption (*ibid.*).

Strict international health standards, set by the EC, have to be adhered to if mussels and oysters are to be sold for human consumption on the international market. Thus, if mussel farming goes ahead as planned, in the Walvis Bay 'bay area', water quality will almost certainly have to be closely monitored in order to make sure that the above- mentioned standards are adhered to.

Other limitations to the expansion of this industry include regular sulphur eruptions and red tides (see section 6.3). These conditions occur mainly in summer between January and March, when the sea is particularly calm. Even though these events are seldom toxic to humans, they kill marine fauna as a result of oxygen starvation (*ibid.*).

Potential Impacts

At present there are few negative impacts of mariculture as it is limited to artificial salt evaporation ponds. However, if the industry is to be expanded into the open water of the bay there are numerous potential impacts that could result. Some impacts relating to mariculture, that have been experienced in other parts of the world, will now be discussed and analysed.

The first conflict is that of the competition for space (Goldberg, 1994). The mariculture industry will have to compete, for water surface space within the bay, with the commercial and fishing harbours, recreational users and nature conservation. This impact will definitely exist if the mariculture industry is to expand into the bay. The space required for the rafts will also conflict with the birds that use the bay area as a habitat. Mussel rafts on the lagoon will also create a visual impact.

Competition with natural populations is another impact to be considered (Goldberg, 1994). Mussels and oysters are filter feeders that will extract food particles from the water that are required by the other organisms living in the surrounding water. This impact may, however, be mitigated to a certain extent due to the upwelling that occurs resulting in extremely nutrient rich water and high productivity rates. However, if the industry expands rapidly to a large size this impact may become more significant.

Introduction of alien species for mariculture is often practised. These alien species may be invasive, thus threatening indigenous species. The introduction of alien species may also result in the change in composition of the Walvis Bay communities.

As the mariculture of mussels and oysters involves the high density culture of organisms on rafts there exists a potential to alter the water quality by the introduction of waste products produced by the mussels and oysters (Goldberg, 1994). The wastes will impact on the surrounding environment in the same way as discussed in section 5.1 - *enrichment*. The potential impact of the waste products may, however, be negligible as the surrounding waters are already extremely rich in nutrients due to extensive upwelling. However, if the industry expands rapidly to a large size this impact may become more significant.

Conflict may arise between mussel/oyster farmers and birds that attempt to feed on the mussels and oysters (Goldberg, 1994). This may result in farmers using methods of deterrent that may ultimately kill or disable the birds.

On the positive side the mariculture industry will create more employment opportunities and foreign exchange for the country.

5.6. IMPACTS RESULTING FROM TOURISM AND RECREATION

One of the major impacts of tourist related activities is that of litter resulting from a lack of environmental awareness by people visiting the area. This is reflected in the figures of waste collected in the annual beach clean-up campaigns at the popular angling sites south of Walvis Bay. In the 1991 clean-up, 365 kilograms of litter was collected from a 20 kilometre stretch of beach, while in the 1990 and 1989 beach clean-ups, in the same area, 518 kilograms and 260 kilograms of litter were collected, respectively (Brown, 1992).

Plastics, plastic containers, fishing line and other wastes may seriously impact on birds and mammals. Birds and seals often get caught up in these materials, ultimately resulting in death or disability. Litter discarded by visitors to the area is also unsightly and has a negative impact on both the visual quality and the water quality of the bay. It is important to note that this form of environmental contamination is readily controllable and involves no philosophical or economic conflicts (Gochfeld, 1973)

Recreational fishing attracts more tourists than any other tourist related activity in Namibia (Baseline Report, 1996). Over-fishing, due to the increased number of fisherman, is a major impact of recreational fishing and it may result in pronounced changes in the structure of fish communities and other ecological communities of the bay (Day *et al*, 1989). This change in community structure may occur because the competitors and food supply of the overexploited fish species increase (*ibid.*). Apart from over-fishing, recreational fishing has several other negative impacts.

Bait is required for fishing which ultimately leads to the over collection of bait species due to the number of fisherman as well as the amount of bait collected by each person. Over collection of bait species may result in a change in community

structure in the areas where bait is collected. This change may occur because of an increase in competitors and food supply of the overexploited species. As mentioned in section 4.2., The Sea Fisheries Act (Act No.29 of 1992) does attempt to manage the impacts of recreational fishing to a certain extent, in that it sets out regulations for the numbers of different species of fish that may be caught daily or transported per vehicle. It also stipulates the number of species of bait organisms that may be harvested from the sea. Sea Fisheries inspectors do patrol the coast to enforce the regulations, however, limited personpower limits the effectiveness of these patrols.

Fishing spots are often remote and four wheel drive vehicles are needed to access these areas resulting in negative impacts on the dune ecosystems and on bird breeding colonies. Vehicles damage dune vegetation and destabilise the dunes. This leads to erosion which prevents the dunes from acting as sand traps, thus changing the sand budget of the dune system (Soboil, pers.com., 1996). Apart from the damage to the dune systems, vehicles also disrupt birds and may destroy eggs and nests.

Crayfish and mussel occur marginally in the rocky outcrops on the shoreline between Walvis Bay and Swakopmund (see section 3.2.1 *Intertidal Fauna*). Due to their limited distribution they are highly sensitive to disruption. Thus disturbance and over collection could be detrimental to these communities. At present tourists may collect up to 7 crayfish and 50 mussels without a permit. As tourism increases in the area these species will be further exploited and thus further threatened.

Further impacts are related to birdwatching and general sightseeing. Bird watching may seem to be a passive enough activity, not causing any impact. However, walking on the mudflats has a major impact on the benthic communities as it destroys the burrowing systems of the organisms and disrupts the underlying sediments. Low flying aircraft, on sightseeing flights over the lagoon, disrupt birds that are feeding. However, at present these flights are infrequent and thus do not pose a major problem.

Tourism also has positive impacts in that it generates employment and foreign exchange. As discussed in section 3.3.1 the tourist interest in the birdlife of the Walvis Bay lagoon and other areas in Namibia generates up to N\$ 5 million per annum. This gives the birdlife and bird habitat an explicit monetary value.

5.7. IMPACTS RESULTING FROM URBAN INFRASTRUCTURE

There are a number impacts resulting from the development of urban infrastructure in and around the study area.

Impacts resulting from the Langstrand/Dolphin Beach Developments

Residential development in these areas has been perceived as a possible threat to the intimate character of the holiday resort as well as a threat to the sensitive coastal environment. This is a result of a trend whereby "high-income" earners who are based in Walvis Bay, buy small sites that are ostensibly reserved for cottages and erect large scale permanent accommodation. This results in high residential densities and the potential of Langstrand becoming a suburb of Walvis Bay possibly resulting in a number of negative impacts that have not yet been investigated. These impacts include all the impacts of tourist related activities (see section 5.6) as well as that of increased sewage and other related infrastructural requirements. The development does detract from the aesthetic quality of the area as it is has been developed along a harsh and stark coastline with few other man made structures.

Impacts resulting from the construction of the road to Paaltjies

The construction of this road resulted in the impoundment of former intertidal flats resulting in them drying up and being covered with sand. This in turn resulted in the increase of aeolian sand movement into the southern extremities of the lagoon. This has subsequently been rectified by the construction of culverts and non-return flap valves that ensure that the interdune slacks remain wetted by water entering during spring high tides (see section 6.2).

Potential Impacts of the Desalination Plant at Paaltjies

The desalination plant to be situated at Paaltjies will require 14.4 MW's of power supply over the next 20 years (Coeln, 1996). Powerlines will have to be erected either above or below ground. Powerlines above the ground will have severe impacts on birds as lines will be in the way of the bird flight paths. Bird mortalities could result from birds flying into the lines. These powerlines will also have a visual impact on the aesthetic quality of the area. Underground powerlines will have an impact on the organisms living in the mud and sandflats. This, however, should have a limited impact as communities should re-establish themselves after disruption.

The abstraction of sea water from the coast and the release of hypersaline water back into the sea may have a profound effect on the organisms living in the affected waters. The visual impact of the plant may also have an impact on the sense of place that the local and visiting fisherman experience when fishing at this popular spot.

5.8. IMPACTS RESULTING FROM GUANO HARVESTING

Besides the economic benefits of guano harvesting and the associated employment opportunities, the construction of the platforms have numerous positive impacts. Most importantly, they provide a safe-haven and roost site for many marine birds, taking pressure off off-shore islands and threatened land-based roosting and breeding sites.

5.9. CONCLUSION

This section has analysed the impacts of the major human activities on the natural and social environment of the study area. It is important that when attempting to manage a coastal zone area, consideration of the impacts and influences of the natural processes on the functioning of the human activities also be taken into account. The following section will consider the impacts of the natural processes on the functioning of the human activities in the study area.

SECTION 6

ANALYSIS OF THE IMPACTS OF THE NATURAL PROCESSES ON THE HUMAN ACTIVITIES WITHIN THE STUDY AREA

6.1. INTRODUCTION

There are several natural processes that impact on the day to day functioning of the human activities within the study area. Some of these natural processes also pose as a threat to the functioning of the Walvis Bay wetland system. The transport of sediments into and around the study area is a natural process that impacts on the day to day functioning of some of the human activities while at the same threatening the Walvis Bay wetland system. This process along with longshore transport, the occurrence of red tides and sulphur eruptions and stable climatic conditions of the study area will be discussed in this section.

6.2. SEDIMENT PROCESSES IN AND AROUND THE LAGOON

The development of the Walvis Bay lagoon to its present state is a result of sedimentation processes that have been operating for thousands of years (CSIR, 1992). Sedimentation of the bay and lagoon has gradually occurred due to marine and aeolian sediments and due to fluvial mud derived from sporadic flooding of the Kuiseb River (*ibid.*). Sedimentation is an ongoing process and the lagoon will inevitably continue to become shallower, primarily as a result of the influx of aeolian sediment and the deposition of biogenic material. This will result in the gradual loss of wetland habitat from the south as the process of infilling continues (*ibid.*). The sedimentation of the lagoon and the subsequent loss in habitat has ecological consequences for biota, which are dependent upon the system and has management implications for the residents of Walvis Bay who perceive the lagoon to be of value as a recognised natural asset and a recreation facility (*ibid.*).

Aeolian sediments are mainly derived from the Kuiseb Delta to the east and south of the lagoon and from the sandy beaches to the south-west of the lagoon. Various developments around the bay have caused some interference to the natural processes of the sedimentation of the lagoon from these areas (*ibid.*). The salt works, and the associated saltpan dikes, is probably the most significant development in this regard and is situated on the southern and western perimeter of the lagoon. The road leading to the salt works, constructed along the eastern margin of the lagoon is also of significance. In spite of the ecological impacts (see section 5.4), the structures associated with these developments have, however, generally retarded the rate of sedimentation which was generated by the south-south-westerly wind regime (*ibid.*).

The development of the Walvis Bay town, the sand trapping barriers (see plate 7) and the other dune stabilising efforts have also effectively cut off much of the sediment influx into the lagoon under both the south-westerly and north-easterly wind conditions (*ibid.*). A system of culverts and non-return flap valves on the road leading to the salt works have been developed to ensure that the interdune slacks remain wetted by water entering during spring high tides (see plate 8). This has effectively limited much of the influx of sand to the lagoon (*ibid.*). However, sand blown off the exposed sand dune ridges separating the ponds will, in time, cause the ground level of the wetted areas to rise. A level will be reached where the sea water will be unable to intrude during high tides. The wetting will no longer be an effective control of sand transport. Aeolian sand supply to the lagoon will increase unless water is pumped into the ponds or the accumulated sand is removed from between the dunes (*ibid.*). The future development of the lagoon shoreline, north of Lover's Hill, will further counteract sedimentation within the lower and middle reaches of the system. This will leave only the upper reaches of the lagoon vulnerable to aeolian sediment inputs during infrequent (north-easterly) bergwind conditions (*ibid.*).

The last major flooding of the Kuiseb River which would have contributed to the introduction of fluvial sedimentation of the lagoon occurred in 1963 (*ibid.*). The northern branch of the Kuiseb delta transported the bulk of this flood water into the bay



PLATE 7

Top: Wooden fences and planted vegetation to limit movement of wind blown sand into the lagoon.

Bottom: Vegetation planted to limit the movement of wind blown sand into the lagoon.

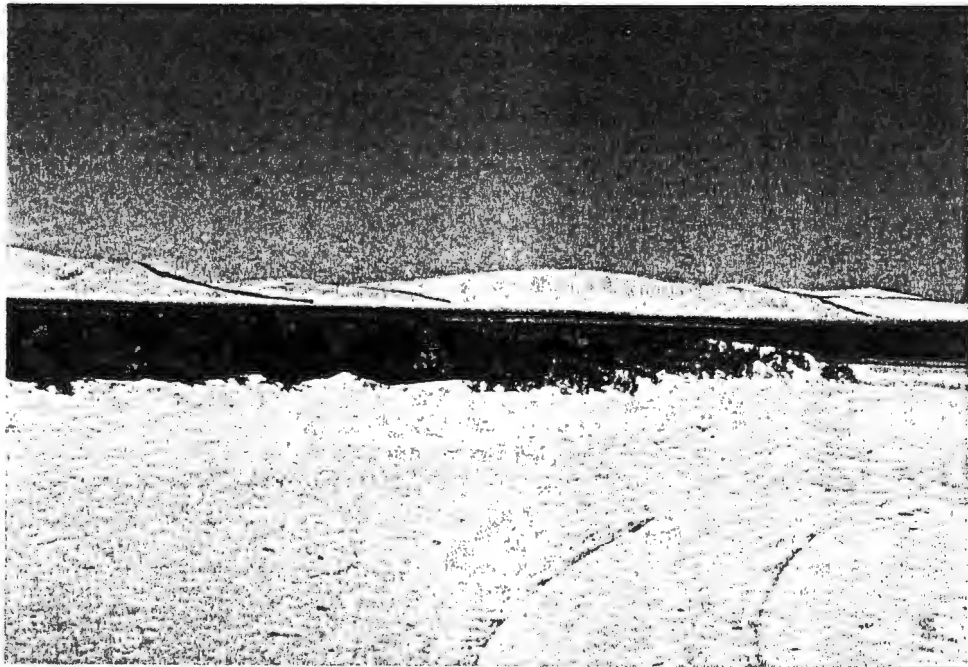




PLATE 8

Top: Road to Paaltjies separating the lagoon from the sand dunes.

Left and Below: System of non-return flap valves to ensure that interdune slacks remain wetted during high and spring tide.



and the southward longshore transport¹ (see Map 4) could have resulted in the introduction of large volumes of fine fluvial sediment into the lagoon (*ibid.*). Subsequent to this event, the Rooiwal flood protection works were designed and constructed to prevent future flooding along the northern arm of the Kuiseb delta. This will eliminate the potential longshore introduction of fluvial sediments to the lagoon from the Kuiseb River in the future (*ibid.*). However, floodwaters which are now diverted along the southern arm of the delta, can reach the lagoon and have a major impact on the system through the massive deposition of fluvial sediment (*ibid.*). This factor probably has the greatest potential to alter the functioning of the lagoon from its present relatively stable state (*ibid.*).

Although many of the management strategies have limited the influx of wind-blown sand and fluvial sediments into the lagoon, a significant potential still exists for rapid sedimentation of the lagoon if these existing management systems become inoperative.

6.3. LONGSHORE TRANSPORT AND MOVEMENT OF SEDIMENTS IN THE BAY

Longshore transport is the transport of sediments along a stretch of coast line resulting from wave actions that resuspend sediments followed by transport in suspension along the coast by longshore currents (CSIR, 1994). The net longshore transport rate along the exposed seaward coast of the Walvis Bay peninsula has been estimated to be between 0,5 million and 1,4 million cubic meters per year in a northerly direction (*ibid.*). This has resulted in Pelican Point having an annual growth rate of 17,4 metres (*ibid.*). The effect of the growth of Pelican Point is primarily to decrease wave action at the harbour even further which is in effect a positive change (*ibid.*).

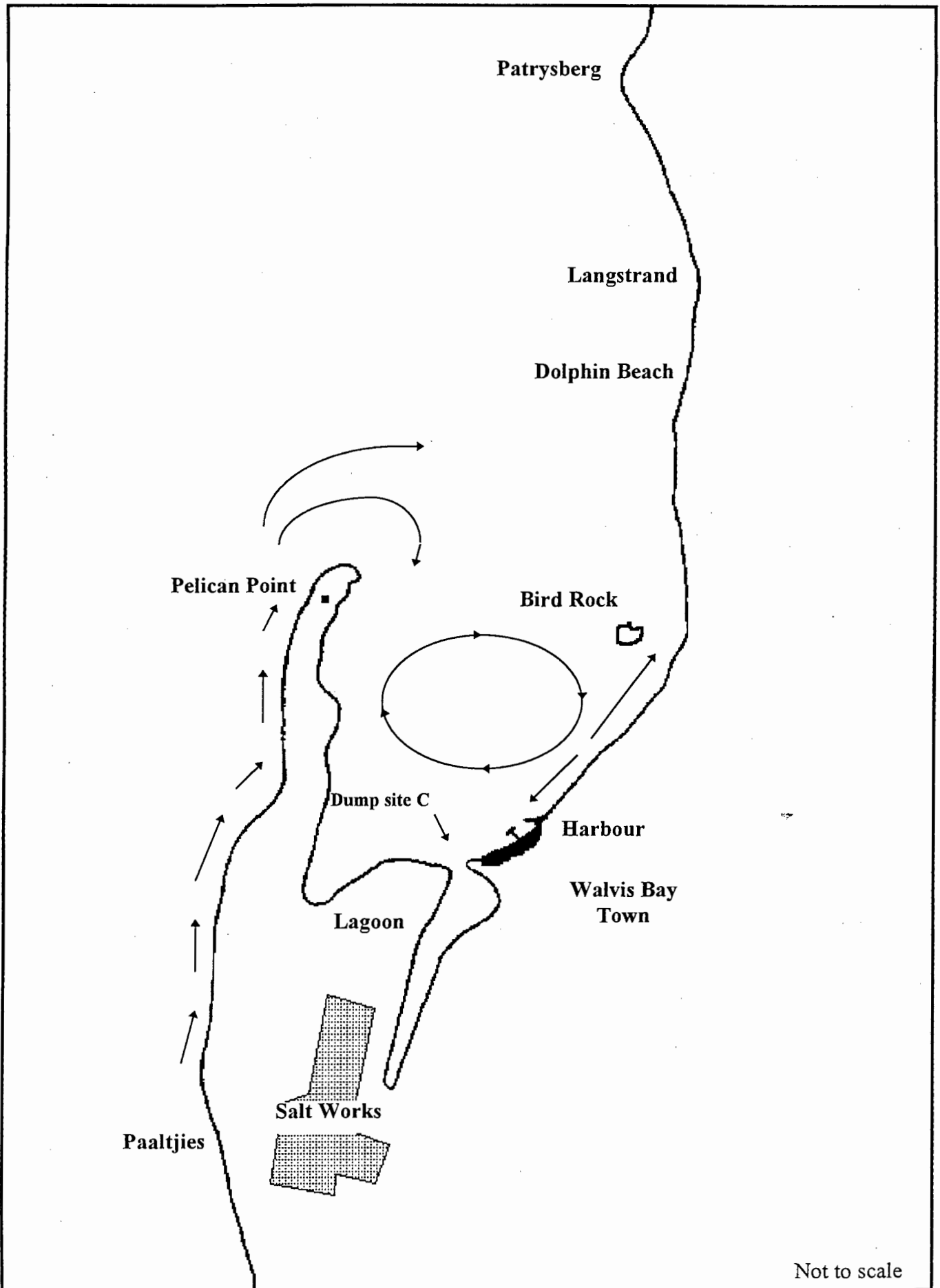
¹ The refraction of waves around the point of the sandspit (Pelican Point) into Walvis Bay generates a southwards longshore current. This transports sediment, including material derived from floods and introduced into the bay via the northern arm of the Kuiseb delta, and has further contributed to the shallowing process in the low energy environment behind the sandspit (CSIR, 1992).

However, recently a low-lying area has developed along the peninsula south of Pelican Point where occasional wave overwash occurs (*ibid.*). This may be a result of the net northward longshore transport. If a breach is caused during a severe storm and high tides, a very serious situation could arise in which the wave attack on the port and sediment transported into the bay could increase considerably resulting in higher maintenance costs (*ibid.*). The cost to close this breach would be considerable as it is a difficult task requiring major dredgers (*ibid.*).

Longshore transport of sediment (sand) along the coast north of the port is also northwards. However, at the northern extremity of the port the movement of sand is southbound near the shoreline. Sediments are also transported in and out of the lagoon by tidal currents. The main mechanism that is causing the sedimentation of the port and the entrance channels, is the predominantly clockwise circulation in the bay (see Map 4)(*ibid.*). This current pattern is mainly wind-driven. The sediments in this case, however, are mud and fine silty sand (*ibid.*). This sedimentation process results in millions of Namibian dollars having to be spent on dredging in order to keep the channels open (see section 4.2 - *Dredging*).

6.4. RED TIDES AND SULPHUR ERUPTIONS

As discussed in section 3.3.2. the coastal waters of Walvis Bay appear to be a major 'sink' of organic material generated by primary production (the conversion of carbon dioxide through photosynthesis to organic carbon by plants). This results in near anoxic conditions on the bed of the bay. Hydrogen sulphide is a product of anaerobic breakdown and periodic eruptions of this gas occur mainly in the summer between January and March, when the sea is particularly calm (Morant, 1996, pers.com., and Baseline Report, 1996). These events are seldom toxic to humans, but they may kill marine fauna as a result of oxygen starvation and toxicity (*ibid.*). Bivalve marine fauna (mussels) can "close down" for a short period thus not being effected by the eruptions. However, if the hydrogen sulphide remains in the water for a long enough period (approximately 2 days) it may result in the death of mussels and other bivalves



Not to scale

MAP 4: LONGSHORE TRANSPORT AND CURRENTS

(Morant, 1996, pers.com.). Red tides are also detrimental to marine organisms as they may be toxic and also result in oxygen starvation.

6.5. ATMOSPHERIC CONDITIONS

Some of the climatic conditions in the study area exacerbate pollution and odour problems. Due to the absence of convection, stable air conditions result in temperature inversions in the lower atmosphere (Baseline Report, 1996). Apart from stable air conditions a high occurrence of fog is also experienced. Pollution particles are hydrophilic and attract the water particles that fog comprises of (*ibid.*). As a result, the fog concentrates pollution and together with the inversion, pollution dispersion is limited (*ibid.*). Even though the dominant winds in the region are regularly strong, and disperse air pollution, sea breezes can result in pollution being blown back to land (*ibid.*). This factor combined with the stable air conditions also exasperates the odour pollution problems being experienced in Walvis Bay town.

6.6. CONCLUSION

In section 5, the impacts of human activities on the natural and social environment of the study area were analysed. In turn some of the impacts that the natural processes have on the functioning of the human activities within the study area have been discussed in this section. In order to decide on the "importance" of these impacts it is necessary to evaluate the impacts of each activity on specific natural and social environmental factors. This is done in section 7.

SECTION 7

EVALUATION METHODOLOGIES

7.1. INTRODUCTION

This section comprises a discussion of the evaluation methodologies used in this dissertation. The Framework Approach for presenting and evaluating information will be discussed and adapted for the purposes of this dissertation. Following this, adapted criteria for use in the Fuggle Matrix to evaluate impacts will be presented and discussed.

7.2. FRAMEWORK APPROACH

The British Department of Transport initially developed the Framework Approach for the evaluation of alternative routes for proposed trunk road developments (The Standing Advisory Committee on Trunk Road Assessments, 1979). The Framework Approach has also been used in a number of other environmental assessments to evaluate and compare the alternatives for specific development proposals. Examples of these are: The Conwy Estuary Tunnel, 1980, Siting of an informal settlement at Redhill, Cape Peninsula, and Alternative routes for the access road to the Mohale Dam site, Lesotho Highlands. Matrices (tables) of alternatives versus environmental factors were used in the above examples to present analysed information on the impacts of the various alternatives of each development proposal on the environment. Significant impacts were then highlighted to aid the decision makers in the evaluation and choice of alternatives.

In formulating a framework it is important that the information presented in the matrix has been analysed and explained in the preceding text of the assessment (The Standing Advisory Committee on Trunk Road Assessments, 1979). Public participation must be used in choosing the appropriate environmental factors to be included in the matrix (*ibid.*). The information in a framework is presented on a

single sheet of paper, and quantitative and qualitative (descriptive) data is included to aid in the comparison of alternatives (*ibid.*). The amount of analysis required and the way the information is presented in a framework depends on 2 factors:

- how much further work the decision makers plan to undertake in analysing the material presented in an environmental impact assessment, and;
- whether or not the environmental impact assessment is intended to identify a preferred alternative.

(The Standing Advisory Committee on Trunk Road Assessments, 1979)

For the purposes of this dissertation I have decided to veer from the format as described above. Instead of a 'traditional' Alternatives versus Environmental Factors matrix I have produced a Human Activities versus Environmental Factors matrix. Although it is suggested that quantitative and qualitative data be used in a framework the lack of quantitative data in this instance has precluded its use in this report.

Each cell of the matrix gives a brief qualitative summary of the impact of the human activity on the related environmental factor as presented in section 5. It is not the intention of this framework to compare activities with one another but, rather, to simply show the impacts of all the activities on the related environmental factors on one sheet of paper. This, it is hoped, will aid decision makers to comprehend the overall status of the Walvis Bay lagoon and 'Bay Area'.

The obvious limitation to the framework method employed in this report is that public participation has been excluded in the choice of the Human Activities and Environmental Factors used as the axes of the matrix. However, the Baseline Report, interview records with various representatives of organisations interested and affected by the activities within the study area and reports from previous meeting held on the status of the Walvis Bay lagoon were consulted in setting up these axes.

7.3. FUGGLE MATRIX

7.3.1. INTRODUCTION

This method of evaluating impacts is simply used to make explicit, the implicit set of criteria used by the author when deciding on the importance score of the various impacts as presented in the Summary Matrix . This set of criteria was adapted from the original Fuggle Matrix as used in the Environmental Impact Assessment of the proposed construction of the Constantia Hypermarket (September 1979) and is shown in Table 1 and Table 2.

7.3.2. COMPLETING THE CELLS OF THE MATRIX

Before deciding on the importance score of an impact the criteria numbered 1 to 5 in Table 2 must first be considered in a logical fashion. This is achieved by being consistent in the order of consideration of the criteria for each impact as depicted in table 2 (i.e. first probability then duration, spatial extent and finally remedial measures). Once these have been decided on for each cell a decision on the relative importance score and whether the impact is positive or negative can be made. The symbol * is simply to indicate whether the impact is a higher order impact and has no bearing on the importance score.

All impacts with importance values of 4 and 5 must then be highlighted on the Summary Matrix so as to indicate it as a major impacts and effects. Highlighting important (significant) impacts enables decision makers to easily identify the problem areas that need to be addressed within the formulation of policies or management plans.

TABLE 1: SET OF CRITERIA USED FOR THE EVALUATION OF IMPACTS AS ADAPTED FROM THE FUGGLE MATRIX (1979)

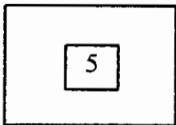
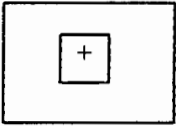
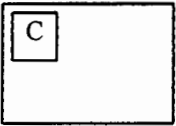
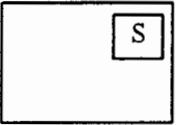
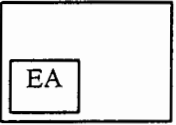
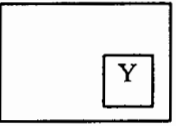
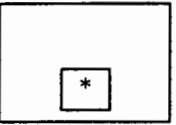
<u>Characteristics Evaluated</u>	<u>Symbols Used</u>	<u>Meaning</u>	<u>Position in Cell</u>
a. IMPORTANCE	5	Major	
	4		
	3	Moderate	
	2		
	1	Minor	
	?	Unable to determine	
b. BENEFIT	+	Positive	
	-	Negative	
	?	Unknown	
<hr/>			
1. PROBABILITY	C	Certain	
	P	Probable	
	U	Unlikely	
	?	Not Known	
2. DURATION	S	Short-term	
	M	Medium-term	
	F	Permanent	
	?	Not Known	
3. SPATIAL EXTENT	EA	Extensive Area	
	LA	Limited Area	
	?	Not Known	
4. REMEDIAL MEASURES	Y	Planned	
	N	Not Planned	
	?	Not Known	
5. HIGHER ORDER IMPACT	*	YES	
6. IRREVERSIBLE			IRREVERSIBLE

TABLE 2: DEFINITION OF THE CRITERIA USE FOR THE EVALUATION OF IMPACTS

Each of the criteria has been defined below in accordance with the way it has been used in the context of this report:

a. IMPORTANCE

This is a subjective judgement, rated on a scale of 1 to 5, as to the significance of an impact that a particular human activity has on a specific environmental factor. The judgement is based on the evaluation all of the characteristics mentioned below.

b. BENEFIT

Whether the effect will be beneficial (+), detrimental (-) or undetermined (?) to the environment.

Before deciding on the importance of an impact and whether it is positive or negative the following must first be considered.

1. PROBABILITY

How certain is it that the potential impact will take place ? (or how certain is it that the potential impact is in fact already taking place ?)

2. DURATION

For how long will the impact be felt ?

- i. Short-term : For a few days or months.
- ii. Medium-term : For a longer period, even a few years but not permanent.
- iii. Permanent : Will go on indefinitely.

3. SPATIAL EXTENT

Over what area will the impact be felt?

- i. Extensive Area: The whole study area.
- ii. Limited Area : A localised fraction of the study area.

4. REMEDIAL MEASURES

Have any remedial measures been planned where impacts are known to be occurring or have remedial measures for impacts been addressed in some type of policy?

5. HIGHER ORDER IMPACT

This is to indicate whether the impact is a higher order impact (e.g. effluents impact on water quality - secondary impact will be the impact of the poor water quality on the marine organisms).

6. IRREVERSIBLE

Permanent impact where no amount of mitigation will improve the situation.

7.3.3. CRITICISMS

Firstly it is important to note that the adapted Fuggle Matrix as described above is not intended to be used to compare project alternatives. It is simply used to make explicit, an implicit set of criteria used by the author in deciding on the importance (significance) of each impact.

The set of criteria in Table 2, numbered 1 to 5, can be scored in a quasi-objective manner by making reference to previous studies of these impacts in similar coastal environments. This analysis of impacts is prescribed in section 5. However, the final decision as to the importance score of each impact is the subjective decision of the author and may have been scored differently if scored by interested and affected parties, or indeed a different author. Nevertheless, as the decision on the importance score of the impacts was made with reference to the Baseline Report (1996), interview records and reports from previous meetings held on the status of the Walvis Bay lagoon, it should represent an "balanced" opinion. While the difference between a score of, say, 3 and 4 may not be defensible, one can have confidence that a score of 3 is different to a 5 and different to a 1. It is expected that others would obtain comparable scores, given comparable information.

7.4 CONCLUSION

Both the Framework Approach and the Fuggle Matrix have been adapted for the use in this dissertation. It is important to note that the Summary Matrix is not for the purposes of comparing the activities with one another but rather a technique for presenting an overall view of impacts resulting from the relevant activities. The Summary and Scoring Matrix will be presented in section 8.

SECTION 8

EVALUATION OF THE IMPACTS OF THE HUMAN ACTIVITIES ON THE NATURAL AND SOCIAL ENVIRONMENT OF THE STUDY AREA

8.1. INTRODUCTION

This section is the evaluative core of the dissertation and uses an adapted Framework Approach (Summary Matrix) and the Fuggle Matrix as discussed in the previous section to evaluate the importance of the impacts of the human activities on the study area. The impacts of the natural processes on these human activities (as discussed in section 6) will, however, not be evaluated in this way. A brief summary of these impacts will be given at the end of this section.

The Summary Matrix has as its axes Human Activities and Environmental Factors with each cell summarising the impact of the relevant human activity on each of the environmental factors. An adapted Fuggle Matrix is used to identify "important" impacts which are in turn shaded on the Summary Matrix. Before the Summary Matrix and Fuggle Matrix are presented, some discussion will be centred around the reasons for choosing the specific Human Activities and Environmental factors used in these matrices.

8.2. CHOICE OF HUMAN ACTIVITIES

When choosing the various human activities to be assessed, reference was made to the Baseline Report (1996) and the main activities operating in the study area were chosen (see section 4). These included: the commercial and fishing harbours, tourism and recreation, salt recovery, mariculture, urban infrastructure and guano collection. These are perceived to be having the most impact on the natural and social environment of the study area.

8.3. CHOICE OF ENVIRONMENTAL FACTORS

The Walvis Bay lagoon and 'bay area' are extremely sensitive natural environments (see section 3.4) which provide habitat for more resident and migrant coastal birds than any other locality in southern Africa (see section 3.3.1). It is for these reasons the Walvis Bay lagoon is rated as one of the five most important coastal wetlands in Africa (Williams, 1988). The extensive birdlife depends on the micromarine fauna within the intertidal zones of the lagoon and on the abundant fish supply in the surrounding coastal waters as a source of food.

As a result of the importance of the Walvis Bay lagoon as a habitat for resident and migrant birds species and the close link between the quality of food and habitat and the survival of these birds, the majority of environmental factors which have been chosen to be assessed are natural environmental factors. As a result the assessment of socio-economic factors has been limited. However, it is important to note that human quality of life is integrally linked to the status of the surrounding natural environment. Furthermore many of the activities which impact on the natural environment will indirectly impact on other human activities within the bay. For example: pollutants released into the bay by commercial harbour activities may result in toxic conditions which may be detrimental to many species of marine fauna. This may, in turn, impact on potential use of the bay waters for mariculture and recreation.

The environmental factors included in the Summary Matrix are as follows:

- Birds
- Large Marine Animals (seals, fish, mussels, oysters, crayfish etc.)
- Small Marine Organism (benthic fauna, phytoplankton etc.)
- Natural Habitats (wetlands, mudflats, dune systems etc.)
- Natural Processes (currents, sediment transport, dune movement etc.)
- Water Quality
- Socio-economic Impacts (job creation, foreign exchange, health risks, noise, aesthetics etc.)

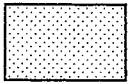
8.4. SUMMARY MATRIX OF HUMAN ACTIVITIES VERSUS ENVIRONMENTAL FACTORS

Table 3 shows the Summary Matrix of Human Activities versus Environmental Factors which indicates the impacts of each activity on specific environmental factors as listed above. This summary information was obtained from section 5 - Analysis of the Impacts of the Human Activities on the Natural and Social Environment of the Study Area. Cross references to the relevant sections and page numbers have been made in every cell.

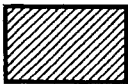
8.5. EVALUATION OF THE IMPACTS OF THE HUMAN ACTIVITIES USING AN ADAPTED FUGGLE MATRIX

A Scoring Matrix was developed by evaluating each cell of the Summary Matrix using the adapted criteria as discussed in section 7.3. This Scoring Matrix is shown in Table 4. Each cell has 6 symbols and 1 number relating to the criteria in Table 1 and Table 2. Once the criteria: probability, duration, spatial extent, remedial measures and higher order impacts were considered for each cell an importance score between 1 to 5 was attributed to the cell. The decision as to the scoring for each cell was made with reference to section 5 of this dissertation, the Baseline Report (1996), interviews with various representatives of organisations interested and affected by the activities within the study area and reports from previous meeting held on the status of the Walvis Bay lagoon. A decision was then made as to whether the impact was positive or negative to society and the environment as a whole. Once this was completed all cells with an importance score of -4 or -5 were considered as major impacts and were thus highlighted on the Summary Matrix as indicated in Table 3. There are several impacts that have occurred in the past have been considered as irreversible as they are either permanent structures or no remedial measure will change the situation (examples of these are the construction of the harbour and the saltpans).

Key for TABLE 3 and TABLE 4



Major Impact with Importance score of -4 and -5



Red Flag Area - Large amount of uncertainty

(5.3,67) This indicates the section number and the page number where the impact has been discussed in the text i.e. Sect 5.3, page 67.

TABLE 3: Summary Matrix of Impacts of Human Activities on Environmental Factors

	COMMERCIAL HARBOUR	FISHING HARBOUR (Fishing Industry)	SALT RECOVERY	MARICULTURE	TOURISM AND RECREATION	INFRASTRUCTURE (excluding harbour)
BIRDS	1. Oil may collect on the birds feathers (and eggs) resulting in death or disability. (5.3,52)	1. Overfishing has contributed to the reduction in bird numbers as birds depend on fish as a food source. (5.3,55)	1. Destruction of natural tidal flooding areas (bird habitat) during construction. (5.4,58)	1. Conflicts may arise between mussel farmers and birds that intend feeding on the mussels. (5.5,61)	1. Low flying aircraft over lagoon area frightens and disrupts flamingoes and other birds. 4 x 4 vehicles disrupt bird breeding colonies and may destroy nests and eggs. (5.6,63)	1. Developments at Langstrand and Dolphin beach may pose a threat to the breeding colonies of Damara Terns due to the increased number of people. (5.7,64)
	2. Plastics, plastic containers and other wastes dumped by ships may result in death or disability of birds. (5.3,54)	2. Longlining is detrimental to seabirds taking the baited hooks. (5.3,55)	2. Now provides permanently flooded shallow waters with extensive shore-lines for birds to inhabit and feed in. (5.4,58)	2. Surface area taken up by the mussel rafts reduces the area for birds to use. (5.5,61)	2. Plastics, plastic containers and fishing line left behind by visitors may result in death or disability for birds that get caught up in them. (5.6,62)	2. The possible construction of power-lines to the desalination plant at Paaltjies could negatively impact on the wetland bird population. (5.7,64)
LARGE MARINE ANIMALS	1. Oil, heavy metals and other toxins may cause mortality, growth inhibition, reduced reproduction, shift in species importance and tainted flesh in fish and shellfish. (5.3,52)	1. Over-fishing has resulted in the collapse of fish stock. (5.3,55)	1. The salt pans create an ideal habitat for the cultivation of oysters. (5.4,58)	1. Introduction of invasive alien species may pose as a potential threat to indigenous shellfish species. (5.5,61)	1. Overfishing (recreational) and overcollection of bait species may result in profound changes in the community structure of fish and other marine organisms. (5.6,62)	1. Increased numbers of people at Langstrand may result in increased exploitation of mussels and crayfish along the rocky shoreline. (5.7,64)
Seals, fish, mussels, oysters, etc.	2. Sewage from ships results in enrichment of the water causing anoxic conditions which may be detrimental to marine animals. (5.3,53)	2. Over-fishing has contributed to the decrease of seal numbers as seals depend on fish as a food source. (5.3,55)		2. Competition for food required by the surrounding natural organisms. (5.5,61)	2. Plastics, plastic containers and fishing line left behind by visitors may result in death or disability of seals and other marine animals. (5.6,62)	2. Increased numbers of people at Langstrand may result in increased litter which can impact on marine animals. (5.7,64)
	3. Plastics, plastic containers and other wastes dumped by ships may result in death or disability of seals and other marine animals. (5.3,54)	3. Effluents from the fish factories result in enrichment of the bay water and ultimately in anoxic conditions which may be detrimental to macro marine fauna. (5.3,53)		3. Wastes produced by the mussels results in enrichment which may ultimately result in anoxic conditions. (5.5,61)	3. Overexploitation of crayfish and mussels may result in the profound change in composition of these species. (5.6,62)	3. The abstraction of sea water and the release of hypersaline water back into the sea at Paaltjies, necessary for the desalination plant may impact on the white mussel and other marine communities in the surrounding area.
SMALL MARINE ORGANISMS (benthic fauna) (Phytoplankton)	1. Oil, heavy metals and toxins cause mortalities, growth inhibition, reduced reproduction, and a decrease in diversity and density. (Sewage from ships results in enrichment-anoxic conditions. (5.3,52)	1. Effluents from the fish factories result in enrichment of the bay water and ultimately in anoxic conditions which may be detrimental to micro marine fauna. (5.3,53)	1. Destruction of natural tidal flooding areas (benthic fauna habitat) during construction. (5.4,58)	1. Competition for food required by the surrounding natural organisms. (5.5,61)	1. Walking on mudflats while birdwatching, or in general destroys burrows and layers of sediments. (5.6,63)	1. The abstraction of sea water necessary for the desalination plant and the release of hypersaline water back into the sea at Paaltjies, may impact on the marine organisms in the surrounding area. (5.7,65)
	2. Dredging destroys benthic communities. Disposal of dredge material results in the suspension and availability of toxic pollutants. (5.3,56)		2. Salt pans have created permanently flooded shallow waters where algae can grow. (5.4,58)	2. Wastes produced by the mussels results in enrichment which may ultimately effect micromarine fauna. (5.5,61)	2. Petrol and oil from ski boats is toxic to marine organisms and may result in death or disability. (5.6,63)	
NATURAL HABITATS	1. Oil spills destroy mud and sand flats by forming a layer that can not be penetrated by oxygen or sunlight. (5.3,53)	1. Effluents from the fish factories released into the bay water result in enrichment of the water ultimately leading to anoxic conditions and the deterioration of the bay water as a natural habitat. (5.3,53)	1. Initial destruction of natural bird habitat now provides permanently flooded shallow waters with extensive shorelines. (5.4,58)	1. Mussel rafts reduce the natural habitat of open water space. (5.5,61)	1. Walking on mudflats destroys burrows and layers of sediments. (5.6,63)	1. The construction of the road to Paaltjies resulted in the impoundment of intertidal flats ultimately resulting in them drying up. (5.7,64)
Walvis Bay wetland and dune systems in the study area.	2. Dredging destroys the habitat of benthic communities. Dredging operations will increase if harbour expansion proceeds. (5.3,56)		2. Resulted in an increased salinity that may have caused the total loss of vegetation from the Walvis Bay wetlands. (5.4,58)	2. Wastes produced by the mussels results in enrichment which may ultimately result in anoxic conditions. (5.5,61)	2. 4x4 vehicles damage dune vegetation which results in dune erosion. (5.6,63)	2. The development of Dolphin Beach and Langstrand resulted in the loss of dune and coastal habitat. (5.7,64)
NATURAL PROCESSES	1. The harbour structures and the implementation of a dredging programme has modified the longshore sediment transport within the bay. (5.3,56)	1. The harbour structures and the implementation of a dredging programme has modified the longshore sediment transport within the bay. (5.3,56)	1. Salt pan dykes have greatly retarded the rate of sedimentation of the lower reaches of the Walvis Bay lagoon. (5.4,59)	1. Mussel rafts may result in a change of the surface currents within the bay. (5.5,61)	1. 4x4 vehicles damage dune vegetation which results in dune erosion resulting. (5.6,63)	1. The construction of the road to the salt works has retarded the rate of sedimentation of the lower reaches of the Walvis Bay lagoon. (5.7,64)
WATER QUALITY	1. Oil pollution, heavy metals and toxins released into the bay will negatively affect the water quality. (5.3,52)	1. Effluents from the fish factories result in enrichment and anoxic conditions. (5.3,53)	1. Salt ponds result in increased salinity. (5.4,58)	1. Waste products produced by the mussels results in enrichment-anoxic conditions. (5.5,61)	1. Litter thrown into the water negatively impacts on water quality. (5.6,62)	
	2. Sewage from ships results in enrichment and anoxic conditions. (5.3,53)	2. Oil and fuel leakages from outdated fishing vessels affects water quality. (5.3,55)			2. Petrol and oil from ski-boat engines impact on water quality. (5.6,63)	
SOCIO-ECONOMIC FACTORS	1. The activities within the harbour promote job opportunities for a substantial number of people. (5.3,55)	1. The fishing industry is the largest employer, employing approximately 10 000 people. (5.3,55)	1. Employs 90 people. (5.4,59)	1. Creates employment opportunities. (5.5,61)	1. Tourism creates job opportunities. (5.6,64)	1. Dolphin Beach and Langstrand have a visual impact on the surrounding area. (5.7,64)
wealth generation, jobs, visual, noise	2. People migrate to WB to find work - results in unemployment, housing shortages, increased crime and TB and AIDS reported cases. (5.3,56)	2. Some jobs in the fishing industry are seasonal resulting in high unemployment during the off season. (5.3,55)	2. Salt pans and heaps of salt can be seen from a far distance and may distract from the visual quality of the area. (5.4,59)	2. Mussel rafts will have a visual impact. (5.5,61)	2. Tourism generates foreign currency and income for the Walvis Bay area. (5.6,64)	2. The construction of a desalination plant at Paaltjies and the power-lines (if above ground) will have a visual impact and an impact on the sense of place of the surroundings. (5.7,65)
	3. Imports and exports moving through generate money for Namibia. (5.3,55)	3. Odours from fish processing affects tourism potential. (5.3,54)			3. Litter and waste left behind by visitors is visually obtrusive. (5.6,63)	
	4. Visual impact, noise, polluted water causes health problems and affects tourism and recreation, coal dust from stock piles. (5.3,55)	4. The fishing industry contributes 3% to the Gross Domestic Product of Namibia. (5.3,55)				

TABLE 4: Scoring Matrix

	COMMERCIAL HARBOUR			FISHING HARBOUR (Fishing Industry)			SALT RECOVERY			MARICULTURE			TOURISM AND RECREATION			INFRASTRUCTURE (excluding harbour)		
BIRDS	C	-5	M	C	-3	S	C	IRREVERSIBLE	F	P	-2	?	P	-3	M	P	-4	?
	EA		Y	?	*	Y	LA		N	LA	*	Y	EA		Y	LA		?
	C	-4	?	U	-1	S	C	+3	F	P	-4	F	P	-3	M	C	-4	F
	EA		Y	LA		Y	EA		-	LA		N	EA	*	Y	LA		Y
LARGE MARINE ANIMALS	P	-4	M	C	-3	M	C	+2	M	P	-4	?	P	-4	M	P	-3	?
	EA		Y	EA		Y	LA		-	EA	*	?	LA		Y	LA		Y
Seals, fish, mussels, oysters, etc.	C	-4	M	P	-4	M				C	-3	?	P	-3	M	P	-3	M
	EA	*	Y	EA	*	Y				LA		?	LA		Y	LA		Y
	C	-4	M	P	-4	M				U	-3	M	P	-4	M			
	LA		Y	?	*	Y				LA	*	?	LA		Y			
SMALL MARINE ORGANISMS (benthic fauna) (Phytoplankton)	C	-5	M	C	-4	M	C	IRREVERSIBLE	F	C	-3	?	P	-2	M			
	EA		Y	EA	*	Y	LA		-	LA		?	LA		Y			
	C	-3	M				C	+2	M	U	-3	M	P	-2	M			
	LA		Y				LA		-	LA	*	N	LA		?			
NATURAL HABITATS	P	-4	M	C	-4	M	C	IRREVERSIBLE	F	P	-4	F	P	-2	M	C	-2	F
	EA		Y	EA	*	Y	LA		-	LA		?	LA		Y	LA		Y
Walvis Bay wetland and dune systems in the study area.	C	-3	M				P	IRREVERSIBLE	F	U	-3	M	P	-3	F	C	-3	F
	LA		N				EA		N	LA	*	?	LA		Y	LA		N
NATURAL PROCESSES	C	IRREVERSIBLE	F	C	IRREVERSIBLE	F	C	+4	F	U	-3	F	P	-3	F	C	+3	F
	EA		N	EA		N	LA		-	LA		?	LA		Y	LA		-
WATER QUALITY	C	-5	M	C	-5	M	P	-3	F	U	-3	?	P	-3	M			
	EA		Y	EA		Y	EA		N	LA		N	LA		Y			
	C	-4	M	P	-3	M							P	-2	?			
	EA	*	Y	LA		Y							?		Y			
SOCIO-ECONOMIC FACTORS	C	+4	F	C	+4	F	C	+1	M	C	+1	M	C	+3	M	C	-3	F
	?		-	?		-	?		-	LA		-	LA		-	LA		Y
wealth generation, jobs, visual, noise	C	-3	M	C	-2	S	C	-3	F	C	-3	M	C	+3	M	C	-3	F
	?		Y	?		?	LA		N	LA		N	?		-	LA		Y
	C	+3	M	C	-3	M							C	-2	S			
	?		-	LA		Y							LA		Y			
	C	-3	F	C	+3	F												
	LA		N	?		-												

8.6. EVALUATION OF THE IMPACTS OF THE NATURAL PROCESSES ON THE HUMAN ACTIVITIES WITHIN THE BAY

Many of the threats that are posed by the natural processes (see section 6) are significant (important) and need to be considered for the effective overall management of the study area. The significance or importance of these threats and potential impacts will now be discussed.

8.6.1. SEDIMENTATION PROCESSES IN AND AROUND THE LAGOON

Sedimentation of the Walvis Bay lagoon is a natural process that has been occurring for thousands of years (see section 6.2). Aeolian sediments (wind-blown) and fluvial sediments are resulting in the sedimentation of the lagoon and gradual loss of wetland area. This is a major threat to the extensive birdlife that depends on the wetland as habitat and a food source. Furthermore, sedimentation processes result in millions of Namibian dollars having to be spent every year on the maintenance of the harbour area for the use by commercial and fishing vessels (see section 4.2 and 5.3 - *Dredging*).

Although many of the management strategies as mentioned in section 6.2 have limited the influx of aeolian and fluvial sediments into the lagoon, a significant potential still exists for rapid sedimentation of the lagoon if these existing management systems become inoperative (CSIR, 1994). It is thus important that the sedimentation status of the lagoon and bay area along with the management strategies designed to limit sedimentation be monitored on a regular basis.

8.6.2 LONGSHORE TRANSPORT AND MOVEMENT OF SEDIMENTS ALONG THE OFF-SHORE SPIT

Longshore transport of sediments along the coastline of the study area, as discussed in section 6.3, is having two major effects on the sandspit (Pelican Point) within the study area. The first impact is that of the growth of Pelican Point at a rate of 17,4

metres per year (CSIR, 1994) This is having a positive effect as it decreases the wave action at the harbour even further (*ibid.*). However, the mid-section of the sandspit is being eroded and recently a low-lying area has developed where occasional wave overwash occurs (*ibid.*). If the sandspit is breached an increase in sediments transported into the bay may occur which will pose as a threat to the functioning of the harbour. It would result in further maintenance expenses in the form of increased dredging operations that would be required to maintain the entrance channels of the harbour. Monitoring of this area is at present being carried out by the CSIR (Morant, 1996, pers.com.).

8.6.3. RED TIDES AND SULPHUR ERUPTIONS

Red tides and sulphur eruptions are natural processes (see section 6.4) that can not be controlled by humans. Although these events are seldom toxic to humans they do pose significant threats to marine organisms. Furthermore, they pose as a significant threat to any form of mariculture (see section 4.5 and 5.5) that intends using the bay water as an area for cultivation.

8.6.4 ATMOSPHERIC CONDITIONS

The stable air conditions and high occurrence of fog experienced in the study area (see section 3.3.3) exasperate the odour problems initiated by the fish processing factories (see section 5.3 - *Odour Pollution*). This problem has reached levels where the Walvis Bay Municipality and newspapers have received several complaints about the odour problems. Several interested parties maintain that the odour problem is so bad that it is effecting the town's prospects of developing as a tourist destination (Baseline Report, 1996).

8.7. CONCLUSION

The impacts of the activities on the natural and social environment of the study area were summarised and presented in Table 3. The Fuggle Matrix was then used to evaluate these impacts. Impacts with scores of -4,-5,+4 and +5 were then highlighted

on the Summary Matrix so as to indicate their importance. This matrix, together with the rest of the information presented in this dissertation, can now be used to draw valid conclusions after which appropriate recommendations can be made.

SECTION 9

CONCLUSIONS, RECOMMENDATIONS AND GUIDELINES

9.1 INTRODUCTION

This section draws together all the information presented in the previous sections. A brief summary of the dissertation is firstly given before the final conclusions are made. Recommendations, for the improvement of the overall management of the study area are then suggested. Finally, more broader suggestions are made in the form of guidelines. These guidelines do not relate directly to the management of the study area, but rather to the general improvement of environmental management in Namibia as a whole.

The decision to act on the recommendations made in this report hinges entirely on the various government departments and organisations that have an interest in, and jurisdiction over, portions of the study area. Of crucial importance is that these parties form a single body that will administer environmental issues within the study area and facilitate co-ordination and communication between all parties.

9.2 SUMMARY

This dissertation is part of a process which began when DANCED initiated the first stages of a project aimed at assisting the Namibian Government in the development of an Integrated Coastal Zone Management Plan for the coastline of the Erongo Region. The first step, in terms of this dissertation, involved the collection and synthesis of baseline data on all environmental factors (natural and social) pertaining to the Erongo Region. After review of the Baseline Report, the greater Walvis Bay 'bay area' was identified as a priority area in terms of the management of the coastal zone of the Erongo Region. This report assumed the task of analysing and evaluating the impacts of the human activities, as identified in the Baseline Report, on the natural and social environment of this area.

In order to make valid conclusions it was first necessary to obtain some idea as to the importance of the study area as a conservation area. The major human activities operating within and impacting on the study area were then discussed, analysed and evaluated in some detail. Natural processes impacting on the functioning of the Walvis Bay wetland and on the human activities operating within the study area also required analysis and evaluation in order to draw conclusions that would incorporate all relevant activities and processes.

An adapted Framework Approach and Fuggle Matrix were used in the evaluation of impacts, identifying major negative impacts that require priority attention. It is from the combination of this evaluation and the analysis of the impacts that the following valid conclusions are drawn.

9.3 CONCLUSIONS

The study area has within its boundaries extremely sensitive natural environments that provide habitat for, amongst multiple other species, thousands of migrant and resident bird species. These bird species depend on the quality of the habitats which support a diversity of fish and other marine organisms that the birds feed on. These facts have been well documented in the past and it is accepted that the Walvis Bay wetland is one of the top 5 most important wetlands in Africa (Williams, 1988). The importance of the wetland has resulted in it being registered as a Ramsar site.

However, the study area also has within its boundaries a concentration of human activities that are dependent on the bay area for their day-to-day operation. Each of the activities is administered and controlled by its own authority or organisation. With the absence of a single overall authority, there is little communication and co-ordination between these various organisations and between other stakeholders that are interested in the maintenance of the environment of the study area. This lack of co-ordination between organisations and authorities together with the day-to-day operations of the activities, is threatening the quality of the surrounding natural and social environment in a variety of ways. Impacts on the quality of the natural habitats

will impact on all marine organisms and animals living in the study area. The deterioration of the natural environment will ultimately effect the day-to-day functioning of the human activities and the surrounding social environment.

The impacts of the human activities were presented using an adapted Framework Approach. Each cell of the Summary Matrix summarised the analysed information of each impact on a specific environmental factor for 6 major human activities. An adapted Fuggle Matrix was then used to evaluate each impact by considering a set of criteria and ultimately giving it a positive or negative "importance" score. From the Summary Matrix (Table 3) the following conclusions can be made:

- The **commercial harbour** is the major human activity operating within the boundaries of the study area and may be impacting on the environment in a number of ways. The majority of impacts as summarised in Table 4 result from the various forms of pollution that are being released into the bay water. These pollutants originate from: oil spills, heavy metal spills, anti-fouling paints and toxins from urban run-off, and sewage and rubbish released by ships visiting the harbour. Furthermore, impacts result from the dredging of the harbour area and the dumping of dredged material. The proposed harbour extension will further add to these impacts.

The potential impact of the pollutants released into the bay may be catastrophic as they can result in mortalities, growth inhibition, reduced reproduction, shift in species importance and a decrease in diversity and density of marine organisms and animals. If pollution of the bay water continues uncontrollably the ultimate consequence may be the total collapse of the ecosystem rendering the surrounding natural environment "dead". This in turn will impact on most of the other human activities as they are dependent on the good quality of the natural environment. Specifically, one can note tourism and recreation, salt recovery and mariculture.

Due to the catastrophic course of events which may follow as a result of continuous uncontrolled polluting of the bay it is most urgent that these forms of pollution be controlled and kept to a minimum, if not prevented entirely.

- The **fishing industry** is another human activity that is impacting on the environment of the study area in a number of ways. The most profound impact is caused by the release of fish factory effluents into the bay. These effluents result in enrichment which impacts directly on the water quality of the bay and indirectly on the macro- and micromarine fauna and flora that live in the water. This is a serious problem as an area of "dead" water on the south side of the breakwater, at the north end of the fishing harbour, has already been identified. If this serious impact is to be mitigated the effluents being released into the bay water must be drastically reduced and some type of monitoring must be undertaken. DANCED is presently assisting the fishing industry with the introduction of clean water technology that will help control the amount and quality of effluent being released into the bay.

Over-fishing by the fishing industry has resulted in the collapse of the fish stock. This has impacted on the bird and seal communities that are dependent on the fish as a source of food. More moderate impacts include those of odour pollution caused by emissions from the fish processing factories and the impact of the unhygienic and cramped living conditions of the fishing boats on the fishermen. The most positive effect of the fishing industry is that it forms the backbone of industries in Namibia. It employs more people than any other industry in Namibia and contributes up to 3 % of the GDP.

- The development of the **salt works** to the south of the Walvis Bay wetland has resulted in some irreversible impacts that have had a moderate impact on the functioning of the wetland. However, the salt evaporation ponds are having a positive influence as they are limiting the movement of aeolian sediments into the lagoon thus slowing down the sedimentation process of the lagoon. This is seen as a major positive influence as the sedimentation of the lagoon is perceived to be a

major threat to the functioning of the wetland. The evaporation ponds have also created shallow water habitats that are extensively used by the majority of resident and migrant birds.

The major threat posed by the salt works is that of possible expansion. If the salt works does decide to expand, extensive environmental impact assessments will have to be undertaken to assess the potential impacts.

- **Mariculture** at present is restricted to the salt water evaporation ponds of the salt works and is not posing any major threat to the study area. However, expansion of the mariculture industry into the open waters of the bay is planned for mid-1996. There are several potential impacts that will exist if this expansion goes ahead as planned. The most obvious will be the competition for water surface space with the commercial and fishing harbour, recreation and extensive bird communities that inhabit the wetland. The introduction of alien species into the marine environment of the bay is another major threat.

There are several other impacts of mariculture such as enrichment of the water and competition for food with endemic species that will to a certain extent be mitigated due to the extremely nutrient-rich water. These, however, may pose as a threat if the mariculture industry expands too much. The expansion of this industry must therefore be closely monitored and the carrying capacity of the bay water established.

- **Tourism** is a growing industry in Namibia and there are several negative impacts that are associated with people visiting the study area. The major impacts associated with tourism are related to recreational over-fishing and over-collection of shellfish (mussels and crayfish) and bait species that are used for fishing. However, the Sea Fisheries Act No.29 of 1992 does allow for regulations that limit the number of fish per boat and per car and the number of bait species collected per fishermen. This is unfortunately having a limited effect as there are insufficient

staff to monitor the numbers of fish and bait species being caught and collected by recreational fisherman.

There are also a number of moderate impacts associated with the tourism and recreation that must be controlled in order to mitigate the possibility of cumulative effects. The first of these relates to the dumping of litter which effects the water quality of the bay and may result in death or disability of birds and mammals. It is also visually obtrusive. The second impact relates to 4x4 vehicles driving on the dunes and along the beaches. This disrupts bird colonies and may destroy bird eggs and nests. It is important that tourist related impacts be controlled and the appropriate funds, personpower and education be allocated to this task.

- The development of **urban infrastructure** within the boundaries of the study area may be resulting in some major impacts. The first of these is the development of the Langstrand residential area and the Dolphin Beach holiday resort. As these areas increase in size so the tourist related impacts will increase posing as a major threat to the bird breeding colonies and shellfish (mussels and crayfish) along the stretch of coast between Walvis Bay and Swakopmund. Furthermore, if the construction of the desalination plant at Paaltjies goes ahead as planned and it is decided that overhead powerlines be used it could have a major impact on the bird population.

More moderate impacts include the visual impact of the Langstrand and Dolphin Beach developments and the possible visual impact if the desalination plant is constructed at Paaltjies.

There are two major areas of concern with relation to the construction of the desalination plant at Paaltjies. These are the impacts of abstraction of salt water and the release of hyper-saline water back into the sea on the marine organisms along that stretch of coast. These impacts must be assessed in detail before the construction of the desalination plant is allowed to commence.

- The seventh human activity operating within the study area that was analysed, but not included in the summary matrix, was that of **guano collection**. Guano collection has no major negative impacts on the natural and social environment of the study area. However, a positive impact is that the platform provides a safe-haven and roost site for many marine birds, taking pressure off off-shore islands and threatened land-based roosting and breeding sites.

Natural Processes

There are two major potential impacts resulting from the natural processes within the study area. The first process; the sedimentation process of the lagoon, is directly threatening the natural functioning on the Walvis Bay lagoon as a wetland. The collapse of the wetland system will have major implications for the extensive bird life that it supports and the use of the wetland for recreational purposes. Furthermore the longshore transport of sediments along the coastline of the study area is resulting in the erosion of the sandspit to the east of the bay. Recently a low-lying area has developed where occasional wave overwash occurs. If the sandspit is allowed to breach it could have serious implications for the maintenance costs of the commercial and fishing harbours. The dynamics of this area are presently being monitored by the CSIR.

Red tides and sulphur eruptions, although seldom toxic to humans, result in the death of shellfish and many other marine organisms. This is a major limitation to be considered for the proposed expansion of the mariculture industry into the open waters of the bay. Another natural process impacting on the study area is that if the stable air conditions which exacerbate the odour problems that originate from the fish processing factories.

9.4 RECOMMENDATIONS

Due to the extent of the activities analysed in this report the recommendations will be limited to broader recommendations that involve administration and co-ordination

rather than specific management action for the mitigation of each impact. However, in some instances, it may be appropriate to recommend specific management actions.

It is obvious from the conclusions that the most urgent problem to be addressed is that of the co-ordinated management of the study area. Once this has been addressed, further recommendations on more specific management actions can be made. It is thus strongly recommended that:

- A Joint Management Committee be set up to administer and co-ordinate the various authorities and organisations that have an interest in or jurisdiction over portions of the study area. This committee should be as inclusive as possible and should as a minimum have representatives from the Ministry of Environment and Tourism, Ministry of Fisheries and Marine Resources, Walvis Bay Municipality, Namport, Pelagic Fishing Association and The Namibian Hake Fishing Association, Round Table of Walvis Bay, Salt & Chemical Co. Pty. Ltd., members representing Tourism and Recreation and at least one member representing other NGO's that may have an interest in the management of the study area. It may also be important to include several other Ministerial Departments such as: Ministry of Water Affairs and Ministry of Transport.
- The Joint Committee have formal (national) recognition and direct communication with Ministries at national level. This should ensure that management plans and recommendations initiated by the Committee be enforceable and contribute towards national planning strategies.

More specific management actions that should be initiated and co-ordinated by the Joint Committee are recommended as follows:

- Initiate and co-ordinate a pollution monitoring programme that will monitor all forms of pollution in the bay including: oil spills, heavy metal concentrations, effluents from the fish processing factories, litter and any other sources of toxins that may be entering the bay. Adopt an appropriate set of pollution level standards.

- Set up policy on mariculture in the open water of the bay, including: spatial requirements, species of shellfish to be farmed, total carrying capacity of the bay area and requirements of impact assessments before farming commences.
- Promote the Walvis Bay wetland as a Ramsar site with emphasis on the extreme sensitivity of the area. The ultimate aim should be to proclaim the Walvis Bay Lagoon as a marine park.
- Monitor proposed and existing infrastructural developments within the study area (especially the proposed construction of the desalination plant at Paaltjies).
- Reconsider the quotas for recreational fishermen (The Sea Fisheries Act No. 29 of 1992). There is an increasing number of fishermen and a limited number of personnel to monitor quotas. These two aspects render the quota system for recreational fishermen ineffectual. Consider declaring portions of the coastline as marine reserves where no fishing may take place and thus where fish stocks can rejuvenate.
- Maintain and improve the present management actions to limit the influx of sediments into the lagoon.

9.5 GUIDELINES

The guidelines differ from the recommendations in that they do not specifically refer to the management of study area but rather to environmental management in Namibia as a whole.

- Legal enforcement of Environmental Impact Assessment, according to the Integrated Environmental Management Guidelines, for all development proposals.
- Improve and consolidate all environmental legislation.
- Legal requirement for conservation authorities to comment on development proposals.
- Increase budget for environmental departments of all relevant Ministries so that the appropriate personpower can be employed to effectively manage Namibia's environment.
- Control urban expansion and population growth.

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