

Strategic Action Plan

for

**Land-Based Sources and
Activities Affecting the Marine,
Coastal and Associated
Fresh Water Environment in the
Eastern African Region**



Sida



Report prepared by

Food and Agriculture Organisation of the United Nations Project for
the Protection and Management of the Marine and Coastal Areas of
the Eastern African Region (EAF/5)

Strategic Action Plan
for
Land-Based Sources and Activities
Affecting the Marine, Coastal and
Associated Fresh Water Environment
in the Eastern African Region



Food and Agriculture Organization of the United Nations (FAO)
Institute of Marine Sciences (IMS) of the University of Dar es Salaam
Swedish International Development Cooperation Agency (Sida)

First Printed 1999

FAO EAF/5 Project Office
Division of Environmental Conventions
P.O. Box 30552
Nairobi, Kenya

This publication is available on-line at:
<http://www.unep.org/water/regseas/eaf/eaf5/home.htm>

This report was prepared with the support of:

- UNEP (EAF/5 project, EAF/14 project, former Water Branch staff –T. Melvasalo, H. Drammeh, O. Vidal, and P. Akiwumi with the assistance of M. Atukoit and P. Nganga);
- Institute of Marine Sciences in Zanzibar (J. Francis, Mmochi and C. Mhando)
- T. Orekoya, private consultant (Ghana)

This technical report was prepared during the course of project identification. The conclusions and recommendations given in the report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

The designations employed and the presentation of the material and maps in this document do not imply the expression of any opinion whatsoever on the part of the United Nations concerning the legal status of any country, territory, city or areas of its authorities, or concerning the delimitations of its frontiers or boundaries.

TABLE OF CONTENTS

ACRONYMS.....	VII
PREFACE	VIII
EXECUTIVE SUMMARY	IX
1. BACKGROUND.....	1
1.1 COUNTRIES OF THE EASTERN AFRICAN REGION: ECONOMIC REALITY	1
1.1.1 <i>Institution Capacities and Population Growth</i>	1
2. WESTERN INDIAN OCEAN ISLANDS AND EASTERN AFRICA.....	3
2.1 CLIMATE AND NATURAL PROCESSES	3
2.2 ECOSYSTEMS	3
3. COMORES.....	4
3.1 INTRODUCTION.....	4
3.2 SOURCE DE DEGRADATION ET DE POLLUTION.....	4
3.3 CONSEQUENCES PERCEPTIBLES	4
3.4 HIERARCHISATION DES PRIORITES.....	4
3.5 <i>RECOMMANDATIONS ET CONCLUSIONS</i>	5
4. KENYA.....	6
4.1 IDENTIFICATION AND ASSESSMENT OF PROBLEMS.....	6
4.1.1 <i>Industrial waste</i>	6
4.1.2 <i>Sewage</i>	7
4.1.3 <i>Solid Waste</i>	7
4.1.4 <i>Waste from Shipping Activities</i>	7
4.1.5 <i>Waste from Beach Hotels</i>	8
4.1.6 <i>Agricultural Waste</i>	8
4.1.7 <i>Livestock Waste</i>	9
4.1.8 <i>Storm-Water Runoff</i>	9
4.1.9 <i>Siltation</i>	9
4.1.10 <i>Coastal and Upstream Non-Point Sources of Pollution</i>	10
4.1.12 <i>Atmospheric Deposition</i>	10
4.1.13 <i>Heavy Metals and Nutrients</i>	10
4.1.14 <i>Sewage</i>	10
4.1.15 <i>Oil discharges</i>	11
4.1.16 <i>Litter</i>	11
4.2 EMERGING AND FORESEEABLE PROBLEMS.....	11
4.3 STRATEGIES AND MEASURES	11
4.4 PRIORITIES FOR ACTION	12
4.5 RECOMMENDATIONS AND CONCLUSION	13
5. MADAGASCAR.....	14
5.1 IMPORTANCE ET SOURCES DE LA POLLUTION.....	14
5.2 PRINCIPALES SOURCES DE DEGRADATION.....	14
5.3 CONSEQUENCES PERCEPTIBLES D 'ALTERATION DE L'ENVIRONNEMENT	14
5.4 STRATEGIES ET MESURES	15

5.5	ACTIONS PRIORITAIRES	15
5.6	RECOMMANDATIONS ET CONCLUSIONS	15
6.	MAURITIUS.....	16
6.1	IDENTIFICATION AND ASSESSMENT OF PROBLEMS.....	16
6.1.1	<i>Agriculture</i>	17
6.1.2	<i>Sugar industry</i>	17
6.1.3	<i>Textile industry</i>	18
6.1.4	<i>Sewage</i>	18
6.1.5	<i>Other industrial waste</i>	19
6.2	REGIONAL ASSESSMENT OF POLLUTION FROM SEWAGE	19
6.2.1	<i>Northern Mauritius</i>	19
6.2.2	<i>Southern Mauritius</i>	20
6.2.3	<i>Eastern Mauritius</i>	20
6.2.4	<i>Western Mauritius</i>	20
6.2.5	<i>Existing On-site Sanitation Systems in the Rural Areas</i>	21
6.3	RECOMMENDATIONS.....	21
6.3.1	<i>Sugar industry</i>	22
6.3.2	<i>Other Waste</i>	22
6.3.3	<i>Effluent and sludge management</i>	22
6.3.4	<i>Sewage Treatment</i>	22
6.3.5	<i>Solid Waste</i>	22
6.3.6	<i>Sand Mining</i>	23
6.4	CONCLUSION.....	23
7.	MOZAMBIQUE.....	24
7.1	PHYSICAL, GEOGRAPHICAL AND SOCIO-ECONOMIC SETTINGS	24
7.2	COASTAL ECOSYSTEMS AND SPECIES BIODIVERSITY	25
7.2.1	<i>Coral Reefs</i>	25
7.2.2	<i>Mangroves</i>	25
7.2.3	<i>Seagrass Beds</i>	25
7.2.4	<i>Marine Mammals</i>	25
7.2.5	<i>Sea Turtles</i>	26
7.2.6	<i>Marine Invertebrates</i>	26
7.3	IDENTIFICATION AND ASSESSMENT OF POLLUTION	26
7.3.1	<i>Agriculture</i>	26
7.3.2	<i>Industrial Activities</i>	27
7.3.3	<i>Sewage and Domestic Solid Waste</i>	27
7.3.4	<i>Tourism</i>	28
7.4	EMERGING AND FORESEEABLE PROBLEMS	28
7.4.1	<i>Industrial Expansion</i>	28
7.4.2	<i>Population Growth</i>	28
7.4.3	<i>Reduced River Flow</i>	28
7.4.4	<i>Mariculture</i>	28
7.4.5	<i>Social Conflicts</i>	29
7.4.6	<i>Natural Gas Drilling</i>	29
7.5	PRIORITIES FOR ACTION	29
7.5.1	<i>Law Enforcement</i>	29
7.5.2	<i>Promotion of Applied Research and Human Resources Development</i>	29
7.5.3	<i>Industrial Effluents/Domestic Sewage</i>	29
7.5.4	<i>Prevention of Soil Erosion</i>	29
7.6	CONCLUSION.....	30

8.	SEYCHELLES	31
8.1	NATURE AND EXTENT OF ENVIRONMENTAL POLLUTION IN THE SEYCHELLES	31
8.1.1	<i>Water</i>	31
8.1.3	<i>Sludge</i>	32
8.1.4	<i>Agricultural waste</i>	32
8.1.5	<i>Municipal Waste</i>	32
8.2	ASSESSMENT OF PROBLEMS	32
8.2.1	<i>Existing Institutional Arrangements</i>	33
8.3	PRIORITY OF ACTIONS TO MITIGATE LAND-BASED SOURCES OF COASTAL AND MARINE POLLUTION	33
8.3.1	<i>Wastewater Discharges</i>	34
8.3.2	<i>Solid Waste Disposal</i>	34
8.3.3	<i>Hazardous Sludge</i>	34
8.3.4	<i>Siltation</i>	34
8.3.5	<i>Environmental Education</i>	34
8.3.6	<i>Economic Incentives</i>	34
8.3.7	<i>Legislation</i>	34
9.	TANZANIA	35
9.1	TANZANIA (MAINLAND)	35
9.1.1	PHYSICAL, GEOGRAPHICAL AND SOCIO-ECONOMIC SETTINGS.....	35
9.1.1.1	<i>The Coastal ecosystem</i>	35
9.1.2	IDENTIFICATION AND ASSESSMENT OF PROBLEMS: SOURCES OF DEGRADATION.....	35
9.1.2.1	<i>Industries</i>	35
9.1.2.2	<i>Waste water</i>	36
9.1.2.3	<i>Sewage</i>	36
9.1.2.4	<i>Domestic waste</i>	37
9.1.2.5	<i>Sand mining</i>	37
9.1.2.6	<i>Agriculture</i>	37
9.1.2.7	<i>Atmospheric deposition</i>	37
9.1.2.8	<i>Hazardous waste</i>	38
9.1.3	EMERGING AND FORESEEABLE PROBLEMS	38
9.1.4	STRATEGIES AND MEASURES	39
9.1.5	PRIORITIES FOR ACTION	40
9.1.6	CONCLUSION	40
9.2	ZANZIBAR	40
9.2.1	ASSESSMENT OF PROBLEMS.....	41
9.2.1.1	<i>Agriculture</i>	41
9.2.1.3	<i>Industrial Activities</i>	42
9.2.1.4	<i>Tourism Development</i>	42
9.2.1.5	<i>Marine Transport</i>	43
9.2.1.6	<i>Vehicle Repair Workshops</i>	43
9.2.1.7	<i>Municipal Waste</i>	43
9.2.2	RECOMMENDATIONS AND CONCLUSION	44
10.	ASSESSMENT OF PROBLEMS IN THE REGION	45
10.1	ASSESSMENT OF PROBLEMS ASSOCIATED WITH AGRICULTURE, INDUSTRIAL ACTIVITY, HARBOURS, PORTS AND MINERAL QUARRYING	45
10.2	ASSESSMENT OF PROBLEMS ASSOCIATED WITH COASTAL URBANIZATION.....	45
10.3	ASSESSMENT OF PROBLEMS ASSOCIATED WITH SOLID WASTE.....	46
10.4	PERCEIVED MAJOR PROBLEM: REGIONAL CONTEXT AND PROPOSED ACTIONS.....	46

10.5	CROSS-CUTTING ISSUES	46
11.	PRIORITIES FOR ACTION	49
11.1	IMPLEMENTATION	50
11.2	THE PROPOSED THEMATIC STRATEGIES INCLUDE:.....	51
11.2.1	<i>Theme I: Addressing the Priority Sources and Activities of the Land-Based Sources of Pollution</i>	<i>51</i>
11.2.2	<i>Theme II: Integrated Management of Major and International Freshwater Basins and Groundwater</i>	<i>52</i>
11.2.3	<i>Theme III: Development of Appropriate Supporting Legal and Institutional Frameworks.....</i>	<i>53</i>
11.2.4	<i>Theme IV: Support to Human Resources Development, Technical and Infrastructural Capacity Building.....</i>	<i>54</i>
11.2.5	<i>Theme V: Improvement of the Monitoring and Assessment of Key Aquatic Environmental Indicators.....</i>	<i>54</i>
11.2.6	<i>Theme VI: Enhancement of Environmental Education, Public Awareness and Participation and Information Dissemination.....</i>	<i>55</i>
11.2.7	<i>Theme VII: Support and Development of Integrated Coastal Policy Guidelines for Sustainable Coastal Development in Eastern African Countries.....</i>	<i>56</i>
12.	THE ROLE FOR THE REGIONAL COORDINATING UNIT (RCU).....	58
	REFERENCES.....	59
	ANNEX I - SUMMARY OF PROPOSED PROGRAMME OF ACTION CARING FOR THE SEAS: THE CONTRIBUTION OF UNEP AND ITS PARTNERS.....	61

LIST OF TABLES

Table 1.1	Population Growth Rates in Selected Countries of the Eastern African Region.....	2
Table 8.1	Overview of Liquid and Solid Waste Loads in Seychelles during 1995.....	33
Table 10.1	Perceived Regional Environmental and Cross-Cutting Problems: Their Causes and Effects.....	47
Table 11.1	Summary of Proposed Actions to Reduce Coastal Zone Pollution in Eastern Africa.....	50

ACRONYMS

BOD	Biochemical Oxygen Demand
CIDA	Canadian International Development Agency
COI	Commission de l'Océan Indien (Indian Ocean Commission)
DFID	Department for International Development (formerly ODA), UK
EU	European Union
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GPA	Global Programme of Action
IAEA	International Atomic Energy Agency
IFCS	Intergovernmental Forum on Chemical Safety
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
IPSMC	International Programme for the Safe Management of Chemicals
LBA	Land-Based Activities
LOCS	Land Ocean Contamination Study
NGO	Non Governmental Organization
NORAD	Norwegian International Development Agency
Sida	Swedish International Development Authority
SIDS	Small Islands Developing States
UNCHS	United Nations Centre for Human Settlement
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNIDO	United Nations Industrial Development Organization
WB	World Bank
WHO	World Health Organization
WWF	World Wide Fund for Nature

PREFACE

The Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-Based Activities and the Project on Protection and Management of the Marine and Coastal Areas in the Eastern African Region (EAF/5) have joined together in an initiative that seeks to prevent further degradation of the marine environment resulting from land-based activities in the Western Indian Ocean Region.

To facilitate the implementation of this initiative, UNEP, as Secretariat of the Global Programme of Action, organized in co-operation with relevant regional organizations, a series of technical workshops. The regional workshops were a means of strengthening national capabilities for protection of the aquatic environment from land-based activities, and to promote regional and sub-regional co-operation in:

- identification and assessment of problems;
- establishment of priorities;
- setting of management objectives of priority problems;
- identification, evaluation and selection of strategies and measures, including management approaches;
- formulation of criteria for evaluating the effectiveness of strategies and programmes; and
- programme support elements.

The EAF/5 project is a project initiated by the Eastern African governments together with UNEP. The main partners of the project include: the Swedish International Development Authority, Sida, National Governments, UNEP and FAO. The two UN agencies are implementing the EAF/5 project. The project is part of the on-going broader concept within the Regional Seas - Eastern African Action Plan framework aimed at enhancing the quality of the marine and coastal environments in partnership with coastal communities and their Governments in the Eastern African Region. The project's main objective is to develop in collaborative effort among the Food and Agriculture Organization (FAO), other United Nations agencies and multilateral/bilateral donors, national self-reliance in matters related to integrated development and management of the environment of the coastal areas.

The major activities implemented by EAF/5 include among others:

- development and implementation of national public awareness material and campaigns;
- development of Integrated Coastal Area Management strategies for selected pilot areas;
- implementation of demonstration projects (such as fish landing sites, dune restoration, public beach facility improvement) on selected sites; and
- development of a regional overview and strategic action programme on land-based activities affecting marine and coastal areas.

In light of the complementarity of the priority activities of these two UNEP projects the EAF/5 project and Global Programme of Action on Land-based Activities affecting the coastal and marine environment are concerned, it was natural for the two projects to work together.

EXECUTIVE SUMMARY

The coastline of the Western Indian Ocean Islands and Eastern African region is an area rich in natural marine resources and breathtaking scenic beauty, comprising pristine beaches of coral, estuaries, mangrove forest, productive lagoons and several beautiful islands rich in biodiversity. The coastal environment is however being seriously threatened by pollution, habitat destruction and the pressures of growing populations, tourism and urbanization.

The destruction of coastal habitats by an expanding coastal population leads to the degradation of interdependent habitats and reduced productivity (e.g. fish catch). For example, a reduction in mangrove cover reduces fish spawning, leading to reduced catches, which has both social and economic implications, particularly for artisanal fisheries, the income from which represents a significant proportion of Gross National Products (GNP). Besides perpetuating productivity (e.g. in fisheries) a pristine environment and unpolluted water along beaches is crucial in maintaining continued success of beach related tourism and its associated industries.

The mechanism to manage coastal resources is lacking and when in place, management programmes are often sectoral and are implemented within weak institutional frameworks that poorly co-ordinate cross-sector activities. The management of solid waste and industrial effluents from land-based activities in coastal zones and hinterland areas has in turn become one of the most complex management challenges.

Also related to economic development is the quality of institutional infrastructure and treatment facilities for the large quantities of domestic sewage generated by expanding urban populations which, if poorly managed, represents the greatest threat to public health in each state of the region. Besides urban sewage and solid waste, coastal waters receive high nutrient levels from agriculture and industrial run-off/effluents. The capacity to quantify threat from agricultural and industrial pollution either limited or lacking altogether.

This Regional Programme of Action present information that will assist in formulating precautionary Action Strategies for protecting the marine environment and achieving sustainable management of coastal and marine habitats. The Programme will also indicate areas where only few scientific studies have been conducted. The strategies and measures suggested seek to address the priority issues identified, including the improvement of sewage infrastructures. Interpretations made in this Regional Programme Action are generic. More targeted country-based strategies and scientific research that quantify and link the causes and effects are contained in the supportive document: Overview of Land-based Sources and Activities Affecting the Marine, Coastal and Associated Freshwater Environment in the Eastern African Region.

1. BACKGROUND

The Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-Based Activities and the Project on Protection and Management of the Marine and Coastal Areas in the Eastern African Region (EAF/5) together provided support to the Institute of Marine Sciences (IMS) of the University of Dar Es Salaam to undertake a number of activities. This collaborative work was funded from (Sida), FAO, UNEP and the Government of the United Republic of Tanzania.

The Institute of Marine Sciences provided support to national experts in updating inventories of the land-based activities affecting the marine, coastal and associated freshwater environment; National experts were used to prepare a regional overview of land-based activities affecting the marine, coastal and associated freshwater environment for the Eastern African nations, namely Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles and Tanzania.

The Overview that emerged from this initiative formed the basis for a draft Regional Strategic Action Programme (SAP) for the protection of the marine, coastal and associated freshwater environment from land-based activities, with a focus on the most appropriate options for intervention and solution to identified issues.

The Regional Strategic Programme of Action was presented to the EAF/5 Project and was discussed in the Regional Workshop on Implementation of the GPA for the Protection of the Marine Environment from Land-based Activities in the East African Region (Zanzibar, 6–9 October 1997). The meeting recognized the commonality of problems faced in each country, and proposed an initial series of actions for consideration by governments in the region.

More specifically, the SAP seeks to:

- identify existing and projected uses of coastal areas with a focus upon their interactions and interdependencies; and
- focus on well-defined issues within defined areas.

The SAP presents a regional assessment of problems associated with land-based activities and sources. The Programme recommends actions to address current and emerging issues. It also identifies potential institutions at the national, regional and international levels having appropriate technical and financial capacity to undertake some of the proposed actions.

1.1 COUNTRIES OF THE EASTERN AFRICAN REGION: ECONOMIC REALITY

The ability to manage environmental degradation caused by human-induced alterations of natural conditions (e.g. pollution from domestic sources, solid waste and pesticides) has been greatly reduced by the rapidly expanding coastal populations of the main urban centres. The expanding population exerts increasing pressure on coastal habitats and resources. Economic activities such as agriculture and its related industries, tourism and rock/mineral extraction, disturb and degrade natural conditions and processes. The degradation of coastal resources and habitats results in serious social and economic implications.

1.1.1 Institution Capacities and Population Growth

The annual per capita (GNP) of the eastern African countries considered in this overview indicates large differences in economic development, from US\$ 700 on one end of the scale to US\$ 6,000 on the other. Besides Mauritius and Re-union, the majority of the countries, (Kenya, Tanzania, Mozambique, Madagascar and the Comoros) are classified as 'poor' according to World Bank criteria (annual per capita GNP of less than US\$ 580).

The governance structures have shown great variances exemplified by the lack of central authority in, for example, the struggling federation government in Comoros. The eastern African countries are further characterized by a number of common phenomena; these include sporadic surges in economic growth and rapidly expanding populations. Economic growth is spontaneous and in most cases unplanned.

Ability to identify and develop appropriate management strategies to deal with economic growth, urban development, industrial effluent, domestic sewage and garbage in coastal urban centres is therefore limited by the inadequate political will, weak institutions and scarce economic resources.

Table 1.1 Population Growth Rates in selected countries of the eastern African region.

Country	Total Population (Millions)	Population growth rate (%)	Area (km ²)	Length of coastline (km)
Comoros	^a 0.54	2.70	1,660	350
Kenya	26.80	^b 3.30	588,045	500
Madagascar	^c 12.10	3.00	592,797	5,100
Mauritius	1.10	1.20	2,040	320
Mozambique	^d 18.53	^d 2.80	800,000	2,770
Seychelles	0.07	^e 1.50	445	600
Tanzania	28.90	^f 2.80	942,654	
TOTAL	85.60			

Sources: a. Abdoulhalik (1997), b. Government of Kenya (1989) c. Ranaivoson (1997), d. National Institute for Statistics (1996), e. Government Management and Information System (1996) f. Bureau of Statistics, Ministry of Finance, Economic Affairs and Planning (1991).

2. WESTERN INDIAN OCEAN ISLANDS AND EASTERN AFRICA

2.1 CLIMATE AND NATURAL PROCESSES

The climate of the region is generally tropical humid to sub-humid. The two monsoon seasons (South-west and North-east monsoons) are the dominant influence on wind direction and strength, temperature and rainfall. The South Equatorial Current and the East African Coastal Current are strongest during the South-west monsoon (April to September). The East Madagascar and the Mozambique current systems are strongest during the North-east Monsoon (November to February). The Somali Current shows reversals in direction reflecting the alternating monsoons. Along the mainland coasts, the average Spring tidal range varies from 2 to 6m, with Beira (Mozambique) having one of the largest ranges and the greatest flushing of coastal waters and inlets.

2.2 ECOSYSTEMS

The coastal ecosystems of the region are generally both rich in natural resources and highly productive. Important habitats include mangrove forests, coral reefs and seagrass beds. These ecosystems sustain a great diversity of marine life and are an important food source for most coastal communities. There is great interconnectivity between the ecosystems. The integrity of each ecosystem is dependent on the health and influence of adjacent ecosystems. For example, there is nutrient, sediment and organic matter interchange between the coral reefs and mangrove ecosystems.

Coral reefs and mangroves are the most biologically diverse ecosystems and greatly at risk. Coral reefs grows in clear water and reefs growth is extremely sensitive to pollution, whether due to chemical contaminants or suspended sediments. The rapid expansion of coastal populations and consequentially increased loads of domestic sewage, agricultural run off and industrial effluent to the marine environment represents a significant threat to the coral reef habitat and human health.

3. COMORES

3.1 INTRODUCTION

Au Comores, l'environnement marin et côtier revêt une importance particulière dans la mesure où ses écosystèmes jouent un rôle important dans l'économie locale et servent de réserve alimentaire pour les populations. La pression anthropique constitue une menace pour la grande biodiversité des différents écosystèmes terrestres et côtiers. Ceux-ci abritent des espèces rares dont certaines sont en voie de disparition: coelacanthé (*Latimeria chalumnae*), tortue verte (*Chelonia mydas*), dugongs et certains invertébrés intéressants (corail noir, huîtres perlières).

3.2 SOURCE DE DEGRADATION ET DE POLLUTION

La fragilité naturelle du milieu défavorise les îles qui restent menacées par des facteurs naturels, érosion, éruption volcanique, et par des actions anthropiques: extraction du sable et des galets, exploitation des coraux, surpêche et diverses pollutions. On observe une pression sur la forêt des bassins versants et sur la flore endémique (pollution tellurique causée par l'érosion) suite au défrichement forestier (bois d'oeuvre et d'énergie) sur des reliefs accidentés. La pollution des eaux côtières et marines est causée par la décharge de déchets liquides (eaux usées, détergents, hydrocarbures, acides), et de déchets solides (métal, plastique, verre, papiers, déchets organiques, déchets hospitaliers etc.). Tous ces déchets sont déversés sans traitement préalable dans le milieu aquatique et sur les sols, ce qui mène à la contamination de la nappe phréatique qui peut avoir des effets néfastes sur la pêche et l'industrie touristique. Plus de 90% des déchets solides sont de source domestique puisque la quantité des déchets générés par les industries est négligeable.

Quoique le gouvernement ait adopté un plan d'action environnemental et mis en place une loi cadre relative à l'environnement, cette législation reste inopérante.

3.3 CONSEQUENCES PERCEPTIBLES

- Augmentation du niveau de la mer dans certaines régions des îles.
- Erosion du littoral et régression des plages par déplacement de sable de mer et prélèvement anarchique de matériaux naturels.
- Accumulation de dépôts sauvages d'ordures sur le littoral et rejets directs en mer de déchets liquides et solides.
- Nappes d'huiles régulièrement constatées et parfois ramenées sur les plages par les courants côtiers.
- Dégradation des récifs coralliens par prélèvement abusif dont l'extraction de corail par dynamitage.
- Espèces marines menacées et appauvrissement de la biodiversité marine associée.
- Diminution de la population de tortues marines protégées au niveau international: massacre des reproducteurs et destruction des sites de ponte par pêche et braconnage.
- Diminution de la population de coelacanthés, poisson "fossile vivant" par manque des espèces pélagiques.

3.4 HIERARCHISATION DES PRIORITES

Parmi l'ensemble des solutions préconisées, un certain nombre d'actions sont prioritaires:

- Des actions concrètes et ponctuelles contribuant à améliorer la gestion des ressources de la zone côtière (des possibilités d'inversion de dynamiques de dégradation de l'environnement sans coûts supplémentaires pour contribuer à résoudre des problèmes écologiques et de gestion de la zone côtière). La régression des plages et l'érosion côtière ainsi que le prélèvement du sable corallien doivent être perçus comme un des problèmes les plus urgents.
- Des formations prioritaires pour le renforcement des capacités nationales sur le plan technique et en matière de planification et de gestion de la zone côtière.
- Consolidation des capacités techniques aux différents niveaux (administration et communautés locales) pour un meilleur suivi de l'évolution du milieu.
- Améliorer le niveau de compréhension global de l'état des milieux littoraux et marins.
- Définition d'indicateurs pertinents pour le suivi continu de l'évolution de la zone côtière et la recherche de solutions concrètes pour la résolution des problèmes identifiés sur le terrain.

3.5 *RECOMMANDATIONS ET CONCLUSIONS*

Aux Comores, la richesse biologique du littoral et de l'océan est incontestable. Ce milieu, fragile et soumis à des conditions extrêmes, et qui abrite un nombre considérable d'espèces animales et végétales souvent endémiques et menacées, connaît des fortes pressions en zone côtière; et c'est aussi sur cette même zone que les enjeux écologiques sont les plus importants. Il est donc urgent de procéder à:

- l'inventaire et études approfondies des écosystèmes marines et côtiers.
- l'évaluation des impacts des activités telluriques ayant des répercussions sur l'environnement marin et côtier et élaboration d'une stratégie qui permette d'atténuer ces impacts.
- la surveillance de la pollution et un suivi des habitats critiques.
- la promotion des activités et des métiers de substitution susceptible de diminuer la pression sur littoral
- l'élaboration des plans d'aménagement et de gestion de la zone côtière
- l'implication des populations locales dans l'élaboration et l'application de ces plans
- l'intégration des considérations environnementales dans toutes les actions locales, nationales, régionales et internationales de développement.
- la formation et le recyclage des compétences nationales dans le domaine des sciences de la mer

4. KENYA

Kenya has a continental type of coastline that stretches 500 km along the Indian Ocean. The natural resources of Kenya's coast include coral reefs, beaches, mangroves, coastal and Kaya forests.

Coral reefs support a rich diversity of species and protect the coastline from wave action. The mangrove habitat which covers an estimated 530 km² forms important nursery grounds for a variety of fishes and crustacea, and roosting grounds for various species of sea birds. In addition to providing stability against erosion, mangroves act as nutrient traps and help reduce pollution of marine waters. Biodiversity in estuarine and brackish water in intertidal mangrove forests is high. Between the fringing reefs and the shoreline are biologically productive lagoons which are critical to fishing activities.

Kenya's sandy beaches and seagrasses are ideal habitats for numerous marine creatures, providing nesting ground for various species of turtles, fishes and molluscs. The lowland and Kaya forests support a highly diverse flora and fauna.

Kenya's coastal strip is generally hot and wet. Landwards lie the Nyika plains—large areas of semi-arid and arid land. Two major rivers, the Tana and Athi rivers, flowing from a rich agricultural hinterland, drain into the coastal water.

Coupled with the pleasant climate, these diverse and productive habitats have attracted a large population to the region. Between 1979 and 1989, the combined population of the country's administrative districts that border the Indian Ocean rose from 1,112,436 to 1,621,918, representing a 46% increase. Today, these districts support 2 million people, equivalent to about 8% of the national population. Population pressure is particularly great in urban centres e.g. Mombasa, where the population has doubled in the last 15 years. Mombasa town, with a population density of 2,348 persons/km², is one of the most densely inhabited towns in Kenya.

Because most urban centres along Kenya's coast area are located in the vicinity of estuaries, mangrove swamps and coral lagoons, the rapid growth in population places significant pressure on the coastal ecosystem.

The major economic activities in the region are tourism, agriculture, fishing and trade. Industrial establishments, mainly the agriculture, food processing and textile industries, are concentrated in Mombasa.

4.1 IDENTIFICATION AND ASSESSMENT OF PROBLEMS

The land-based sources of pollution in coastal Kenya that were assessed include: industrial waste, sewage, solid waste, waste from shipping activities, waste from beach hotels, agricultural run-off, livestock waste, stormwater run-off and siltation. Pertinent information was obtained from local government offices in the region, relevant provincial and district government offices, the Ministry of Industry and other authorities. Information was also obtained from the management of selected industrial establishments.

4.1.1 Industrial waste

Most of the polluting industries occur in Mombasa's industrial area. Other industrial establishments that contribute to generation of industrial waste are found in Kilifi and Lamu districts.

Very few industries along the coast treat their effluents and such effluents, some containing toxic chemicals, are allowed to discharge into municipal sewers and storm water drains to end up in the marine environment. Some industrial establishments discharge their effluents into vertical drains, which pollutes the groundwater table. During floods and high tide, the drains sometimes overflow and seep into the marine environment.

The petroleum refinery at Chagamwe produces considerable quantities of hazardous sludge contaminated with oil marcaptans, tetraethyl lead and rust. These are disposed of on agricultural land within the refinery.

Cashewnut processing factories produces about 15,330 tonnes/year of solid waste composed of mainly kernels,

which are disposed by burning within the factory site.

The sisal processing factories produce approximately 8,400 tonnes per year of solid waste, which is composted and used to fertilise the sisal farms. It also discharges considerable quantities of liquid wastes directly into the sea, thereby exerting a significant biological oxygen demand (BOD).

In Mombasa, the official dumpsite for solid waste from industries is at the Kibarani landfill at the Makupa creek; there is also illegal dumping at Miritini. Solid industrial waste is of unknown composition and quantity, but likely includes hazardous waste.

Pollution from solid industrial waste and effluents is on the increase. The degradation of marine habitats results in poor fish yields, impacting socio-economically on the local fishing communities. Marine pollution also threatens public health, as it contaminates seafood and recreational areas. Poor aesthetics and odours are also increasingly interfering with other traditional uses of the sea.

Due to the proximity of the industrial area to the natural drainage systems of the Mombasa island and the west mainland, most of the pollution load from industrial effluents ends up in the Kilindini and Port Reitz creeks.

4.1.2 Sewage

Increasing pollution from domestic sewage and solid waste is the most severe pollution challenge in coastal Kenya.

About 60% of the population in Mombasa uses pit latrines, while the rest uses septic tanks and soak pits for sewage and waste water disposal. The Mombasa municipality has separate systems for domestic sewage and storm water drainage. The domestic sewerage system serves about 15% of the population. Sludge from septic tanks and pit latrines is mainly dumped at the Kibarani landfill site and other mangrove areas.

In other coastal urban centres, the use of pit latrines predominates, with only about 20% of the urban areas being served by septic tanks and soak pits. As most people rely on pit latrines and septic tank soakage pit systems for waste disposal, the pollution occurs underground, where it contaminates ground-water sources. Thus water-borne diseases, including cholera, dysentery, schistosomiasis, infectious hepatitis, typhoid and malaria have become important in coastal towns, resulting in significant loss of human productivity.

4.1.3 Solid Waste

The problem of inadequate/inefficient domestic and municipal solid waste disposal in Mombasa and the surrounding urban centres is on the increase. For example, in 1992, 61% of refuse generated in Mombasa was collected. Four years later in 1996, only 53% of the refuse was collected by the municipal machinery.

The Mombasa municipality is the largest producer of solid waste. The waste is dumped at the Kibarani landfill. It is estimated that 54,750 tonnes of refuse are dumped here annually.

There are at present no services for collecting and disposing solid waste in coastal Kenya's urban population centres. Beach hotels and other commercial establishments make private arrangements for solid waste disposal.

Solid wastes, often including particulate and other non-biodegradable matter that threatens marine life, are carried by storm-water into marine waters. Improperly disposed of solid waste also litters the coastal environment and degrades its aesthetic value.

4.1.4 Waste from Shipping Activities

Shipping activities contribute significant pollution loads to the marine environment. The Kilindini harbour is an important port in East Africa, with a hinterland encompassing Uganda, Burundi and Rwanda. According to the Kenya Port Authority (KPA), a total of 1,465 ships arrived at the port of Mombasa in 1992, with a gross average of 4.0 days at port per ship. That year, 15,779 and 12,028 passengers respectively, disembarked and embarked at Mombasa port. The KPA has no facilities for the disposal of wastes from ships; however, the Authority does

provide passenger ships with bins for solid waste disposal and make arrangements for the disposal of liquid wastes whenever required. Oil residue from ship tanks is usually sold to soap manufacturers and other industries which use it to fuel boilers.

An attempt was made to get an indication of the amount of waste generated from ships. The main contributors of waste were assumed to be ship crew based on the number of days spent at port. It was estimated that respectively, 13.5, 11.0, 1.8 and 0.2 tonnes per year BOD, suspended solids (SS), nitrogen (N) and phosphorus (P) were produced from ship wastes at the Mombasa harbour in 1992.

4.1.5 Waste from Beach Hotels

Tourism, currently the top foreign exchange earner for the country, has stimulated activities in other sectors of the Kenyan economy, such as agriculture and manufacturing. Coastal tourism accounts for 60–70% of the national tourism industry. Indeed, some of the large coastal urban centres, e.g. Malindi, Watamu and Diani owe their economic development to tourism.

The total number of beds in the beach hotels in Mombasa is currently estimated at 7600, with an estimated occupancy of 70% (GoK Hotels and Restaurant Authority 1996). The contribution of waste from the beach hotels in Mombasa to marine pollution was estimated to be 100, 85.4, 17.5 and 21.1 tonnes/year BOD, SS, N and P respectively. The corresponding BOD, SS, N and P loads for Kwale district (Diani beach area), with 5350 hotel beds, are respectively, 70.3, 6.1, 12.3 and 1.5 tonnes/year. Those for Kilifi district were: 76.0, 91.0, 19.0 and 2.0 tonnes per year. The 60-odd hotels in Lamu (with 1000 beds) produce an estimated 3.8, 3.2, 0.7 and 0.1 tonnes/year BOD, SS, N and P respectively.

It is noteworthy that two beach hotels, one in Diani and the other in Bamburi, have recently equipped themselves with biological treatment systems for their sewage.

4.1.6 Agricultural Waste

Although Kenya's coastal region is important for the production of vegetables and tropical fruits and some livestock rearing, most of its land is not given to commercial agriculture. Thus, apart from the two large commercial sisal farms located 30–60 km north of Mombasa which also rear livestock, agricultural activities are by and large subsistence, with little or no agrochemical usage.

Agricultural chemicals and fertilisers are used by some large-scale farms in Mombasa, Kilifi, and Lamu. In addition, the use of agricultural chemicals and fertilisers is replacing traditional farming methods in smallholder farms. River transportation of agro-chemicals through runoff during the rainy season is the main pathway through which those chemicals reach the coastal and marine environments.

Persistent and ecologically harmful chemicals with toxicity to fishes, such as organochlorine insecticides, are widely in use, though on a small scale. Other classes of pesticides such as organophosphorous, carbamates and pyrethroids are also used on agricultural food crops. Ecologically harmful herbicides like 2, 4-Diamine and 2,4,5-Triamine are also used.

Only in Kilifi district does agricultural runoff contribute significantly to overall pollution loads in the region. The contribution of runoff from the Kilifi plantations Ltd and Vipingo Estate Ltd was estimated by applying runoff factors from US agricultural areas. The combined contribution of N and P from these farms to marine pollution was found to be 92.5 and 5.3 tonnes/year respectively.

Fairly large amounts of fertilisers are used in Kenya. The Tana and Athi rivers draining the hinterland agricultural areas carry significant quantities of nutrients into estuaries and lagoons. Their adverse effects, though localised, are already evident in the marine ecosystems.

Sediment inputs, through the nutrients they carry, lead to the proliferation of algal blooms, which consume excessive amounts of dissolved oxygen, making the water incapable of supporting marine life. The water also becomes unsuitable for recreational use and can affect public health. Its inability to support marine life creates seafood scarcity and can lead to poor health in fishing communities who depend on seafood as their primary

source of protein. Marine-based poverty alleviation activities are also curtailed.

4.1.7 Livestock Waste

In Mombasa district, the rearing of livestock is practised mostly in smallholdings, where zero-grazed cattle and limited feedlots for poultry and pigs are maintained. We estimated that livestock wastes from Mombasa, Kwale, Kilifi and Lamu districts combined exert a BOD of 1855 tonnes/year and contain 12,718, 1544 and 1093 tonnes/year of SS, N and P, with the highest contribution in all parameters arising from Mombasa.

In Kwale district, mainly dairy cattle are kept along the coastline. Other farm animals are found further inland. The main slaughterhouses in the district are located off the immediate coastal areas.

In Kilifi district, the Vipingo Estate Ltd, Kilifi Plantations Ltd and the Agricultural Development Corporation farm in Malindi are the major livestock farms along the coastal areas. These farms manage low-density pasture units, in which livestock waste is used as pasture manure. However, they also run some of the busiest slaughterhouses in the area and contribute to marine pollution through this activity.

In Lamu the main contributor of livestock waste is the 3000-odd donkey population and the slaughterhouses. Liquid waste from the Lamu Slaughterhouse is disposed into a soakage pit.

4.1.8 Storm-Water Runoff

Storm-water introduces nutrients and pollution to coastal waters. Only in Mombasa district are there some storm-water drains. However, they are too few to serve the whole area. The inadequacy/non existence of drainage allows rainwater to cause flooding and provides non-point sources of pollution into coastal waters.

In Mombasa district, there are three storm-water drains discharging into the Tudor creek, and three others discharging into the Kilindini creek from the island and west mainland areas. The rest of the Mombasa area provides non-point sources of storm water into the creeks.

To estimate the contribution of storm-water runoff to the pollution load, reference was made to pollution loads from the circulation area studies (WHO, 1989). A runoff coefficient of 0.75 was assumed for the (mostly paved) Mombasa island and 0.5 for the non-paved mainland areas. An average of 1027 mm of rainfall for the years 1988–92 was used in the calculation. Since practically all the population centres in Kwale district are unpaved and are surrounded by farmland, an average runoff coefficient of 0.25 was assumed. A mean annual rainfall figure for 1995 of 1151 mm for Kwale town was used in performing this locality's calculations.

In this way, the following BOD, SS, N and P values (in tonnes/year) for storm-water runoff were arrived at: Mombasa: 551.2, 4447, 166 and 11.1; Kwale: 142, 1198, 45 and 2.8; Kilifi: 274, 2116, 88 and 5.9; and Lamu: 4, 28, 11 and 0.8 respectively.

Provision of storm-water drainage is hampered by a proliferation of unplanned physical development in the region.

4.1.9 Siltation

The mining of sand and coral for the construction and glass-making industries is an important contributor to soil erosion and siltation of the sea. In the Ngomeni area of Malindi, a large area formerly covered with mangrove is now a salt mine. There are about 9,500 ha of tidal swamps producing an estimated 70,000 tonnes of salt annually.

The rivers discharging into the Tudor and Port Reitz creeks are sources of sediments and nutrients, as evidenced by the frequent dredging of the Kilindini port for maintenance purposes. Heavy sedimentation occurs in the Malindi area from the Galana and Sabaki rivers originating from upland agricultural areas. Siltation of beaches by the two rivers has reduced their aesthetic quality and tourism potential, resulting in loss of employment to the coastal communities. At the port of Mombasa, dredging to maintain required depth is an important cost factor to the Kenya Port Authority.

The construction of a dam upstream of the Athi River has changed the flow characteristics of the river. This

project has affected estuarine productivity downstream and the local population have not only lost fertile farming grounds but are now faced with an invasion of weeds.

4.1.10 Coastal and Upstream Non-Point Sources of Pollution

Within coastal Kenya, only Mombasa has waste water treatment facilities for domestic wastes, both of which at the time of this study were out of service. Untreated waste water discharging into the sea constitutes the largest point source pollution to the marine environment. Indeed, preliminary observations showed elevated faecal coliform counts particularly in the vicinity of sewage outfalls in the Kilindini and Tudor creeks. Pit latrines and soakage pits have also been found to contaminate ground waters. The industrial establishments concentrated in Mombasa generate large quantities of organic matter which is dumped at a dumpsite near the sea. Most of these industrial wastes are untreated and enter coastal waters through storm-water drains and the municipal sewerage system. In Mombasa, the Kilindini/Port Reitz harbour creek receives the bulk of effluents from industries.

Recreational and tourism facilities, particularly the beach hotels found along the coastline, use septic tanks/soakage pits systems for their sewage disposal. When full, these wastes are generally emptied into the coastal waters. This constitutes a high BOD input to the marine environment.

Dredge spoils, which are disposed of in the sea, are another source of degradation to the quality of the marine environment.

Widespread coastal (particularly sand) mining has eroded the Kenyan coastal area. Habitat modification through the filling of wetlands, dredging and clearing of mangrove habitats has been associated with coastal erosion and loss of biodiversity in this ecosystem. These activities are on the increase as physical development of the coastal area accelerates.

4.1.11 Coastal and Upstream Diffuse Sources of Pollution

Urban run-off, particularly in Mombasa, contributes significantly to coastal pollution. Here, garbage collection is only about 50% of generation and most of that garbage finds its way into the marine environment. Agricultural runoff from areas in which agrochemicals and fertilisers are used is another source of diffuse pollution. Erosion as a result of poor farming practices upstream is a problem that is affecting the entire Kenyan coastline.

4.1.12 Atmospheric Deposition

The main sources of atmospheric deposition within the coast are the Bamburi Cement Company and the Athi River Cement Company. The on-site incineration of wastes by some industries and hospitals also contributes to atmospheric deposition.

4.1.13 Heavy Metals and Nutrients

Oteko (1987) studied heavy metal contamination of inshore waters in Mombasa, and found that most of this contamination originates from industrial establishments.

4.1.14 Sewage

Raw sewage is responsible for the elevated faecal coliform counts recorded in some of the areas studied, while pit latrines and soakage pits constitute the other source of coliforms both to groundwater sources and the marine environment. Results from the Government Chemist indicate that groundwater contamination has spread to all the coastal districts (J. Njoya, pers. commun. 1997). Public health concerns include food poisoning from eating contaminated fish, drinking contaminated water and contracting diseases transmitted via such water.

4.1.15 Oil discharges

There is evidence of oil discharges into marine waters. Although the volume of discharges is not known, large tar balls were observed in 1981 along the Kenya Coast at Bamburi by the Kenya Marine and Fisheries Research Institute. The source of these oil discharges was presumably the giant tankers carrying crude oil from the Middle East. These oil wastes are harmful to marine organisms and reduce the aesthetic value of the coastal ecosystem.

4.1.16 Litter

Litter constitutes another environmental problem within the coast. Apart from being disposed of at the official dump site, litter is now also being dumped in mangroves. It degrades the shoreline and the mangrove ecosystem and the aesthetic value of the region.

4.2 EMERGING AND FORESEEABLE PROBLEMS

Presently there are damming activities upstream of the Tana river, meaning that there will be less water coming downstream and the sediment balance will be altered. This could affect aquaculture and farming activities downstream.

Kenya is in the process of establishing an export processing zone a few kilometres from Mombasa town. Since most of the upcoming industries depend on agricultural produce as raw material, the region may soon be faced with increasing quantities of high-BOD wastes.

There is also the expanding plastics industry. Plastic containers/bags are easy to manufacture, but being non-biodegradable, have now become an environmental nuisance.

Titanium has recently been discovered in Kilifi District. The excavations that will take place during mining will result in both physical alteration of the area, atmospheric discharges and increased sediment loads into the coastal and marine areas.

A new power-generating plant is being built at Kipevu in Mombasa. Operations of this plant are likely to result in oil wastes entering into the marine environment and particulate matter into the atmosphere.

There are also efforts to relocate the official dumping site. The new area will most likely suffer the same problems experienced at Kibarani.

Groundwater extraction is on the increase in order to meet the water demands of an ever-increasing population. In some areas, such extraction is higher than recharge, resulting in salt water intrusion into underground water sources. The sinking of wells and boreholes alongside human settlements is another emerging problem. Water from such sources is contaminated with faecal coliforms and will increase the incidence of waterborne diseases.

With the government encouraging agricultural development and the people having little environmental awareness, increased pesticide and fertiliser use will increase the pollution of the marine ecosystem.

The predicted rise in sea levels due to global warming will also influence the topography of Kenya's coast and thus the state of its marine habitats.

4.3 STRATEGIES AND MEASURES

It has been recognised that Kenya's coastal area requires special attention in order to promote the sustainable use of its resources and to prevent or reduce its degradation. There is the need therefore to develop programmes that integrate the resource conservation and economic sectors. Interconnections within coastal ecosystems have to be appreciated and a sectoral approach to marine management discouraged. Institutions with primary responsibility for coastal management ought to be provided with the necessary means and legislative authority to achieve sustainable use of coastal resources through coordination of activities in an integrated coastal zone management plan.

In order to mitigate contaminant and other forms of degradation, there is a need to research on cleaner production technologies and industrial waste minimisation.

Measures to prevent or mitigate the degradation of affected areas may include: Creation of new disposal sites with sanitary facilities while abandoning the old sites to allow them to recover; promotion of waste recycling; development of management programmes to rehabilitate degraded areas; and encouragement of waste generators to treat their wastes before disposal at designated sites.

The coordination role of the Coast Development Authority should be made more effective by providing a legislative framework with enforceable policies, regulations and laws. The interation between Coast Development Authority and Kenya Wildlife Service, Directorate of Occupational Safety and Public Health and the Government Chemist should be guided by enabling policies. The local authorities should be assisted in their role of protecting public health through their water quality monitoring activities. In order to be prepared for accidental oil spills in the marine environment, the National Oil Spill Response Committee should be upgraded to a legally established institution and its contingency plans fully developed. National emergency plans for other marine disasters ought to be put in place. The Kenya Marine Fisheries and Research Institute (KMFRRI) should also be supported in its research work on fisheries, coastal dynamics and pollution studies, among other functions.

To achieve the desired results, it is necessary to put in place mechanisms to enforce compliance and follow-up in waste management matters. Stiff penalties should be imposed to offenders. The problem of shortage of equipment in public laboratories that handle pollution control should be addressed, because at present these institutions are not at all effective. Furthermore, there is a shortage of local expertise in environmental sciences and it is necessary to train indigenous personnel in this discipline.

4.4 PRIORITIES FOR ACTION

The following are envisaged to be some of the important activities that would serve to reduce the incidence of marine pollution in coastal Kenya:

1. Prepare a classified inventory of all the wastes polluting the marine environment.
2. Formulate handling and disposal guidelines for the different categories of wastes, including standards for waste discharges.
3. Improve the storage, collection and transportation networks in all major centres.
4. Offer incentives for waste recycling.
5. Improve monitoring of waste generators and encourage the use of clean technologies.
6. Upgrade waste treatment plants and landfills.
7. Review and update existing legislation to form a comprehensive and well-defined environmental policy.
8. Accord donor support to training and research institutions in the field of environmental science.
9. Conduct public awareness campaigns on improved waste management.
10. Institute a capital improvement plan that addresses alternative solid waste collection mechanisms and identify alternative disposal sites.
11. Establish a regulatory or non-regulatory water quality management that sets the standards and evaluation criteria for marine and coastal waters.
12. Review existing institutional structures and strengthen, harmonise and reactivate relevant institutions and programs, to ensure the establishment and maintenance of a water pollution monitoring and management plan.
13. Institute management measures to protect marine resources from further degradation by, for example, supporting reef restoration projects.
14. Establish projects, such as mangrove planting, that will make immediate progress towards restoring marine habitats.
15. Develop accurate habitat maps for use in coastal zone management.
16. Address the problem of coastal erosion by developing environmental impact assessment (EIA) protocol, identifying the best management practices that reduce coastal erosion and designing criteria for emergency shoreline protection.
17. Encourage the enactment of policies that address poor agricultural practices with a view to arresting the siltation problem.

4.5 RECOMMENDATIONS AND CONCLUSION

Based on the rapid assessment of land-based sources of pollution along the Kenya Coast, the following recommendations, which could be effected on a local scale, are made:

- Control procedures for the discharge of industrial effluents into the marine environment and coastal areas need to be formulated.
- There is a need to adopt appropriate measures to reduce pollution loads due to sewage from municipalities and tourist resort areas.
- The levels and effects of identified pollutants should be monitored with the aim of identifying pollution 'hot spots' and their impacts on the coastal marine environment. In this regard, investigations on the level of contamination of sensitive marine habitats, should consider the following pollutants: (a) organic, microbial and nutrient contamination; (b) heavy metals and (c) petroleum-based hydrocarbons.
- Further studies should also be conducted on the impact of sediment loading on the marine environment and EIA guidelines on coastal development put in place in order to arrest or at least mitigate the coastal erosion problem.

5. MADAGASCAR

5.1 IMPORTANCE ET SOURCES DE LA POLLUTION

A Madagascar, la pollution de l'environnement marin et côtier est due aux activités industrielles, agricoles, portuaires et minières dont l'importance et les conséquences ne sont pas bien quantifiées. La plupart des polluants sont biodégradables mais on rencontre aussi des polluants organiques persistants d'insecticides hautement toxiques comme le D.D.T. utilisé dans la lutte antipaludique, et les phénols émanant des industries du bois (34% des industries en zone côtière). Les défrichements et les feux de brousse en amont des zones côtières et la pollution d'origine tellurique constituent une menace pour le littoral, la biodiversité et les écosystèmes côtiers et marins comme en est le cas des récifs coralliens de Toliara. Cette pollution est à la fois liée à l'intensité de la sédimentation d'origine continentale amenée par le fleuve Fiherenana et à l'accroissement des rejets polluants urbains (domestiques et industriels) de Toliary, une ville côtière à forte croissance démographique. Les plaines littorales et la plupart des zones de mangrove souffrent également de l'intensité de la sédimentation d'origine continentale. Les principaux problèmes y rencontrés sont la salinisation des sols et l'extension de grandes surfaces dénudées généralement stériles. La sédimentation est d'autant plus spectaculaire en saison des pluies, pendant laquelle le débit des cours d'eau peut atteindre 3.000- 4.000 m³/s contre 40 à 60 m³/s à l'étiage.

Le problème de pollution réside en l'absence de politique globale de gestion de l'environnement (législation, personnel technique qualifié, équipement etc.).

5.2 PRINCIPALES SOURCES DE DEGRADATION

A Madagascar, ces sources de dégradation sont soit ponctuelles ou diffuses. Les sources ponctuelles sont souvent dues aux grandes installations industrielles comme les raffineries, les chantiers navals, les mines, etc. La raffinerie de pétrole ou SOLIMA à Toamasina, le chantier naval SECREN à Antsiranana, dont les effluents contiennent des polluants d'origine naphthénique, des sulfures et des thiophénols qui se rattachent à ce type de sources ponctuelles. Il en est de même des zones d'extraction minière (mica, quartz, fer, chrome, graphite) dont les polluants sont constitués de rejets solide et des suspensions de boues minérales. L'exploitation aquacole semi-intensive de crevettes en zones de mangrove compte deux fermes opérationnelles. Cet élevage est censé limiter les impacts négatifs de la charge polluante, surtout biodégradable, par un contrôle régulier mis en place à chaque ferme.

Les sources diffuses sont constituées par les eaux résiduaires urbaines (domestiques et industrielles) et agricoles ainsi que les poussières et gaz. Parmi les sources de pollution de ce genre, on peut signaler le secteur industriel en zones côtières qui représente 34 % de toutes les entreprises industrielles malgaches. Ce secteur est dominé par les industries agro-alimentaires (38,4%) et les industries du bois (34,8%). L'érosion côtière dont l'ampleur est observée sur les côtes ouest, nord-ouest et est de Madagascar (régions de Mahajanga, de Maintirano, de Morondava et de Manakara), et qui est consécutive aux modifications hydrodynamiques sur le littoral, rentre dans ce groupe de pollution. La pollution atmosphérique résultant des fumées et poussières émanant des zones d'extraction minière et fumées denses ou émanations gazeuses des grandes usines existe, mais elle n'est pas très ressentie. Il faut ajouter que la majeure partie des eaux d'égout et des effluents des industries est déversée brutes en mer sans traitement préalable.

Les plages constituent pour la plupart des villes côtières le lieu de décharge publique (immondice et rejets de sels nutritifs). Seuls 17 % des ordures ménagères sont ramassées dans les grandes villes. En ce qui concerne les installations sanitaires, 62,2% des maisons en sont démunies, et le reste de ces installations comprend les fosses perdues (28,8%), les fosses septiques (3,8%) et les tinettes (1,2%). Les rejets de sels sont constitués par les effluents domestiques riches en azote et phosphore qui contaminent le milieu marin.

5.3 CONSEQUENCES PERCEPTIBLES D'ALTERATION DE L'ENVIRONNEMENT

La dégradation physique de l'environnement marin et côtier se manifeste par les phénomènes suivants:

- Portions de plage boueuses, ensablement des plaines littorales et écumes là où débouchent les rejets polluants.
- Pellicules persistantes d'hydrocarbures à la surface des eaux.
- Eutrophisation des lagunes côtières et mauvaises odeurs émanant des eaux et du sédiment.
- Dépérissement des palétuviers et extension de zones nues stériles à l'arrière des mangroves.

- Erosion côtière et dégradation des récifs.
- Plages encombrées par des épaves de bateaux échoués suite à des accidents nautiques.
- Excréments et ordures encombrant des portions de plage.
- Déchets de fibres végétales, de carton dans les canaux d'évacuation entourant les usines.
- Modification des régimes hydrologiques et inondation des plaines côtières.
- Dégradation des zones de mangrove et changement de la biodiversité associée.

Sont surtout concernés par cette pollution les zones récifales, de mangroves, les lagunes côtières, les basses plaines littorales, les zones côtières basses et sableuses, et toute la biodiversité associée.

5.4 STRATEGIES ET MESURES

Compte tenu du danger de plus en plus manifeste de la pollution, des dispositions à moyen et long terme suivantes peuvent être promues:

- Pratiques de production ou d'investissement propres à l'usage de tous les secteurs socio-économiques.
- Substitution des produits dans les processus industriels trop polluants et traitement des rejets.
- Promotion du système de gestion intégrée des zones côtières, tenant compte des traditions et des intérêts des populations côtières.

5.5 ACTIONS PRIORITAIRES

En attendant la mise en place de la politique nationale de gestion des zones côtières et de la pollution, les actions prioritaires suivantes doivent être prises en compte:

- Inventaire de toutes les zones côtières menacées de pollution et des activités continentales susceptibles d'avoir un impact sur l'environnement marin et côtier ainsi que de la réhabilitation des habitats ou zones dégradés.
- Sensibilisation des opérateurs industriels et économiques sur le bien fondé d'un traitement des rejets à court et à long termes et formation d'un personnel spécialisé dans le suivi et le contrôle de la pollution en zones côtières.
- Sensibilisation de toutes les parties concernées par la gestion des zones côtières (communautés et collectivités locales, ONG, industriels, coopératives d'agriculteurs, de pêcheurs etc.).
- Éducation des populations côtières sur le bien fondé d'avoir une plage ou bord de mer hygiénique et propre.
- Ratification des conventions internationales relatives surtout à la prévention des pollutions de l'environnement marin et côtier, comme la convention MARPOL 73/78.

5.6 RECOMMANDATIONS ET CONCLUSIONS

Au terme des considérations énoncées ci-dessus, des recommandations suivantes s'imposent:

- Accélération de la mise en place des instruments de gestion de la pollution en général et de la pollution de l'environnement marin et côtier: législation et ratification des conventions, normes nationales et mise en place de moyens matériels et humains de contrôle.
- Sensibilisation des opérateurs économiques et autres investisseurs sur les liaisons entre environnement continental et marin, ainsi que sur le développement économique écologiquement durable.
- Sensibilisation des populations en amont sur l'impact de certaines de leurs activités de production (dont les défrichements) sur l'environnement général des populations côtières qui conduisent à la dégradation des lieux de pêche, à la stérilisation des sols des plaines côtières autrefois fertiles etc.
- Mobilisation des parties concernées sur les avantages d'une gestion intégrée de l'environnement marin et côtier.
- Coopération régionale et internationale effective pour une meilleur résolution des problèmes communs de gestion de l'environnement marin et côtier.

6. MAURITIUS

Mauritius is a volcanic island located some 800 km south-east of Madagascar. It covers 1865 km², with a maximum extension of 60 km from north to south and 50 km from east to west. It has a mountainous topography with the highest peak rising some 817 m above sea level. The coastline is about 320 km long and is almost completely surrounded by a fringing coral reef system, enclosing 243 km² of lagoon area into which 50 rivers and rivulets drain. With hardly any continental shelf, the water depth reaches 3000 m within 20 km of the coastline.

Some of the major islands that dot the Mauritian waters are Rodrigues, St-Brandon, Agalega, Diego Garcia and Tromelin.

The coastal zone of Mauritius is surrounded by coral reefs of the fringing type, except at a few places and near river mouths. The total length of the coral reef system is about 230 km.

The Mauritian coastal zone is comprised of the following:

- (a) A sedimentary zone made up of an accumulation of sand, coral rubbles, basaltic and beach rock fragments.
- (b) Coral reefs, which provide a buttress against wave action and support numerous marine species, including *Porites*, *Pocillopora*, *Faviidae* and *Millepora* spp.
- (c) Passes of variable lengths and widths (15 to 2,500 m) with depths of 2 to 20 m, reaching 50 m in only rare cases. *Pheophyceae* and sparse populations of *Halophila* species thrive here.
- (d) Lagoons: The lagoon area occurs between the fringing reefs and the shoreline at a distance from a few hundred metres to six kilometres.
- (e) Mangrove Swamps: In some segments of the coastal region, such as near river mouths or estuaries e.g. Terre Rouge, Riviere Noire, Baie du Cap, Riviere du Rempart, Trou d'Eau Douce, Poste Lafayette, Bras d'Eau, Roches Noires and Poudre d'Or, salt-tolerant intertidal tree species (e.g. *Rhizophora mucronata*) occur on flat muddy ground or swamps. These mangrove habitats are of ecological and economic importance including:
 - Protecting the shoreline from erosion and serving as a breakwater to wave action.
 - Providing nursery ground for many economically important marine organisms and plant communities.
 - Providing food and building materials.
 - Harbouring a host of waddling and fishing birds.
 - Entrapping land-based sediments that would otherwise get deposited on corals to adversely affect the productivity of the marine ecosystem.

The present state of health of mangroves in Mauritius and Rodrigues is poor. Much damage has been done to this plant community by poorly planned coastal development. With the construction of many hotels and roads on the coastline, many mangrove stands have been felled and the remnants are in poor shape.

(f) Coastal wetlands: Coastal wetlands are ecologically sensitive areas that play a vital role in the functioning of the coastal ecosystem and the maintenance of its carrying capacity. They provide essential habitats for many important marine species such as shore birds, crabs, fish, shrimps and worms. Wetland vegetation also plays a key role in recycling organic waste.

However, particularly in the northern and northwestern regions of Mauritius, many coastal wetlands have either been filled up or partly reclaimed for the development of roads, hotels and residential houses. This has caused flooding in many of these formerly wetland areas.

The increased incidence of eutrophication of marine life in the northern and northwestern sea has also been attributed, to a major extent, to changes in the drainage pattern of the wetlands.

6.1 IDENTIFICATION AND ASSESSMENT OF PROBLEMS

As early as 1980, many environmental nuisances had been noted in the Mauritian coastal ecosystem. However, these were easily absorbed by the self-healing capacity of the environment and serious cause for concern was not perceived. However, with increasing population pressure and industrialisation, environmental problems soon began to emerge and at present, if no urgent action is taken, the environment will suffer irreparable damage.

This report deals mainly with preparation of an inventory of the pollution sources and loads, and offers input on setting priorities and selecting management strategies and programmes.

The following sectors are considered to be of major importance in Mauritius:

- Agriculture;
- Sugar industry
- Textile processing;
- Sewerage; and
- Other industries

6.1.1 Agriculture

Until the late seventies, agriculture was the main foreign exchange earner in Mauritius. It was also the largest sector both in terms of output and employment.

The area under cultivation in Mauritius (90,100 ha) represents about 48% of the size of the island. Sugarcane cultivation in Mauritius occupies about 77,000 ha, representing about 90% of the arable land. The island has a long history of pesticides use. Approximately 1153 tonnes of pesticides are imported annually into Mauritius, out of which 59% represents herbicides, 31% insecticides and 8% fungicides. The annual importation of fertilisers for the period 1979–1989 averaged 57,500 tonnes. Ammonium compounds make up about 50% of the total imports, while potassium compounds approach a third of the total.

The vast majority of the country's 35,000 smallscale farmers use hand sprayers, resulting in wastage and spillage of the pesticides. In addition, plant growth regulators and fruit and cane ripeners are being increasingly used. Besides, some unscrupulous agrochemical importers continue to sell banned pesticides.

Preliminary investigations undertaken by the Water Resource Unit indicate that nitrate levels in ground water in some agricultural areas were already approaching tolerance limits.

6.1.2 Sugar industry

6.1.2.1 Waste Water

Sugar mills discharge large volumes of hot condenser water, carbon column workings, fly ash, scrubbing liquid, spent cooling water, highly alkaline waste water, and organic solvents. Some of the effluents contain high loads of soot and ash. Such effluent has high biological oxygen demand (BOD) levels and is mainly discharged into rivulets or canals, where it poses a serious threat to the quality of the water and survival of aquatic life.

The amount of waste water leaving a cane sugar factory is usually greater than the volume of raw water input because of the high moisture content of sugarcane (70 to 75 %). However, a five-fold reduction in the total waste water discharged from a factory can be achieved by re-circulation of condenser cooling water.

In Mauritius, two sugar factories operate sedimentation ponds, three operate anaerobic lagoons and one used to operate an artificially aerated aerobic lagoon, which was not operational by 1997. In 1993, six factories had achieved zero discharge of wastewater into rivers and the sea by using their waste water for irrigation instead.

6.1.2.2 Oil waste

Six sugar factories in Mauritius separate oil and grease from their waste water before it is discharged into rivers and the sea. These factories then burn the recovered oil with bagasse as fuel. Four factories separate the oil and grease from their effluents then dump them as solid wastes. Six other factories do not have any oil or grease separator; any oil present in their effluent is discharged into rivers or the sea.

6.1.2.3 *Particulate matter*

The most significant pollutant emitted by bagasse-fired boilers is particulate matter. Fly-ash and unburnt bagasse particles are emitted into the atmosphere through smoke stacks. The amount of particulate matter emitted depends on the removal efficiencies of the air pollution control equipment installed on the boilers. It should be noted that seven boilers in Mauritius have no air pollution-control equipment.

The Ringelman scale of 1–5 was used to evaluate the smoke opacity of the 27 boilers in Mauritian sugar factories. According to this scale, R1 is equivalent to 20 % and R5 represents 100 % smoke opacity. The smoke from chimneys of only 9 out of the 27 existing boilers had ratings less than 2.0, i.e. 40% opacity. Eleven boilers had a Ringelman rating of 2.0. The ratings of smoke from the individual stacks of 5 boilers that are not equipped with any air pollution control equipment, except for the one boiler operating under low load, exceeded 2.0. The opacity readings from these boilers averaged 2.1 to 3.5, with the corresponding maximum readings averaging 2.9 to 3.9 on the Ringelman scale.

6.1.2.4 *Solid and Hazardous Waste*

The following types of hazardous wastes are generated in Mauritian sugar factories:

- Biocides used for mill sanitation and seed cane preparation;
- Organic solvents, resins, adhesives, paint sludge, etc., used in mill workshops;
- Oil-water emulsions from the mills;
- Substances containing Polychlorobenzenes (PCBs) from electrical transformers of factories exporting electricity to the grid;
- Batteries;
- Laboratory chemicals such as lead subacetate and mercury iodide;
- Used oil from vehicles and factory machinery; and
- Acids, alkalis and other industrial chemicals.

Although substitutes to the use of heavy metal-based chemicals exist, the Mauritian sugar industry continues to use mercuric iodide and lead acetate for preserving and clarifying laboratory samples of various sugar solutions. The 19 sugar factories together use and dispose of over 108 kg of mercuric iodide and 2,400 kg of lead subacetate annually.

6.1.3 **Textile industry**

Liquid wastes from textile mills arise mainly from wet-finishing treatments, where large volume of water and chemicals are used in textile baths.

If the bath is discharged directly to the surrounding, it becomes a major source of pollutants hazardous both to human and aquatic life. This is because most dyes and chemicals used are synthetic and are not readily biodegradable. The desizing process, which uses enzymes or mineral acids such as sulphuric acid, is particularly significant because it produces effluent with a high biochemical oxygen demand (BOD) rating, high total dissolved solids (TDS) and some suspended solids in colloidal form.

Other effects of untreated effluent from dye houses are: Colour and turbidity which contributes to the asphyxiation of aquatic life; contamination of aquifers and formation of scale in pipes, condensers and boilers as a result of sulphate contamination.

6.1.3.1 *Airborne wastes from the textile industry*

Gaseous wastes from the textile industry, often containing solvent vapours like ammonia and formaldehyde, are normally diffused into the atmosphere. Another form of air waste originates from boilers. Most of the textile mills use coal or gas as fuel, and large amounts of gases are liberated into the atmosphere.

6.1.4 **Sewage**

Following a study of the sewerage system covering the islands of Mauritius and Rodrigues, the following conclusions were reached:

1. Contrary to the general belief, the most densely populated localities of the country are not confined to the urban districts of Port Louis and Plaines Wilhems. Indeed, a number of rural areas have high population densities. According to the 1990 population census, 55.5% of the total population resides in the seven rural districts of Mauritius, namely Mahebourg VCA, town of Beau Bassin-Rose Hill, Piton VCA, Town of Curepipe, Town of Quatre Bornes, Town of Vacoas-Phoenix, souillac VCA, Chemin Grenier VCA and Town of Port Louis.
2. Industrial development through the proliferation of industrial estates, in particular the setting up of textile dye-houses in rural areas without waste water treatment facilities, presents serious sewage disposal problems. Untreated sewage is often illegally discharged on land, into rivers or the sea.
3. Municipal sewerage facilities in Mauritius cover only the urban areas of Port Louis and Plaines Wilhems. The remainder of the island and the rural areas generally use on-site disposal systems. However, some isolated rural housing, industrial and tourist developments are provided with waterborne sewerage systems. The on-site systems generally consists of soakage/absorption pits and some septic tanks with soakaways.
4. Inadequate water supply has been and still is a constraint to rural sanitation in the areas.
5. The existing network of sewers cannot cope with peak flows during times of heavy rainfall.
6. Frequent blockages, recurrent overflows, polluting discharges and lack of preventive maintenance characterize the rural sewage system.

6.1.5 Other industrial waste

The three main industrial zones in Mauritius are Plaine Lauzun, Coromandel and Vacoas-Phoenix. Most of the polluting industries are found in these zones.

There are about 85 industries in operation in the industrial zone of Plaine Lauzun, including dye houses, ethanol distilleries, battery manufacturing, soap and detergent manufacturing, galvanising, food canning, and chemical manufacturing industries. These industries consume about 4000 to 5000 m³ of water daily and their effluent is discharged to in the Fort Victoria sewerage treatment plant, where only pre-treatment is done. The effluent is released into the sea through a 800-m-long sewage outfall. A few of the industries, e.g. the galvanising plant, release toxic effluents into the sewerage system without any treatment.

The Coromandel industrial zone comprises about 70 industries, the most important being dye houses which use the most water and contribute the most to water pollution. These are followed by the soap- and food-processing industries, whose daily consumption of water is about 3000m³. Their untreated effluent is discharged through a 600-m-long outfall into the Pointe aux Sables lagoon.

The Industrial zone of Vacoas-Phoenix has 31 industries, including dairy industries with a daily water consumption of about 2000 m³. Untreated effluent from these industries is discharged into the sewerage network after pre-treatment at the St Martin treatment plant.

6.2 REGIONAL ASSESSMENT OF POLLUTION FROM SEWAGE

6.2.1 Northern Mauritius

Northern Mauritius encompasses the districts of Pamplemousses and Rivière du Rempart, in which nearly 32% of the total rural population resides. The main population centres in the two districts include: Long Mountain, Pamplemousses, Plaines des Papayes, Triolet, Grand Baie, Petit Raffray, Grand Gaube, Goodlands, Riviere du Rempart, Belle Vue Maurel and Roches Noires.

Within the major towns in northern Mauritius, only around 48% of the population has access to a flush toilet

connected to a septic tank or absorption pit; 52% use pit latrines, with only 8% of the population having a water seal pit latrine.

In the northern part of Mauritius which is relatively dry, there is conflicting demand for water for agriculture and domestic use. Lack of storage reservoirs in the area as well as an ageing and leaking water supply network means that the little water available is not being efficiently exploited.

There have been major hotel developments in the Northern Tourist Zone, which comprises the coastal stretches from Balaclava to Grand Gaube. As a result of these developments, pollution problems are evident in the lagoons.

6.2.2 Southern Mauritius

The districts of Grand Port and Savanne comprise southern Mauritius, in which nearly 28% of the country's total rural population resides. The main population centres within southern Mauritius, including the towns of Mahebourg, Chemin Grenier, Rose Belle, Plaine Magnience, Rivière des Anguilles, Surinam and New Grove, accommodate over 50% of the total population of the two districts.

Nearly 49% of the total population of Southern Mauritius uses pit latrines. A similar proportion does not have piped water supply in their homes. Despite being the most densely populated region of Mauritius, with 10,382 persons per square kilometre, Mahebourg is not served by a waterborne sewerage system and about 33% of its population uses dry pit latrines.

6.2.3 Eastern Mauritius

The region comprises mostly agricultural land, most of which is under sugarcane cultivation. Besides agriculture there has also been some industrial development in the area. The MEDIA Industrial Estates are to be found at Central Flacq, Bel Air and Quartier Militaire. Two textile dye-houses are also located within this region: Coloutex Dyers near Moka and Tinturia da Ponte near Quartier Militaire.

Tourist hotels have recently been developed along the eastern coast, particularly along the stretch extending from Belle Mare to Trou d'Eau Douce.

Presently, only 46% of the population of eastern Mauritius has access to a flush toilet connected to a septic tank or absorption pit. The rest of the people use pit latrines. Only 40% of the people in this region have piped water inside their houses and a further 42% have water supplied outside the houses but on their premises.

There are as yet no major pollution problems evidenced in the area. However, the extensive coastal development that is underway along the stretch from Poste de Flacq to Trou d'Eau Douce may emerge as a future source of environmental pollution.

The on-site waste water disposal facilities in Centre de Flacq, the most important and rapidly developing town, are inadequate. The existing housing estates in Centre de Flacq also have serious problems with sewage disposal, which poses a public health hazard.

6.2.4 Western Mauritius

The Black River district of western Mauritius is the driest and most sparsely populated part of the country, with only 8% of the total rural population residing there. The main population centres in this district are Petite Riviere, Bambous, Gros Caillou, Case Noyale - La Gaulette, Tamarin, Grand Riviere Noire and Flic-en-Flac.

The main activity in the area is fishing. Some agriculture occurs in the northern part, and industrial activity is confined to the MEDICA estate located at Bambous. Coastal tourism is an important sector, thanks to the beaches found from Flic-en-Flac to Le Morne. This South Tourist Zone, as it has come to be known, has already undergone major hotel developments.

Presently, approximately 44% of the population within western Mauritius has access to a flush toilet connected to an absorption pit or septic tank. Nearly 55% of the population uses pit latrines.

The western district is presently fed by the Mare aux Vacoas Water Supply System, supplemented by the numerous boreholes in the area. Because only 32% of the population within this area has piped water supply, the provision of a water-driven sewerage system cannot be envisaged in the short term. Furthermore, major improvements to the present supply system are required.

The National Housing Development Company plans to construct some 1700 housing units on 21 ha. of land at Bambous, which at present has a population approaching 8000. The intention is to create a satellite town here, having a density of 80 houses per hectare with a borehole water supply. It will be important to provide adequate wastewater facilities, lest the underground aquifer be contaminated.

In recent years, extensive coastal development has taken place at Flic-en-Flac. Eight major hotels are now located in the area and offer more than 1000 tourist beds per night. A number of restaurants have also opened in the past few years. The existence of extensive areas of barren land in the vicinity of the coast has prompted major residential developments. As a result of such development there are already signs of pollution and degradation of the local environment. There exists the risk of pollution of the lagoons and fringing coral reefs from seepage of wastewater from local on-site disposal systems into the sea.

6.2.5 Existing On-site Sanitation Systems in the Rural Areas

As has already been pointed out, most of the population of Mauritius relies on on-site facilities for the waste disposal. The problem areas identified in an earlier study were revisited for a more rigorous assessment. It was found that:

- The most common form of on-site sanitation system in rural Mauritius was the pit latrine with separate soak pits for disposal of sullage.
- In almost all cases the existing disposal system was working satisfactorily irrespective of water use, population or housing density. Cases of failure could be attributed to poor operation and maintenance or to the system having reached the end of its working life, rather than the inappropriateness of the system itself. Most of the systems investigated here were aged 10–20 years. In most cases replacing the pits is all that was necessary to revive the disposal system.
- The efficiency of the system was not related to the soil conditions. Soil profiles in the areas studied were mostly thin and either contained or overlaid rocks, boulders or cobbles. This indicates that the movement of wastes from the pits is predominantly through fissures rather than through the soil matrix.
- Water consumption also appeared to have no effect on sanitation effectiveness. This is because most people dispose of their sullage in soak pits rather than in toilet pits.
- Sanitation effectiveness was not related to the type of flushing unit. However, households with a simple pour pan used about 4 litres of water whereas those with a cistern used 20 litres per flushing.
- Apart from in some areas in the estates, only a few complaints were recorded from residents about existing latrines causing a nuisance. None of the latrines or pits were objectionably odorous or appeared to have any other local environmental impact.
- With current levels of water consumption, population and housing density, virtually all of the rural sector of Mauritius could be served with some form of on-site sanitation system. The most sensitive area visited was the commercial area of Centre de Flacq. Any further increase in building density will make it impossible to find sufficient space on the existing plots to construct appropriate disposal systems.
- The quality of toilet construction is generally good. However, the toilet buildings on some of the housing estates are in need of rehabilitation because of corrosion of the metal structure and erosion around their concrete base.
- Seepage of wastes from the pits is likely to be through fissures, indicating that there is a distinct possibility that ground water sources are being polluted.

6.3 RECOMMENDATIONS

Based on the review of the various sources of pollution, their collection, treatment and disposal, the following recommendations are made that would help in reducing the levels of marine and freshwater pollution in Mauritius:

6.3.1 Sugar industry

Alternatives to lead subacetate and mercuric iodide may be used in Mauritian sugar factories without any distortion of laboratory results. Adequate tests should be carried out to determine the best substitute and the optimum interval between collection and analysis of juice samples.

6.3.2 Other Waste

Oil-water emulsions that are spilled on the factory floors should not be allowed to enter the water streams. Instead, such oil should be mopped up with bagasse or rags and burned in the boilers.

Batteries and other solid wastes that can be recycled should be. Other hazardous wastes should be taken to sanitary landfills.

There is an on-going risk of contamination of underground water resources from seepage of sewage from absorption pits and septic tanks into underground aquifers. Regular, long term monitoring of borehole and well water is recommended to determine the effect of these sewage discharges on water quality. Furthermore, a 1-km radius should be established between pollution sources such as pit latrines and boreholes or other groundwater sites.

Extension of the sewered areas should be planned to cater for any potential developments as well as the need to protect underground water resources.

Improvements on wastewater facilities should be undertaken until a central sewerage system can be put in place.

6.3.3 Effluent and sludge management

Where practicable, the use of tertiary treated waste water for irrigation should be considered. This is particularly relevant in the western areas of Mauritius where the climate is drier and there is proximity to large areas of irrigated sugarcane plantations. Treated sludge may be recycled as a soil conditioner and fertilizer substitute in sugar cane fields.

6.3.4 Sewage Treatment

The following measures are proposed for sewage management:

- Improve screening facilities;
- Provide additional biological treatment; and
- Relieve hydraulic overloading and flow distribution.

6.3.5 Solid Waste

In order to minimise the amount of solid waste, a culture of reuse and recycling needs to be inculcated in Mauritius. Moreover, public education should be undertaken on the control of littering and litter receptacles provided in all public places.

Manufacturers choosing to use, for example, plastic containers, should be required to reduce their impact on the environment in a 'polluter pays' framework.

Rehabilitation of official dumping sites should be undertaken and other sanitary landfill sites designated.

Tourism development should be planned with comprehensive information on environmental impact and its mitigation. In this regard, proper sanitary disposal systems for solid waste generated by hotels and other tourists facilities should be developed.

Controls on boat-cleaning operations and monitoring of oil slicks should be established, particularly in the areas with high concentrations of vessels.

6.3.6 Sand Mining

The existing legislation, structural plans and programmes for action formulated to minimise the environmental impact of sand mining should be enforced.

6.4 CONCLUSION

The coastline of Mauritius needs protection as a priority. The immediate coastal areas, near-shore lagoons and reefs are in comparatively good condition. There are however, localised water pollution problems in estuaries near urbanised or industrial areas and in lagoons adjacent to high-density tourist developments.

All the environmental problems mentioned in this report are currently undergoing in-depth study. In certain cases, such as the sugar industry, industrialists are being given the opportunity to invest in pollution-control equipment.

Mauritius is fortunate in that it is not yet faced with environmental problems of overwhelming proportions. Action at this time will be effective in avoiding future costs.

7. MOZAMBIQUE

7.1 PHYSICAL, GEOGRAPHICAL AND SOCIO-ECONOMIC SETTINGS

Mozambique has a 2770-km-long coastline, with a coastal area of 738,030 km². The country's continental shelf area covers approximately 68,000 km² and is fairly narrow, dropping to below 200 metres within less than 10 km in most places.

Seven Mozambique's eleven administrative provinces—Cabo Delgado, Nampula, Zambezia, Sofala, Inhambane, Gaza and Maputo—extend to the coastline. Of the 110 districts in the country, 42 are coastal.

Diverse landforms are found, ranging from the coastal plains through the middle plateau to the upland plateau and highlands along the Malawi and Zimbabwe borders.

Mozambique's woodlands cover some 70% of its land and are comprised of broadleaf forests (48%), grassland with trees (21%) and mangroves (1%).

The drainage system is determined by several major rivers, which drain from the highlands of the neighbouring Zambia, Zimbabwe, Swaziland and South Africa into the Indian Ocean. These include rivers such as Umbeluzi, Incomati, Maputo, Limpopo, Save, Buzi, Pungue, Zambezi and Rovuma. It is estimated that Mozambican rivers and internal lakes cover a total area of about 13,000 km².

The climate of Mozambique is predominantly tropical humid to sub-humid. Annual rainfall follows a strong seasonal pattern, and also depends on geographical position.

The coastal belt of Mozambique may be divided into three main geomorphic zones. These are from north to south: the coral coast; the swamp coast and the parabolic dune coast.

Except for the northern and southern ends of the country, most of coastline of Mozambique is protected from the influences of open ocean. The climate, oceanographic processes as well as coastal and marine resources of Mozambique are influenced to a large extent by the warm, southward-flowing Mozambique Current. The Current attains its maximum speed during the NE monsoon (November to February). It flows close to the coast near Mossuril and Cabo das Correntes.

The three major international sea ports are the capital city Maputo (with capacity of 14 million tonnes/year), Beira (annual capacity of 5.5 million tonnes/year) and Nacala. Other small ports include Pemba, Quelimane, Chinde, Angoche, Pebane, Macuse and Mocimboa da Praia.

The population of Mozambique is currently estimated to be 17–18 million. This figure includes refugees from neighbouring countries. The annual population growth rate is estimated at about 2.7%. It is presently estimated that 40 to 50% of the population is concentrated on the 50-km-wide coastal strip, resulting in a population density of 28.3 persons per km² in 1994 compared to 15.7 persons per km² in 1970.

The level of industrialisation in Mozambique is still low. However, since the end of the civil war, there has been a substantial increase in the number of industries. The major industries include textile, food- and beverage-processing, tyre manufacturing, paper milling, glass and plastic manufacturing, oil refinery, tourism and its related industries and ports and harbours. Seventy-six percent (76%) of the industries are located in the Maputo/Matola area and 16% are in Beira.

The mining industry is not well developed, although the country is rich in, for example, coal, natural gas and precious and semi-precious minerals.

Agriculture, the backbone of Mozambique's economy, employs about 80% of the country's work force and is a major foreign exchange earner from cashewnut, cotton, sugar, tea, beans, timber and copra exports. The fishing industry also plays an important role in the country's economy. In 1993, prawn export contributed 50% of the total export earnings.

Tourism has emerged as one of the fastest-recovering sectors, with tourists particularly from South Africa, visiting different parts of the country. The most popular tourist sites include Porta do Ouro (Machungulo Peninsula), Inhace Island coastline, the Macaneta Peninsula, the Bilene (Xai-Xai)–Chonguene coastline, the Inhambane coastline and the Bazaruto archipelago.

7.2 Coastal Ecosystems and Species Biodiversity

The coast of Mozambique is characterised by diverse and productive ecosystems such as coral reefs, mangroves, seagrasses, estuaries, deltas, barrier islands, sandy beaches, sand dunes and mudflats. These ecosystems are under variable pressure, with the greatest stress occurring in areas adjacent to urban and industrial centres such as Maputo and Beira and those in the vicinity of coastal touristic sites.

7.2.1 Coral Reefs

Corals are found at intervals all along the entire Mozambique coastline. The longest stretch of shallow-depth corals extends from the Rovuma River in the north to the Primeiro/Segundo Archipelago in the south. Corals also occur at intervals in deeper waters from Bazaruto southwards to South Africa.

A recent study at the Ibo Island coral reef systems (Rodrigues, 1996) identified 12 families of corals, namely Acroporidae, Agariciidae, Faviidae, Fungiidae, Merulinidae, Mussidae, Dendrophylliidae, Pocilloporidae, Poritidae, Oculinidae, Alcyonidae, and Xenidae.

7.2.2 Mangroves

Rivers flowing across Mozambique discharge sediments into coastal waters, resulting in the formation of extensive mudflats and mangrove forests particularly in the vicinity of the Zambezi River. Mangrove forests are well developed in the northern and central sectors of the coast and less so along the southern sector. The most extensive mangrove forests are found in the Zambezi river delta. In northern Mozambique, six species of mangrove occur, namely *Rhizophora mucronata*, *Bruguiera gymnorrhiza*, *Ceriops tagal*, *Avicennia marina*, *Sonneratia alba*, and *Xylocarpus granatum*.

Mangroves form an ecologically important ecosystem; they stabilize the coastline, provide nursery ground for many valuable plant species and are the primary source of timber, firewood, charcoal as well as medicinal plants for coastal inhabitants. The mangrove forests in Mozambique are still reasonably unaffected by human activity (average of 2.6% reduction between 1972 and 1990).

7.2.3 Seagrass Beds

Seagrasses occur in shallow, relatively calm waters and serve to accrete suspended sedimentary materials, thus preserving the purity of the sea water. In Mozambique, seagrasses are found in the protected shallow seas between offshore islands and the mainland or in estuaries with suitable substrate. Seagrass beds also provide shelter, food and nursery grounds for some of the most important species of fish, shellfish, dugong and turtle.

The dugong (*Dugon dugon*) and the green turtle (*Chelonia mydas*) feed mainly on seagrasses and their distribution in the Mozambican coast is closely associated with that of seagrasses beds.

7.2.4 Marine Mammals

Several marine mammals have been recorded in the coastal waters of Mozambique. These include dolphins, whales, dugongs, and seals. The largest population of dugong along the East African coast occurs in the Bazaruto Bay and a smaller population is found in the Inhambane and Maputo Bays.

Several species of dolphin inhabit the littoral waters off Mozambique. These include, for example, the humpback, bottlenose, spotted and rough-toothed dolphins and the false killer whale. It is known that during winter, whales migrate from the Southern Ocean to the coastal waters of Mozambique for breeding.

7.2.5 Sea Turtles

Five species of sea turtle found in the Indian Ocean nest on the beaches along the Mozambique coastline. The loggerhead turtle (*Caretta caretta*) and leatherback turtle (*Dermochelys coriacea*) nest along the coast, concentrating mainly in the Ponta do Ouro region, Maputo Game Reserve, Inhaca Island, Qewene Peninsula and the Bazaruto Archipelago.

The green turtle nests along the coast from Qewene Peninsula to Quirimbas Archipelago, with the highest concentration being found in the Primeiras e Segundas islands.

7.2.6 Marine Invertebrates

Many of the marine invertebrates found in inter-tidal zones of Mozambique waters are of commercial and subsistence value. These include molluscs, crustaceans and echinoderms. Coastal communities harvest shellfish for local consumption and to a lesser extent, for sale. The shellfish harvested include clams, oysters, mussels, cockles, scallops, and tritons.

7.3 IDENTIFICATION AND ASSESSMENT OF POLLUTION

In this section, the major sources of land-based pollution that affect the coastal, marine and associated freshwater environments in Mozambique are identified and wherever possible, quantified. In each case an assessment is made of their impact on:

- food security and poverty alleviation,
- public health,
- coastal and marine ecosystem health, including biological diversity,
- economy and
- social and cultural values.

7.3.1 Agriculture

Agricultural activities within the coastal region and in the hinterland areas contribute to the pollution of the coastal, marine and associated freshwater environments through sedimentation, and through pesticide and fertiliser runoffs.

Throughout the coastline of Mozambique, small-scale peasant farming is widely practised and contributes substantially to the livelihood of coastal communities. This type of farming involves mainly slash-and-burn methods, with farms divided into cultivated, fallow and grazing subsystems.

Most of the agricultural activities take place along or close to the main river basins. Therefore, rivers are the main pathways through which agrochemicals enter the coastal and marine environments.

Several major rivers, including the Zambezi, Pungue, Buzi, Limpopo, Save and Rovuma drain the hinterland agricultural areas of Mozambique and its neighbouring countries. Others are the Umbeluzi, Incomati and Maputo rivers, all of which flow directly into the Maputo Bay.

Agricultural chemicals and fertilisers are widely used in the intensive farms in Incomati, Umbeluzi and Maputo Rivers valleys, particularly in the sugarcane plantations in the Umbeluzi River valley in Swaziland.

Analysis carried out by Laboratorio Nacional de Alimentos e Aguas de Maputo have shown the presence of various pesticides residues, including DDT, lindane and hexachlorobenzene, at the mouths of the Monapo, Pungoé Maputo and Incomati rivers.

Poor land-use practices, including deforestation of the coastal as well as in the hinterland areas, are the main contributors to sedimentation of the coastal and marine environments of Mozambique. This necessitates frequent dredging of the Maputo and Beira harbours. Recent surveys by the dredging company EMODRAGA show that between 1,200,000 m³ and 2,500,000 m³ of sediments need to be dredged annually from the Maputo and Beira Ports respectively. However, owing to various reasons, these targets are not achieved each year.

7.3.2 Industrial Activities

Along the Mozambican coastline, industrial activities are mainly concentrated in the Maputo/Matola and Beira areas. Few industries treat their effluents and such effluents, which may contain toxic chemicals, are discharged directly into canals, rivers and coastal waters.

In Maputo, large factories such as the TEXLOM textile factory, the FAPACAR paper factory, the MACMAHON brewery and the MABOR tyre factory, discharge their waste into the Infulene river that enters the Maputo Bay. FAPACAR, for example, discharges 1220 m³ of water into the river daily.

The Infulene river is polluted with salts, organic matter and faecal matter downstream of FAPACAR and MACMAHON. Water from Infulene river is used for irrigation; studies by the Ministry of Health have shown that crops in the lower Infulene Basin are contaminated with faecal organisms.

Studies by Laboratório Nacional de Alimentos e Aguas de Maputo have revealed the presence of heavy metals, particularly lead, in a number of localities. These include the Port of Maputo, the mouths of Matola and Maputo rivers and the Nacala Bay, in particular near the cement mill.

7.3.3 Sewage and Domestic Solid Waste

Maputo is the only city in Mozambique with central sewage systems. However, only 30% of the households in the city are connected to the system; the rest use septic tanks. The outskirts of Maputo, as well as other major cities and towns in the country, use pit latrines and septic tanks.

A 1993 survey to evaluate the hygiene and upkeep of pit latrines within the peripheral quarters of Maputo; revealed the following:

- latrine coverage ranged from 70% (Maxaquene B) to 100% (Urbanização, Mahotas e Ferroviário);
- In 50% of the quarters of 20–40 houses, simple latrines were mainly used. However they were in generally poor hygienic state;
- Latrines with cement surfaces which are easier to clean, were also found to be in poor hygienic state;
- Due to lack of running water in particularly schools and markets, improper waste disposal through septic tanks caused chronic blockage of pipes.

The above study also included an assessment of disposal of solid waste within the same area. It was verified that solid waste was managed by the residents on individual bases, usually by using open pits dug in their backyards and periodic burning of the wastes.

The study recommended involving the residents in cleaning of the area, solid waste collection and unblocking drains in a 'Food for Work' programme. It also recommended that simple latrines be replaced with improved ones, and that schools and markets have their sanitation improved by involving students, their families and the larger community.

Due to high population density, there is insufficient provision for waste disposal sites, and it has become common to see accumulation of solid waste along the streets and around houses and markets. The Maputo municipality provides 21 waste containers at various sites, but these are emptied irregularly.

There is only one sewage water treatment plant in Mozambique, located on the Infulene river. Sewage from Maputo city is channelled through the same river. However, it is estimated that only about 50% of Maputo's sewage is treated. The treatment plant comprised of a series of anaerobic and facultative tanks is designed to treat only organic matter.

Studies on sewage pollution of the Infulene River and Maputo Bay have revealed the following:

- Faecal coliform levels in the canal leading into the Infulene river are extremely high (4.6×10^5 bacteria counts/100 ml). These levels are also high in the river itself (more than 2400 bacteria counts/100 ml).
- In Maputo Bay, faecal coliform, faecal streptococci and *E.coli* were detected in both marine waters and shellfish tissues, with levels being consistently higher in shellfish.
- The bacteria *Vibrio parahaemolyticus* and *Vibrio minicus* were isolated from clams at Rio Incomati and

- Polana and Matola respectively. *Vibrio* spp. are known to cause severe gastro-intestinal infections in humans.
- Coliform levels of in the Maputo Bay have been increasing over the years. In fact, waters in some parts of the Bay, e.g. at the Miramar Point, are not safe to swim in.
- High levels of biological pollution have also been recorded at the Beira and Nacala Bays, although they are lower than those at Maputo Bay.

A study by Casadei et al. (1995) revealed that between 1982 to 1985, the level of nitrate in wells around Maputo was positively correlated to their distance from latrines, their depth and population density of the surrounding area. However, analysis of ground water for the period 1992–1996, carried out by the Laboratório Nacional de Alimentos e Aguas de Maputo (LNHAA) for the same areas shows the situation to have improved significantly. This may be attributed to the successful implementation of the National Programme for Low Cost Sanitation.

Analyses conducted by the LNHAA on the water quality in boreholes and wells from different coastal provinces have revealed that a significant number are contaminated with biological pollutants.

7.3.4 Tourism

The return of peace to Mozambique led to a substantial increase in tourism along the coast. Activities related to this industry that impact on the coastal and marine environments include:

- Physical destruction of coastal habitats during construction works: The construction of tourism complexes on sand dunes, in clearing dune vegetation, exposes them to erosion and destroys the nesting sites of turtles.
- The driving of 4-wheel-drive vehicles on the beach above the high water mark, particularly along the coastline between Ponta do Ouro and Inhambane, disturbs important nesting sites for the loggerhead and leatherback turtles.
- Discharge of untreated sewage and waste water from coastal tourist complexes into the sea pollutes the marine environment.

7.4 EMERGING AND FORESEEABLE PROBLEMS

Emerging and foreseeable problems arising from land-based activities and their potential impact on the marine and coastal environments are identified in this section. Current and anticipated economic and social development in the country, coupled with an increase in the population of urban coastal cities and towns are expected to exert greater pressure on the coastal and marine environments. These developments are outlined below.

7.4.1 Industrial Expansion

As Mozambique's economy continues to attract more investors, many large-, medium- and small-scale industries are likely to be established or revived. Without a corresponding increase in appropriate waste disposal facilities, these are likely to aggravate the existing problem of marine pollution.

7.4.2 Population Growth

If the population growth rates in the major urban centres of Maputo and Beira remain high, and without parallel expansion of sanitation facilities, the existing problem of disposal of domestic sewage and solid waste is likely to worsen. This might also lead to increased incidence of water-borne diseases.

7.4.3 Reduced River Flow

Reduced river flow can result in extensive upstream intrusion of salt water; less water to flush away, for example, agricultural chemicals, urban wastewater and silt substantially changes the ecology of coastal areas. It adversely affects organisms in the coastal environment whose survival depends on the existence of an estuarine environment.

7.4.4 Mariculture

The mariculture industry in Mozambique is still at its infancy. Three main regions have been selected for mariculture development and land allocated for the first phase of the project: 7500 ha in Maputo, 19,500 ha in Beira and 6000 ha in Quelimane. If not properly planned and implemented, these developments, particularly of

shrimp mariculture, could result in a modification of the coastline, irreversible conversion of coastal habitats and degraded water quality from the chemicals, hormones, and nutrients used in the ponds.

7.4.5 Social Conflicts

With the increase of legal and illegal allocation of large pieces of land along the coast for tourism, conflicts between developers and local people are likely to increase as they compete for limited land and coastal resources.

7.4.6 Natural Gas Drilling

The exploitation of natural gas discovered in the Panda area might create environmental problems if the project is not properly planned and executed.

7.5 PRIORITIES FOR ACTION

Most, if not all, of the environmental issues discussed in the previous section may be attributed to a combination of factors including: lack of planning, coordination and management of coastal zone development; limited use of environmental impact assessment procedures in making investment decisions; limited human resources; inadequate enforcement of existing laws and lack of incentives to encourage conservation of the marine environment.

In order to arrest the problem of marine and freshwater pollution in coastal areas of Mozambique, a number of practical strategies and measures could be applied. These include scientific, technical, political, legal, economic and resource-management practices and policies. Mozambique should strengthen its capacity for inland and coastal zone management and environmental assessment through the involvement of all the relevant ministries and national institutions. Any development planning should involve personnel with training in environmental sciences.

7.5.1 Law Enforcement

There is a need to strengthen the capacity to enforce existing environmental laws and involve local communities in conservation efforts.

7.5.2 Promotion of Applied Research and Human Resources Development

The following should be given priority:

- Strengthening the national capacity for applied research on coastal, marine and associated freshwater environments;
- Strengthening environmental laboratory capacity; and
- Conducting research on cleaner production technologies and waste minimisation.

7.5.3 Industrial Effluents/Domestic Sewage

There is a need to:

- Strengthen technical capacity by providing incentives for industries to monitor, evaluate and reduce their harmful effluents;
- Develop guidelines for the siting of industrial estates and other industries outside of the industrial estates; and
- Promote the use of waste stabilisation ponds, as a low-cost method of sewage treatment

7.5.4 Prevention of Soil Erosion

On a national scale we envisage the following activities:

- Protect and rehabilitate natural barriers such as mangroves and reefs;
- Rehabilitate existing artificial barriers;
- Protect catchment areas;
- Use alternatives to sand and other materials extracted from areas vulnerable to erosion.

7.6 CONCLUSION

The coastal and marine environments of Mozambique are increasingly threatened by a number of land-based pollutants. These include domestic and industrial effluents, agricultural runoff, as well as waste generated by the rapidly expanding tourism industry. Most of the threats and impacts which have been identified could be reduced or prevented altogether by appropriate environmental planning and management, the use of environmental impact assessment and enforcement of well laid out environmental regulations.

8. SEYCHELLES

Of the 100 Indian Ocean islands that make up the Seychelles, Mahe, which covers 152.9 km², is the largest and is home to 89 % of the country's 70,000 inhabitants. Praslin (37.6km²) and La Digue (10.1 km²) are inhabited by 7 and 3 % of the country's population respectively.

Seychelles enjoys a tropical climate, with average annual rainfall of 182.3mm, temperatures of 24.4 to 29.8° C and average relative humidity of 80%.

8.1 NATURE AND EXTENT OF ENVIRONMENTAL POLLUTION IN THE SEYCHELLES

8.1.1 Water

Water pollution in the Seychelles is on the increase. For example faecal contamination of rivers in Mahe from defective sewage systems and septic tanks has been detected. Discharges from pig-rearing facilities is another source of water pollution. Samples collected from marshes near the Anse Marie Louise piggery have been found to be significantly contaminated. The major industries in the Seychelles known to be sources of water pollution are: the Seychelles Marketing Board agro-industry (producing dairy products), The Seychelles Marketing Board food-processing plant (processing poultry and other meat products), Seychelles Brewery (producing beer and soft drinks), Indian Ocean Tuna Limited (tuna canning), Penlac Factory (producing paint), Sodepak (manufacturing soap), cattle and poultry abattoirs, domestic sewage treatment plants and the electricity-generating plant.

The fishing industry, particularly commercial fishing, also produces significant amounts of pollutants, notably garbage, fish waste and petroleum products which are dumped in the sea without treatment.

Hotels, which are mainly concentrated along the coast, have also been a major source of water pollution. A survey in 1990 revealed evidence of organic contamination of coastal waters and deterioration of coral reefs, which was attributed mainly to sewage effluent from hotels.

Pollution from agricultural activities has not been precisely assessed in Seychelles, but it is likely that agricultural fertilisers and pesticides constitute a significant source of coastal water pollution. Large-scale construction, road-building and dredging activities have been responsible for siltation and damage to corals in some areas along Seychelles' eastern coast.

Other commercial activities that have over the years contributed to pollution of the marine environment include:

Hairdressing Salons: Water contaminated with chemicals runs directly into the waste disposal systems and is carried into the soil or streams.

Photographic Laboratories: Discharge silver compounds and other chemicals.

Textile Industry: Dye pigments, many of which contain heavy metals, are discharged into the environment.

Restaurants and Bakeries: Untreated waste water from these sources discharges through septic tanks into the environment.

8.1.2 Solid Waste

Solid waste in the Seychelles is at present managed by the Ministry of Foreign Affairs, Planning and Environment and the Solid Waste Agency Corporation (SWAC). The agency is responsible for the collection and disposal of solid waste generated by domestic and commercial activities. The type of waste generated in Mahe may be categorised as follows:

Municipal waste

- Assorted domestic solid waste;
- industrial and commercial waste;

- 'green' waste from parks and gardens; and
- construction waste.

Waste from special sources

- Waste from ships at the port;
- hospital waste;
- hotel waste;
- aircraft waste;
- beach waste, particularly seaweed;
- scrap metal; and
- abattoir; waste

Special and hazardous waste

- Dry cells, paints, solvents, engine oil, acid and pesticides;
- Mechanical oils from vehicle workshops, sludge from petrol stations, laboratory chemicals dry-cleaning agents; and
- Hospital waste (infectious waste and radioactive waste).

8.1.3 Sludge

This category of waste includes: septic tank waste, industrial sludge and waste water-treatment sludge.

8.1.4 Agricultural waste

The two important categories of agricultural waste in Seychelles are fisheries waste (particularly the by-catch that is dumped back into the sea) and waste from facilities rearing pigs, chicken and cattle.

8.1.5 Municipal Waste

Mixed solid waste (MSW), including residential, commercial area and workshops waste from five different areas including the greater Victoria was analysed. The following thirteen categories of waste were found:

1. Fruit and vegetable waste;
2. Paper (newspapers, cardboard, stationery and books);
3. Soft plastics (folies, paper bags made from polythene, polyvinyl chloride (PVC), and polypropylene (PP));
4. Hard plastics (bottles, and cups made from polystyrene, PVC, PP and High density polythene (HDPE));
5. Glass (clear, green and brown);
6. Iron, steel and aluminium (cans, bottle tops, nails and vehicle spare parts);
7. Other metal (including electronic scrap from radios, electrical household articles and wire);
8. Compound products (packaging made from plastic and metal, and disposable diapers);
9. Batteries (dry cells and rechargeable batteries);
10. Paint, solvents, acids, pesticides, oil, chemical and pharmaceutical products);
11. Textiles;
12. Wood, rubber, bones, stones, ceramics, leather;
13. Inorganic material such as sand and gravel.

The study revealed that Seychelles' municipal waste has a relatively high proportion of packaging material, mainly plastics (9.2%), glass (7.2%), metal (7.8%) and disposable diapers (6.1%).

There is currently in Mahe very little reuse or recycling of waste products such as cans and bottles, which aggravates the pollution problem in the country. Recyclable material in Seychelles is not collected, either to provide raw material for the recycling industry or for direct re-use, as happens in some countries.

8.2 ASSESSMENT OF PROBLEMS

Information on waste generation and disposal was obtained from government reports and from the following

sources : Seychelles Marketing Board (SMB) abattoir, the Public Utilities Cooperation (PUC) Management of Information & Services Division (MISD), Centre for Industrial, Scientific, Technological, Industrial & Documentation, Penlac, SMB-Agro, SMB-Prawn Industry, Sodepak, Printec Agency and SMB-Foodpro.

From the data, a national overview of pollution was arrived at, which is summarized in Table 8.1.

Table 8.1 Overview of Liquid and Solid Waste Loads in Seychelles during 1995.

Pollutant	Tonnes
Leachates	834.9
Biological oxygen demand	2783.1
Suspended solids	8998.6
Oil	186.6
Total N	5481.7
Total P	4576.6
Putrefiable solids	50,201.0
Non-hazardous Solid	47,544.0
Non-hazardous sludge	3120.8
Hazardous sludge	1.1

8.2.1 Existing Institutional Arrangements

There is under the Ministry of Foreign Affairs, Planning and Environment, a Division of Environment which is responsible for policy and programme matters on environmental protection, conservation and forestry. The three main implementing arms of the Division are the National Parks and Conservation section, the Forestry section and the Environmental Assessment and Pollution Control section.

The specific portfolio of the Division since June 1992 has been to keep the environment clean in respect of streams and rivers outside Victoria, preserve marshes, national parks and reserves, protected areas (including beaches in marine parks), public parks and gardens and the general administration of the Environment Protection Act.

The other departments, agencies and Ministries having environment functions include:

The Public Utilities Corporation (PUC): Supplies electricity, potable water and domestic sewage treatment facilities.

The Solid Waste Agency Corporation (SWAC): Responsible for collection and disposal of solid waste.

The Department of Community Development (Land and Infrastructure Division—Land Use Planning): Controls development and building construction, the implementation of the Plan d'Aménagement du Territoire, activities, structural work, national drainage and issuance of permits for quarrying.

Seychelles Bureau of Standards: Responsible for drafting environmental standards and providing laboratory facilities to national research institutions.

Seychelles Fishing Authority: Mandate includes the control and development of fisheries and protection of marine species. Carries out research on the marine and coastal environment and controls pollution in the fishing ports.

Department of Tourism and Transport (Ports and Marine Services Division): Responsible for the control of pollution discharges and accidental oil spills from ships in the harbour and within the territorial waters.

8.3 PRIORITY OF ACTIONS TO MITIGATE LAND-BASED SOURCES OF COASTAL AND MARINE POLLUTION

In view of the upward trend of land-based pollution of the Seychellois marine and fresh water environments, the following recommendations are made that will contribute towards mitigating further degradation of these natural resources:

8.3.1 Wastewater Discharges

- The major hotel establishments, industries and factories should be required to have wastewater treatment plants built and efficiently operated.
- Environmental Standards for Industrial Effluents should be enforced to control wastewater quality from industries and hotels.
- The domestic wastewater treatment plant should be expanded to cater for the growing number of residential houses along the eastern coast.

8.3.2 Solid Waste Disposal

- The present solid waste disposal site, which is situated within the coastal environment, poses the risk of leaching contaminants into the coastal ecosystem. The water quality within that ecosystem should be monitored in order to assess any degradation in its quality. Moreover, an alternative site for solid waste disposal should be identified further inland.
- Solid waste classification should be encouraged right from the households to the industries.
- Alternatives should be sought to the burying of plastic waste, as this practice cannot be taken as a long-term solution, due to the limited space available on the islands. Recycling and re-use of such waste should be encouraged.
- Scrap metal should be recycled or exported as a possible means of its disposal.

8.3.3 Hazardous Sludge

Hazardous sludge, mainly from the paint factory, poses an environmental risk in the long term. A solution should be sought for its safe disposal. The same applies to the accumulated oil residue from the power generation plant.

8.3.4 Siltation

Construction of access roads near the coast should only be undertaken during the dry season. When such work is carried out in the rainy season, run-off is transported into the coastal ecosystems, depositing silt and clay onto the coral ecosystem.

The dredging of corals has been another direct source of siltation. When essential, it should be done with all possible counter-measures to protect the corals from its adverse effects.

8.3.5 Environmental Education

Environmental education should be strengthened through the national educational programme. Public awareness of the importance of environmental protection should be extended through the use of television and radio.

8.3.6 Economic Incentives

Economic incentives should be offered to industries as a means of safeguarding and protecting the environment. A scheme of Environmental Awards could be applied to industries.

8.3.7 Legislation

Conflicting views among governmental agencies charged with similar environmental responsibilities hinders the efficient implementation of tasks. It is necessary to reassess the legislative mechanism so that enforcement of environmental laws becomes more efficient.

9. TANZANIA

9.1 TANZANIA (Mainland)

9.1.1 PHYSICAL, GEOGRAPHICAL AND SOCIO-ECONOMIC SETTINGS

Tanzania has a narrow continental shelf (less than 5 km), except in the vicinity of the relatively shallow Mafia and Zanzibar channels, where it reaches a width of about 60 km. The shelf covers a total area of approximately 30,000 square km, including the islands of Mafia and Zanzibar.

Several permanent and seasonal rivers, and numerous creeks traverse the coastal plains of Tanzania. The permanent waterways discharging directly into the Indian Ocean are the Pangani, Ruvu, Wami, Rufiji, Ruvuma, Lukuledi, Mbemkuru and Matandu rivers. These belong to the five major river basins, which constitute the Indian Ocean Drainage Basin.

The coastline is characterised by a mixture of sandy beaches, rocky outcrops, seagrass beds, fringing coral reefs and extensive mangrove stands. Marine rocks consist chiefly of marls, limestones, sandstone and shells.

The Rufiji mangrove forests comprise about 50% of the mangroves in Tanzania. Seagrass beds occur in clear shallow waters and raised platforms protected from strong waves, and support numerous marine organisms as feeding and nursery sites. The coral reefs have a high diversity of marine life, which makes them important habitats for fish breeding and shelter. Extensive coral areas in the Zanzibar Channel, around Dar es salaam and Mafia Island are the best grounds for artisanal fishing. The other remaining coastal forests in Tanzania support remarkably high levels of endemism and biodiversity.

The population of Tanzania in 1997 was estimated at 29 million. The population growth rate is higher in coastal areas, with a 7.8% annual growth rate in Dar es Salaam. The city of Dar es Salaam has an estimated population of 2.3 million, which accounts for 25% of the country's urban population. It is the administrative, commercial, industrial and transport centre of Tanzania. With an estimated 144,181 inhabitants, Tanga municipality is the second-largest coastal town after Dar es Salaam, and the third-largest urban centre in Tanzania after Dar es Salaam and Mwanza.

9.1.1.1 The Coastal ecosystem

The coastal plains of Tanzania are traversed by several permanent and seasonal rivers, and numerous creeks. The permanent waterways discharging directly into the Indian Ocean are the Pangani, Ruvu, Wami, Rufiji, Ruvuma, Lukuledi, Mbemkuru and Matandu rivers. These belong to the five major river basins, that constitute the Indian Ocean Drainage Basin.

The coastline is characterized by a mixture of sandy beaches, rocky outcrops, seagrass beds, fringing coral reefs and extensive mangrove stands. Marine rocks consist chiefly of marls, limestones, sandstone and shells. Natural gas reserves, consisting almost entirely of methane, have been found in shallow waters near Songo Songo island north of Kilwa.

The Rufiji mangrove forests comprise about 50% of the mangroves in Tanzania. Seagrass beds containing algae occur in clear shallow waters and raised platforms protected from strong waves, and support numerous marine organisms as feeding and nursery sites. The coral reefs have a high diversity of marine life, which makes them important habitats for fish breeding and shelter. Extensive coral areas in the Zanzibar Channel, around Dar es salaam and Mafia Island are the best grounds for artisanal fishing. Other remaining coastal forests in Tanzania support remarkably high levels of endemism and biodiversity.

9.1.2 IDENTIFICATION AND ASSESSMENT OF PROBLEMS: SOURCES OF DEGRADATION

9.12.1 Industries

About 80% of the industries in Tanzania, including agro-industries, chemical factories, breweries, soap and steel-manufacturing establishments, are located in the coastal city of Dar es Salaam. Pollutants originating from these

industries end up in the sea.

Much of the Industrial development in Tanzania was embarked on without specific provision for handling resultant environmental pollutants. Consequently, few industries in the country treat their waste. The majority of industries are located in coastal urban centres, and their effluents are discharged untreated or partially treated into nearby water bodies. The twelve streams draining through the heavily inhabited areas of the city constitute the major pollution drainage routes for industrial effluents into the Indian Ocean. Although the level of industrialisation of Tanzania's urban centres is relatively low, untreated industrial wastes causes significant levels of localised pollution.

Out of the 57 industries surveyed in Dar es Salaam, about 68% contribute to pollution of the Indian Ocean either directly or indirectly. Industrial pollution in Dar es Salaam consists primarily of biological oxygen demand, BOD (2,715 tonnes/year) and suspended solids (SS) (15,454 tonnes/year), equivalent to 19% and 55% of the total BOD and SS loads for the city, respectively.

The Msimbazi Creek and Mzinga Creek are thought to be the most heavily polluted spots of the Dar es Salaam coastline. Tanzania Breweries Limited accounts for 857 tonnes p. a. of the BOD₅ load discharged into Msimbazi stream. The brewery discharges its effluents into the stream untreated. On the other hand most of the nutrients, nitrogen (N) and phosphorus (P) loads originate from the Kimara slaughterhouse and the Vingunguti abattoir.

Rapid assessment of the industries surveyed found that about 67% of the large industries in Tanga Municipality contribute to water pollution. The Tanga region has major waterways, such as the Pangani, Soni, Mkulumuzi, Mnyuzi and Vuga rivers. Most of the rural sisal estates discharge industrial effluents into these rivers. However, the Mkulumuzi and Sigi rivers that pass through the heavily inhabited parts of the Tanga Municipality are not seriously polluted. Grab samples indicate that Mkulumuzi river has 5.3 mg/l BOD and pH 7.8, whereas the Sigi river has 1.8 mg/l BOD and pH 9.7. The direct discharge of untreated industrial effluents through rivers is of economic and health concern. The Msimbazi river in Dar es salaam for instance, whose water is extensively used for irrigation of numerous smallscale farms along its valley, is heavily polluted with industrial effluents.

In Tanga, sludge from the septic tanks as well as the 60% of the pit latrines assumed to be desludged by the cesspit/vacuum trucks, is emptied into the Indian Ocean either directly or indirectly. From this source, 5,000 tonnes of BOD is exerted on the Indian ocean annually. Domestic liquid wastes constitute most of the BOD load discharged into the ocean. The major source for the N in Tanga is domestic liquid wastes, which exert respectively, 4991.7 and 571.4 tonnes/year BOD and N.

Most of the industrial and domestic solid waste generated in Dar es Salaam is disposed of on site. Non-hazardous domestic wastes are disposed of at Vingunguti, the city's official disposal site. Metal industries lead in recycling wastes, with about 53,000 tons annually followed by hospitals from which 3,600 tonnes of putrefiable solid wastes per year are recycled. The breweries produce 1, 190 tonnes of such waste per year, which is mainly sold to farmers as animal feed.

9.1.2.2 Waste water

The Dar es Salaam City has a total of nine waste stabilisation ponds (WSP). The Vingunguti, Ubungo/Mabibo and Msasani/Mikocheni ponds serve the four major industrial areas, namely the Ubungo, Pugu Road 1, Pugu Road 2 and Changombe. However, the WSP are sometimes out of order or are operated inefficiently and do not achieve their intended purpose. Part of Pugu Road industrial area and all of the Chang'ombe industrial area are not sewerred. The liquid wastes from unsewerred industrial areas are either discharged untreated directly through one of the nearby major drainage streams or into on-site septic tanks.

9.1.2.3 Sewage

Of Dar es Salaam's 2.3 million inhabitants, 13% are served by a central sewerage system, 11% use septic tanks and 76% use pit latrines. Most of the central business district of Dar es Salaam city is sewerred. However, from the screen- house, this sewage is discharged untreated to the Indian Ocean. The sludge from the septic tanks is periodically removed using cesspit emptiers or vacuum trucks, which in turn empty their contents either into the Vingunguti ponds or into a screen-house where the contents discharge into the Indian Ocean untreated through a 1-

km sewer sea outfall located at Msimbazi Creek.

In Tanga the central sewerage system, serving 13% of the population in Tanga, discharges untreated into the Indian Ocean, at a point slightly north of Ras Kazone. Untreated sewage discharges directly into the sea spills over the intertidal area, contaminating habitats where fish, molluscs and crustaceans are collected for human consumption. Overflow of soak-away pits and septic tanks, particularly during the rainy season, impacts directly on public health. Water-borne diseases such as cholera, schistosomiasis, and filariasis are some of those associated with untreated sewage discharges.

9.1.2.4 Domestic waste

Domestic sewage in Dar es Salaam produces pollutants with an annual BOD of 11,681 tonnes, 12,641 tonnes of suspended solids (SS), 2222 tonnes of oil and 3320 tonnes of phosphorous compounds (P). Approximately 150 kg of non-hazardous domestic refuse per capita are generated in Tanga municipality, giving a total of 53,588 tonnes of domestic refuse generated annually. Only 31% of this waste is collected by the municipality, with the remaining 69% being dumped on site in pits.

9.1.2.5 Sand mining

Since the early 1980s, there has been a dramatic construction boom in the coastal urban areas of Tanzania, particularly Dar es Salaam, with a corresponding increase in the demand for building materials such as sand, wood and gravel. In Dar es Salaam, sand is obtained by mining river beds. A field survey conducted by Griffiths (1987) to estimate the extent of sand extraction along the four main streams (Tegeta, Nlbezi, Mlalakuwa and Kijitonyama) which drain the hinterland of Kunduchi beach, revealed that a minimum of 100,000 cubic metres of sand were being extracted annually from the four streams.

9.1.2.6 Agriculture

The agriculture industry employs about 80% of Tanzania's population and accounts for about half of the Gross Domestic Product (GDP). Most agricultural activities in Tanzania take place in river valleys and flood-plains. The combined effects of sedimentation and turbidity limit filter feeding and photosynthesis of coral reefs. However, the extent of this source of pollution has not yet been evaluated in Tanzania.

To control pests, diseases and improve farm yields, the agricultural industry in Tanzania uses a range of synthetic chemicals, many of them imported. The pesticides commonly used in Tanzania include aldrin, dieldrin, lindane, endosulfan and heptachlor. Fertilisers include ammonium sulphate, calcium carbonate, ammonium nitrate, urea, triple super phosphate and NPK. Marine and river water pollution resulting from leaching of fertilisers and pesticide residues constitutes a direct potential health hazard to animal, plant and human health. Poor storage and transportation of such chemicals may result in accidental spills into the fresh and sea water systems.

9.1.2.7 Atmospheric deposition

Out of the 57 major industries surveyed in the Dar es Salaam region, 37% of them have been identified as sources of air pollution. Domestic combustion in Dar es Salaam City accounts for 96% of all the CO discharged into the atmosphere and 93% of all the total suspended particles (TSP). Tanzania Portland Cement Ltd at Wazo Hill accounts for most of the air pollution. The industry accounts for: 2,185 tons of TSP (i.e. 40%); 323 tonnes (51%) of the total SO₂ and 323 tonnes (i.e. 60%) of the total nitrogenous oxides per year discharged by industries into the atmosphere. Land transport produces 16,758 tonnes of CO annually, i.e. 11% of that discharged into the atmosphere annually.

Most of the industrial establishments in Tanga Municipality are small- to medium-sized. The only large firms are the Tanga Cement Factory at Pongwe, and the Amboni Plastics factory. The major polluter is the Tanga Cement Factory which emits 2,355 tonnes (i.e. 37%) of the total TSP emissions in Tanga per year. The Factory accounts for 342 tonnes (i.e. 73%) of SO₂ and 720 tonnes (i.e. 49%) of NO_x emissions per year taking place in Tanga Municipality. Exposure to excessive concentrations of industrial emissions increases the frequency of human respiratory ailments such as colds and influenza, and worsens existing respiratory diseases such as asthma, tuberculosis and pneumoconiosis.

9.1.2.8 Hazardous waste

In Dar es Salaam, hazardous sludge originates mainly from the TIPER oil refinery, which produces about 3517 tonnes per year of such sludge, representing 73% of the city's total. About 1588 tonnes per year of hazardous sludge are generated by the several other industries (Aluco, Pipeco, Steelco, Galco and Ubungo Spinning Mills, Cottex Spinning and Shelys Limited). Most of this sludge is dumped on site.

The major producer of infectious solid waste in Dar es Salaam is Muhimbili Hospital which disposes of 896 tonnes of such waste annually. Other hospitals in Dar es salaam City dispose of 1,512 tonnes of hazardous waste on site annually. In Tanga municipality, 382 tonnes of infectious solid waste are generated by hospitals.

9.1.3 EMERGING AND FORESEEABLE PROBLEMS

a) There has recently been a growing interest by the private sector in prawn farming. Several coastal areas have been proposed for this development. The proposed farms would be located on the river mouths of Ruvu (Bagamoyo), Rufiji, Matandu (Lindi) and Lukuledi (Mtwara). The proposed giant farm at Rufiji would cover more than 19,000 ha in the delta, expropriating 11,000 ha of mangrove. The farm is set to include upwards of 9,500 ha of ponds, a hatchery, a feed mill plant, a processing plant and other supporting infrastructure. This proposal has met with resistance from residents and environmentalists. Potential impacts associated with such large-scale aquaculture development include:

- Introduction of foreign species and live feed which could spread into the surroundings and bring about a change in the natural fauna of the area; the introduced organisms could also carry pathogens.
- Destruction of mangroves and coral reefs as well as air, water and noise pollution and siltation during construction of the farm;
- Waste and pollution problems due to inputs of organic matter, chemicals and nutrients;
- Potential dangers to humans from chemical farm inputs.
- Increased pressure on the water and energy resources.
- Land ownership conflicts.

b) For many years, tourism in Tanzania has been concentrated in the terrestrial national parks. In recent years however, coastal tourism has been growing rapidly, especially on the islands of Zanzibar and Pemba. The major areas experiencing rapid coastal tourism development include Mafia Island, Bagamoyo, Kilwa, Tanga, Lindi, Mtwara and Dar es Salaam. Increased coastal tourism, although beneficial to the national economy, may have undesirable effects on the environment and on the local communities, for example, increased sewage and solid waste output, and water shortages.

Of particular concern is the relatively large number of developers interested in the Utende area of Mafia Island. Although the area is relatively small, there are plans to develop hotels with a capacity of approximately 70,000 tourist nights p.a. The only freshwater supply of the island is a lens that floats on top of the sea-water underneath the island. There have been no studies to determine whether this water supply is sufficient to sustainably support the proposed projects. There is the risk of salination of the lens with increased demand for fresh water.

c) The Dar es Salaam Harbour Expansion project, which is in its initial stages, is aimed at enabling ships to enter the port at all times of the day and night. Expansion of the ports of Tanga, Mtwara, Zanzibar, Mafia is also planned. Potential environmental impacts from this development are associated with blasting, disposal of dredged spoils and alterations on wave action, currents and siltation patterns. There could also be an increase in harbour traffic, with an accompanying increase in marine pollution.

d) The accumulation of large amounts of expired chemicals is emerging as an environmental problem. In Dar es Salaam alone, there are currently 11,000 tonnes of expired herbicides and 200 tonnes of veterinary medicines waiting to be disposed of. Lack of local technological know-how and the capacity to safely dispose of the chemicals is a major handicap. Environmental concerns include contamination of freshwater sources and the coastal and marine environments.

e) The popular use of plastics, especially polythene bags which are cheap and easy to manufacture, is another emerging problem. The major concern pertains to the non-biodegradable nature of these materials and the lack of

recycling facilities.

f) Natural gas, consisting almost entirely of methane, has been found in shallow waters near Songo Songo Island, north of Kilwa. It is estimated that these reserves could meet the country's energy needs for 30 years. Plans to exploit the natural gas resource are underway; these include the construction of a pipeline to transport the gas to Ubungo, Dar es Salaam, for electricity production. Apart from environmental degradation during construction, another risk associated with this undertaking may include possible leakage of the gas into the atmosphere.

9.1.4 STRATEGIES AND MEASURES

Tanzania's quest for the prevention of environmental degradation and the sustainable use of coastal and marine resources has been an on-going process. A strategic approach started in 1983 when the Environment Conservation Act No. 19 was enacted. The National Environment Management Policy (NEMC) was established in the same year. Practical implementation of various conservation measures started by undertaking coastal and marine resources surveys, and drawing up an inventory of destructive activities to the aquatic environment. These studies revealed that the resources were being heavily over-utilised and the environment degraded. Currently, management issues of the marine and coastal resources in Tanzania are addressed through a number of bodies and programmes such as:

- The National Management Plan for the Conservation of Mangroves;
- The Mafia Island Marine Park;
- The Tanga Regional Integrated Coastal Management Project;
- The National Conservation Strategy for Sustainable Development;
- The National Marine Contingency Plan;
- The Kunduchi Integrated Coastal Area Management Programme (Dar es Salaam); and
- The National Environment Action Plan.

These initiatives are in their infancy and considerable additional resources must be allocated before they can bear fruit. To achieve an integrated coastal area management system, there is a need to:

- a) Look into the possibility of having a single agency with the overall responsibility for managing the entire coastal area. Alternatively, a consultative co-ordinating management body may be established.
- b) Impose and enforce standards (effluent standards, daily maximum loads, reporting requirements) and impose penalties for discharging key pollutants into water bodies, in order to deter industrial, municipal, mining and agricultural pollution. Industrial discharges can usually be addressed through waste treatment in combination with cleaner production technologies. Incentives for modernising manufacturing plants by adopting less polluting practices and installing pollution-control equipment should be provided. In order to control sewage pollution, investment should be made in low-cost sewage collection and treatment facilities and existing ones rehabilitated.
- c) Sensitise agriculturists on the importance of soil conservation through the adoption of better farming practices; increased extension work and technical assistance are needed. Where possible, intensive agriculture in erosion-prone areas such as hill slopes and river banks should be avoided. The cultivation of tree crops and crops that require less fertiliser and pesticide applications should be encouraged. Moreover, farmers should be encouraged to opt for compost or manure over synthetic chemical fertilisers. Irrigation should not be allowed to withdraw ground-water to the extent that the water table is decreased.
- d) Implement existing mangrove management plans and bring the clearing of mangroves to a minimum. Alternative energy sources to replace charcoal and wood should be developed and promoted, together with more efficient charcoal-burning kilns and stoves.
- e) Initiate public environmental education and awareness programmes on the impact of marine pollution, at all levels in the community. The 200-m buffer zone from the high water mark should be re-established and new developments within this area prevented. Sand mining from coastal river bottoms should be prohibited.
- f) Enforce regulations on tourism development in terms of waste water treatment and set-backs from the beach. Planning for tourism should be done as part of an Integrated Coastal Area Management Programme to minimise environmental destruction and maximise economic gains for local populations. Sensitive sites and species should

be protected.

9.1.5 PRIORITIES FOR ACTION

The following are the immediate priorities for action towards arresting the growing marine and fresh water pollution problem in Tanzania:

- Formulate guidelines and criteria for environmental impact assessment (EIA) and ensure their observance.
- Initiate programmes aimed at redressing resource degradation and rehabilitating degraded coastal habitats such as mangroves, corals and beaches.
- Develop mechanisms to enable local communities to sustainably manage coastal resources.
- Institute and implement a “Polluter Pays” principle in order to minimise [particularly industrial] pollution.
- Establish regulations and guidelines for the disposal of hazardous wastes (including expired chemicals) and ensure their implementation.
- Set up mechanisms to ensure cross-sectoral co-ordination at national and local levels on all aspects of coastal and marine management.
- Offer incentives for pollution control by reducing and recycling waste at all levels.
- Review and develop training and research curricula relevant to integrated coastal management.
- Strengthen the capacity of the existing environmental research and training institutions.
- Develop a national integrated coastal area management policy that allows for multiple use of coastal resources, in which complementary activities are integrated and conflicting activities segregated.
- Educate farmers on better farming practices, including the environmental and health risks associated with poor farming methods and agro-chemical use and abuse.
- Establish the capacity to monitor and deter principal polluting activities.
- Review existing sectoral legislations relevant to coastal and marine resources management.
- Prepare an economic inventory of the coastal resources for use in development planning.
- Quantify and evaluate the environmental impact of some of the proposed developments, including the long-term cost of non-action.

9.1.6 CONCLUSION

The land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environment of Tanzania are concentrated in the urban areas of Dar es Salaam, Tanga, Lindi and Mtwara.

Although economic resources are very scarce at the moment, the degradation of marine and coastal resources, which undermines future social and economic development, needs to be addressed as a priority. Early action will safeguard the livelihood of the coastal communities, and ensure their sustainable contribution to national development.

9.2 ZANZIBAR

The Zanzibar coastal area has of recent times emerged as an important area of progress and development in the country. Activities within the coastal zone have transformed a once sleepy, clove-dependent economy into potentially a major trade, industrial and touristic country, with the private sector emerging as the principal player. The country, which for a long time has been a more-or-less closed society, has opened its doors to outsiders following the adoption in the mid 1980s of the Free Trade policy, some elements of which encourage foreign and local investment. This has attracted many investors, most notably in the tourism sector. Following these developments, Zanzibar has witnessed tremendous social and economic changes. New industries, such as algal culture, have flourished along most of the eastern coastal belt. In terms of trade, Zanzibar is regaining its ancient reputation of being the center of commerce in the East African region. These developments have had a strong impact on the social and natural environments. Concurrent with the expansion of the tourism sector, other supporting activities such as construction and marine transportation, have increased.

In the wake of these developments, there has been a significant population increase. Zanzibar’s population which was 640,575 in 1988, is currently estimated at 800,000, with most inhabitants

living in various coastal towns and villages. This increase has come about from the high population growth rate (3.2%) on the islands and more significantly, from the migration of people to coastal towns both from within the islands and from the mainland. The islands' coastal ecosystems are among the most productive in the area and provide local communities with their various daily needs such as food (from coastal agriculture and coral reef-based fisheries), firewood, charcoal and building materials. The coastal area also provides employment to a large sector of the community especially in the fishing, aquaculture and other subsistence activities.

The aesthetic value of its beaches, combined with a rich history and culture and easy access to the big game reserves on the East African mainland have made Zanzibar a potentially important tourist destination in the region. The tourism sector is emerging as an important employer.

These developments have had some adverse effects on the environment in terms of increased demand on resources and degradation of the environment. For example, the demand for fish and other marine products, which are the principal source of protein for the islanders, now far outstrips supply. Recent statistics show a continued trend in the decline in fish catches despite a substantial increase in fishing effort (Jiddawi et al, 1992). Loss of habitats, especially corals, due to destructive fishing practices such as the use of dynamite, anchor damage and pollution, have also contributed to this decline. Large areas of mangroves have been cut with adverse consequences to resources in terms of loss of breeding and nursery grounds for important marine species. Loss of mangroves has also been linked to the increased incidence of beach erosion in some areas of the coast.

The rapid increase in population in recent years, combined with the increase in tourist arrivals has had serious impact on local water quality. Sewage discharge is poorly managed, leading to high bacterial levels in some areas of the coast (Mohammed, 1997). Another important impact is on the freshwater resource. Increased demand on coastal aquifers, especially that brought about by the increased number of visitors, has led to saltation of some water wells, particularly on the eastern coast.

9.2.1 ASSESSMENT OF PROBLEMS

9.2.1.1 Agriculture

Agricultural activities in Zanzibar are still artisanal in nature, dominated by the cultivation of food crops rather than cash crops. Food crops include banana, cassava, yams, sweet potatoes, rice, millet and maize. Sugarcane is cultivated in the northern district, mainly for sugar production.

The use of fertilisers and pesticides has remained relatively low. Fertilisers are used mainly in rice and sugarcane cultivation. However, given that supply of the chemicals is often erratic, their use has been severely curtailed. For example, use of fertiliser dropped from 2800 tonnes in 1988 to 406 tonnes in 1996 (Ministry of Agriculture, Zanzibar).

Mariculture development started in Zanzibar in 1989 and has so far been confined to in the cultivation of a red algae, *Echeuma* sp. However, plans are underway to start a pilot fish culture farm in the Makoba area, north-east of Unguja island. This development will put more pressure on an area which already suffers increased organic pollution from a sugar factory operating nearby. It is planned that the experience gained from this pilot venture will be used to initiate farming in other coastal villages. Discharge from such fish farms has the potential of significantly increasing the nutrient load of the coastal waters.

9.2.1.2 Livestock Development

According to the Zanzibar Livestock census of 1993, there are about 73,000 domestic animals on the island. Most of these animals are taken to communal dips, to protect them against such diseases as the East African fever (ECF), bobesiosis and anaplasmosis, which are common on the island (Awali et al.) These dips are located in various areas of Unguja. The chemicals used in these dips include steladone, saladone, dekatix, spotone and other organophosphates.

Poor management characterises these dips. Almost all do not have designated methods of waste disposal. About 70 % have simple pits dug in their vicinity, into which waste solutions from the dips are dumped. The rest of the dips do not have even such simple arrangements and the waste is simply discarded onto the ground. According to estimates, about 300,000 litres of waste are disposed of in this way annually (Alawi et al., 1994). However, given that the majority of smallholders do their own dipping/spraying, the amount of the waste getting into the environment is far more than this. Of more serious concern is that many water wells are located near some of these dips. Consequently, there is a strong possibility of contamination of these water sources. Furthermore, most of these dips are not fenced, hence the dips and dip solutions are easily accessible to non-users.

9.2.1.3 Industrial Activities

Many of the industries active in 1993 no longer exist. These include Afrochem Ltd (manufacturing foam mattresses and detergents), Cotex (Z) Ltd (yarn and printed fabrics), the milk factory and the State Leather and Shoe Factory, formerly situated at the Mtoni industrial area. Furthermore, many of the smallscale industries which were housed under the Jitegeme Small Scale Industrial Complex (paint, aluminium utensils, hardware and soap) at Amaan, have collapsed. The once-mushrooming soap-making cottage industries have also folded probably due to competition from cheap imports.

However, new industries, mainly soap- and edible oil-manufacturing, have been established at the neighbouring Mombasa. An animal feed mill (Zanzibar Poultry Company, ZAPOCO) started operating at Maruhubi in 1995 and a flour mill has recently been opened at Mtoni. With trade liberalisation, a free trade and an export-processing zone have been established at Fumba, a few kilometers from Zanzibar Town. It is expected that this area will be the site of various industries.

9.2.1.4 Tourism Development

Tourism is currently the fastest-growing industry on the islands. The main catalyst to the development of the industry was the near-collapse of the clove industry which has for generations been the mainstay of the national economy. Tourism development was seen by the Zanzibar government as the natural replacement. In this regard, the government took deliberate steps to develop the industry. These included the enactment of the 1986 Private Investment Act which ensures investment protection and provides incentives and guarantee rights and obligations of investors. In 1992, the Commission for Tourism was established. This is an autonomous body established to specifically deal with tourism issues, including enforcement of tourism-related regulations. As a result of these positive steps, tourism grew manyfold. By 1993, of the 200 projects approved by the Zanzibar Investment Promotion Agency, about 60% were tourism-related. The number of hotels in the country mushroomed from 3 in 1987—all government owned—to over 104 in 1997. Likewise the number of visitors skyrocketed from 77,700 in 1985 to 226,000 in 1994.

Unfortunately, accelerated but poorly planned tourism development as experienced in Zanzibar has a number of drawbacks. These include physical and cultural degradation.

Physical degradation of the natural environment on the island as a result of tourism development is already apparent. This is especially true in the rural coastal areas where basic facilities are missing. Ironically, these are the areas where tourism is growing fastest. The large hotels located on the east coast of Unguja, for example, generate large volumes of both solid and liquid waste. There is no established programme for waste collection from these hotels and as a result, disposal of solid waste, for example, has been haphazard. Uncontrolled dumping of solid waste reduces the aesthetic value of the areas surrounding some of the tourist hotels. Solid waste may also attract pests and thus become a health hazard. The tourist hotels, especially those located along rural beaches, use septic tanks and soak pit systems for sewage disposal. In most cases these are poorly designed and given the coralline nature of the land in these areas, there is a possibility of contamination of ground water sources and coastal waters through leakage. None

of the hotels has waste treatment facilities.

Zanzibar is endowed with a good supply of ground water. This is assured by the excellent recharge rate by local monsoon rains. However, this resource is not evenly distributed around the islands in terms of quantity and quality. The eastern coraline belt in Unguja Island, which hosts a number of tourist hotels, experiences water deficiency. Like other parts of the island, there are no surface water sources in these areas and the only reliable source is shallow wells from which both tourist hotels and local villagers alike draw their water. (Tourists are known to use ten times as much water per capita as rural villagers). This increased exploitation of the water resource has led to saline intrusion in some village wells. The villages which are most in danger of suffering from this problem include Nungwi, Uroa, Michamvi, Paje, Chwaka and Jambiani. These are all within the designated Tourism Development Zone and all already have major hotel developments.

9.1.2.5 Marine Transport

The liberalisation of trade in Zanzibar has catalysed the expansion of the marine transportation sector. Earlier, Zanzibar had only two government-owned vessels which ferried passengers between the islands as well as along the mainland coast. Very few cargo vessels called at the Zanzibar harbour. With trade liberalisation, the private sector invested heavily in marine transportation and the number of locally owned vessels quadrupled. Currently there are about 14 vessels registered in Zanzibar. Moreover, the number of cargo vessels calling at the Zanzibar harbour has shot up from 40 in 1990 to 190 in 1995. These developments have understandably increased the risk of oil pollution in the harbour areas. Incidences of oil discharges in the area resulting from shipping activities have been on the increase (personal observation), threatening the reef formations fronting this area.

9.2.1.6 Vehicle Repair Workshops

No statistics exists on the number of vehicle repair workshops operating in Zanzibar. However, there is no doubt that the number of such workshops has increased in recent years. There are no officially designated areas where such workshops may be sited. Consequently, these workshops are scattered in various areas of the main towns. For example in the Stone Town area of Zanzibar Town, small workshops are seen operating—both legally and illegally—along the narrow streets of the town. Such workshops dump their wastes into the main sewers which empty into the coastal waters. Outside the Stone Town area, wastes, which may contain oil, grease and heavy metals, are dumped at street corners. When it rains such waste find their way into the sea via storm runoff, thus threatening marine life.

9.2.1.7 Municipal Waste

9.2.1.7.1 Liquid Waste

Accurate figures for water consumption on Zanzibar's islands do not exist. This is principally because bulk metres are not in use and individual households are not metred. However, estimates put daily per capita water consumption in the order of 68–105 litres. (Dorsch Consult, 1993). According to the Zanzibar Urban Water Supply Development Plan for 1991–2015, the estimated daily per capita water consumption in Zanzibar town—excluding waste—is 90 litres.

Domestic waste continues to be the main source of pollution to coastal waters in Zanzibar. The problem of coastal pollution is compounded by two factors: the ever-increasing population of the coastal towns, especially in Zanzibar Town and the inadequate sewerage system, which dates back to the late 1920s. People served by this system are connected to septic tanks that empty into a combined sewerage-storm water system. This system discharges untreated waste into the sea by means of a series of short out-falls. Many of these out-fall pipes remain in a dilapidated state. Untreated waste pollutes the waters fronting Zanzibar Town area. The remainder of the

population, including that from surrounding and newly built areas, is served entirely by pit latrines and soak pits.

The antiquated sewerage system has been plagued by lack of maintenance such that many of the discharge lines often embed silt to a depth of one metre or more. Illegal dumping of garbage into the system has compounded the problem. Missing flap valves at pumping stations often cause ingress of seawater at the stations during high tides. As a result severe flooding of storm-water and waste water occurs in some areas of the Stone Town and some of the newer areas. However, the most affected is the market area where flooding is a feature of every rainy season. In some areas, the flood level reaches up to one metre above ground level. Because this is a combined system, any backup cause faecal pollution in these areas. It is not surprising that water-borne diseases such as malaria, gastroenteritis and filariasis are a major concern of health authorities in Zanzibar.

9.2.1.7.2 *Solid Waste*

A survey carried out in 1992 in which three sites in Zanzibar Town were sampled for ten days showed that the per capita amount of solid waste generated by Zanzibar townspeople is 182 kg (Dorsch Consult, 1993). A high percentage of the waste is organic biodegradable material; over 80 % of it is food waste, mainly vegetable and fruit waste. The proportion of hazardous waste was very small, reflecting the low industrial activity on the islands.

Waste collection in the municipality has for a long time been lower than 30 %. (Dorsch Consult, 1993). The rest of the waste is burnt, buried or illegally dumped at different sites in the municipality, contributing significantly to environmental pollution. The waste that is collected by the Zanzibar Municipal Council is dumped at three official dumping sites. These are:

- *Saateni*: The 7000 m² site lies about 2.5 km north of the municipality, adjacent to a mangrove forest. Leachate from this site runs directly into the forest and the coastal waters. The site has been in use for a number of years and the filled-up areas are currently used to grow vegetables.
- *Mikunguni*: This site lies in an abandoned quarry located in a predominantly residential area some 2.5 km outside the centre of the municipality.
- *Mwanakwerekwe*: Located about 6 km from the central town, this is the largest dumping site on the municipality. It covers approximately 100,000 m². However, the area is not very suitable for dumping of waste as it is located close to a fast-growing residential district. Part of the dumpsite is almost permanently burning and smog pollutes the nearby residential areas. The water table on this site is very close to the surface and the surrounding area is almost permanently waterlogged. Consequently, it is very difficult to control leachates from this site.

9.2.2 **RECOMMENDATIONS AND CONCLUSION**

The coastal waters of Zanzibar are increasingly threatened by pollution, especially that emanating from municipal sources. High coliform levels, for example, have been recorded in these areas especially during the rainy seasons, when outbreaks of waterborne diseases become common. The ongoing rehabilitation of the Zanzibar Town sewerage system may help a little. However, since this is not set to include the installation of sewage treatment facilities, the problem is not expected to cease altogether.

Industrial pollution is still a minor problem. However with the proposed establishment of an export processing zone in Zanzibar, the situation could change dramatically. There is therefore a strong need to plan carefully in order to avoid undue degradation of the environment.

10. ASSESSMENT OF PROBLEMS IN THE REGION

10.1 ASSESSMENT OF PROBLEMS ASSOCIATED WITH AGRICULTURE, INDUSTRIAL ACTIVITY, HARBOURS, PORTS AND MINERAL QUARRYING

Contamination of ground waters in Mauritius has been linked to intensive use of nitrate in agricultural activity. However, there is insufficient evidence to indicate whether pesticide pollution in the intensively farmed coastal areas of the region poses a significant threat to potable water supplies. The trend of increased use of both fertilizers and pesticides in intensive agricultural production is likely to lead to higher concentrations of nutrients in agricultural runoff and ground waters. With the exception of Mauritius and Seychelles, the physical effects of siltation resulting from upstream agricultural activities, most notably along the coasts of Kenya, Madagascar and the Comoros, are currently of greater concern throughout the region than is agrochemical pollution.

In Mauritius, high biological oxygen demand (BOD) load is associated with the periodic release of effluent from sugar cane-processing factories to rivers, and its subsequent transfer to lagoonal waters with longer residence time.

More information and data are however required on the residence time and mixing of industrial effluents in coastal waters of the region. This information will assist in the assessment of the significance of the BOD load in the long term and the consequences to critical marine habitats.

By increasing the suspended solid load (turbidity) of coastal waters, mineral extraction and quarrying activities have the potential to damage coastal habitats, particularly coral reefs. Significant damage to coastal habitats related to mining and quarrying has been reported in Kenya, Tanzania, Seychelles and Mauritius. At regional level the likely impacts of current mineral development or quarrying activities are yet to be quantified. Detailed appraisals at the national levels are required prior to a regional assessment.

10.2 ASSESSMENT OF PROBLEMS ASSOCIATED WITH COASTAL URBANIZATION

Many of the industries in the region are located in coastal urban centres that have limited capacity for waste treatment, resulting in contamination of fresh water systems. A high proportion of the population in coastal urban centres has poor waste disposal systems that result in the contamination of ground water.

High population densities and expanding tourism industry exert high demands on fresh water resulting in depletion of ground water aquifers (especially in islands) to levels that allow the intrusion of salt water.

Rapid population growth in the countries in the region and particularly in the coastal areas has led to rapid changes in land-use patterns and natural ecosystems are being destroyed or replaced by agricultural crops. The rapid population growth is also putting pressure on the marine and coastal resources. Lack of infrastructure and treatment facilities for the large quantities of domestic sewage generated by expanding coastal urban populations. The contamination of the ground water and near-shore coastal waters represents the greatest threat to public health and economic development in each state of the region.

The release of untreated domestic sewage has been associated with the occurrence of eutrophication in near-shore coastal waters, phytoplankton blooms and the subsequent degradation of coastal habitats and reduced fish catches. Faecal coliform resulting from on-site disposal of domestic waste has contaminated surface and groundwater in wells and boreholes in Maputo and Mombasa. High faecal coliform and bacteria counts have been reported in Maputo bay both in marine waters and shellfish tissues and in Infulene River in Mozambique. The concentrations of faecal coliform and bacteria at the Maputo bay have been increasing over the years. Consequently, some areas of the bay are not safe to swim in. Furthermore, the levels of fecal coliform in ground waters around Maputo positively correlate to distance from latrines, depth of the wells and population density.

In the Comoros and Zanzibar State of the United Republic of Tanzania reliable data are not available, but there is a perceived link between domestic sewage and the occurrence of gastroenteritis.

There is an urgent need to monitor microbial contamination of ground waters in coastal areas of all states of the region in order to assess the scale of the problem.

10.3 ASSESSMENT OF PROBLEMS ASSOCIATED WITH SOLID WASTE

The degradation of coastal habitats caused by the dumping of domestic and industrial waste in coastal areas, and its transport via near-shore waters, represents a serious threat to the ecological health, biological diversity of coastal habitats, and, in the long term, tourism-based economic growth.

10.4 PERCEIVED MAJOR PROBLEM: REGIONAL CONTEXT AND PROPOSED ACTIONS

The Western Indian Ocean (WIO) region has river basins that transcend national boundaries and these rivers have long geographic impacts that are experienced several kilometres into the ocean. Negative effects experienced in estuarine and to a larger extent coastal areas are often a result of activities carried in upper reaches of the catchment areas, including the landlocked countries. Therefore, the pollution-related problems summarized in Table 10.1 are essentially regional.

10.5 CROSS-CUTTING ISSUES

Adequate national capacities and effective legal and institutional framework are important components in environment management. A number of environmental regulations exist in all countries across the region. However, despite their existence, the region is still faced with a number of problems. These include: poor enforcement of existing regulations due to inherent weaknesses in law enforcement mechanisms; chronic shortage of funds; shortage of reliable information to guide implementation of both policy and legislation; lack of co-ordination among relevant ministries and departments; and inadequate technical capacity to implement and enforce both policy and legislation.

The institutional and legal frameworks in the Eastern African region are characterized by the following features:

- Weak co-ordination and integration among institutions, sectors and different levels of governance.
- Weak or non-existent mechanism for ensuring linkage in decision-making criteria around key cross-cutting issues and problems.
- Conflicts among institutions as well as overlapping responsibilities, a common occurrence among institutions dealing with coastal and marine issues in the region.
- Lack of clear and mutually supportive linkages between national and local government responsibilities.
- Lack of or poor enforcement of legislation and regulations. Legislation and regulations are typically based on a 'command and control' approach, while in reality the governments of the region do not have adequate resources (technical and human) to enforce them.
- Weak legislations that exclude environmental impact assessment requirements, standards for emissions and environmental monitoring programmes.
- Limited institutional capacity and human resources.
- Inconsistencies between economic policies and environmental practices policy.
- Distorted resource valuation and inappropriate tenure systems.

Table 10.1 Perceived Regional Environmental and Cross-cutting Problems: Their Causes and Effects.

PERCEIVED MAJOR PROBLEMS	CAUSATIVE FACTORS/EFFECTS
Environmental and resource-based problems	
Freshwater shortage and contamination	<ul style="list-style-type: none"> → Most coastal areas in the WIO region area receive limited rain; fresh water is therefore a scarce resource. Many of the industries in the region are situated in coastal urban centres which have limited capacity for waste treatment, resulting in contamination of fresh water systems. High population densities in coastal urban centres have poor sanitary conditions that result in the contamination of ground water. → Land and fresh water are limiting resources in island states. High population densities and expanding tourism industry exert high demands on fresh water resulting in depletion of aquifers to levels that allow the intrusion of salt water. The lack of effective and efficient sewage treatment results in contamination of the ground water and near shore coastal waters.
Decreasing harvests of marine and coastal living resources	<ul style="list-style-type: none"> → Loss of income from regional and global trade of marine products. → Region-wide decrease in the diversity of the marine living resources including the disappearance of valuable natural resources. → Increasing catch/effort on pelagic species such as tuna, billfish, king fish and sharks. → Non-compliance to the FAO Fisheries Code of Conduct.
Loss of coastal zone habitats (notably mangroves, seagrass beds and coral reefs) and biodiversity	<ul style="list-style-type: none"> → Region-wide destructive fishing techniques degrading coral reef, mangrove and seagrass habitats. → Different types of pollutants and unsustainable resource uses have decimated coastal and marine ecosystems adversely affecting the diversity of coastal and marine areas. Endemic and or rare species have regional and global significance. Some endangered species such as turtles are highly migratory. Degradation of habitats that support the different stages of turtles life history in one country do affect the survival of these species regionally. → Incidental catches of endangered species such as turtles and dugongs by fisheries targeted at migratory species such as tuna.
Unsanitary conditions of beaches and coastal waters as well as contamination of coastal living resources of urban centres.	<ul style="list-style-type: none"> → Contaminated beaches, coastal waters and seafood that affect the health of both local people and visitors from afar. → High costs of mitigation. → Loss of revenue from tourism and sea food products. → Loss of recreational areas.
Cross-cutting problems	
Ineffective regional coordination mechanism	<ul style="list-style-type: none"> → Although the Nairobi Convention was signed more than a decade ago, it came into force only two years back. → Most of the countries in the region are signatory to international convention and agreements including participation and endorsement of Chapter 17 of Agenda 21 of UNCED. However, these have not been translated into regional and national strategies for implementation.
Inadequate national measures and capacities, distorted valuation and inappropriate tenure	<ul style="list-style-type: none"> → Weak regional and national marine and coastal environmental governance. → Growing economic pressure on use of marine and coastal resources driven by national, regional and global market forces. → Poor revenue collection on marine and coastal resources and products. → Dependence of coastal communities on marine and coastal resources. → Lack of economic alternatives.

Table 10.1 Continued. Perceived Regional Environmental and Cross-cutting Problems: Their Causes and Effects.

Intermediate causes:

<ul style="list-style-type: none"> → Lack of Policy Guidelines for management and Development of Intergrated Coastal Management → Weak or ill-defined roles and responsibilities of institutions 	<ul style="list-style-type: none"> → Lack of clear authority and ill-defined responsibilities → Overlapping jurisdictional mandates in national institutions
<ul style="list-style-type: none"> → Inadequate horizontal and vertical integration in planning at all levels 	<ul style="list-style-type: none"> → Poor urban/industrial and land use planning → Lack of capacity for participatory planning processes and sectoral approach to planning with poor inter-sectoral coordination → Weak integration of scientific information in the decision-making process and lack of understanding regarding the economic and scientific value of marine and coastal environments → Lack of international coordination → Lack of national prioritization of marine and coastal issues → Economic and environmental policy conflict
<ul style="list-style-type: none"> → Lack of political will and public awareness 	<ul style="list-style-type: none"> → Serious lack of awareness on marine and coastal environmental issues at all levels of society → Lack of political support in for development of effective coastal and marine governance → Entrenched perception that the oceans house inexhaustible resources → Lack of understanding regarding the economic and scientific value of marine and coastal resources
<ul style="list-style-type: none"> → Poor legislation and weak enforcement 	<ul style="list-style-type: none"> → Poorly defined and inept environmental laws and regulations → Lack or inadequate surveillance to ensure sustainable levels of use of marine living resources → Inadequate compliance → Lack of regional harmonization of national laws relevant to trans-boundary issues → Lack of and/or weak laws and regulations on environmental impact assessment (EIA) → Lack of laws and regulations that empower ownership of stakeholders to marine and coastal resources.
<ul style="list-style-type: none"> → Lack of the culture and weak capacities for assessment, monitoring and evaluation 	<ul style="list-style-type: none"> → Sporadic and isolated scientific assessment and evaluation of the stocks of marine living resources of the region → Lack of monitoring and assessment of socio-economic impacts of management programs for learning and sharing of experiences → Lack of the culture of transferring successful experiences from one programme to another → Inadequate human and technical capacities for assessment, monitoring and evaluation
<ul style="list-style-type: none"> → Insufficient public involvement 	<ul style="list-style-type: none"> → Lack of stakeholder participation → Poor identification of stakeholders and therefore lack of a defined constituency in marine and coastal issues → Lack of transparency in marine and coastal governance → Poor communication and education on marine and coastal issues.
<ul style="list-style-type: none"> → Inadequate financial resources 	<ul style="list-style-type: none"> → Minimum or lack of national financial allocation to sectors responsible for marine and coastal governance → Inept resource valuation and distortion in markets.

11. PRIORITIES FOR ACTION

The Regional Strategic Action Programme for the protection of the marine, coastal and associated freshwater environment from land-based activities, proposes the most appropriate options for intervention and solution to identified issues. As mentioned earlier, this Strategy provides a framework for the long-term protection of the marine, coastal and associated freshwater environment from land-based activities. Proposed actions have been formulated to address the identified issues, within the context of a broad framework, which serves to identify a set of general policy areas for targeting more specific proposals for action. This section discusses these proposed activities/actions. In all states of the Region there are on-site disposal systems that raise concerns which require detailed investigation, for example the microbial contamination of coastal water that threatens public health. Several national reports perceived that public ill health was related to groundwater contamination. However, few studies have been conducted to confirm the epidemiological relationship or investigate the scale of the problem. A programme of action to address priority issues is proposed based on expert recommendation from the regional workshop held in Zanzibar in 1997. The strategies and specific actions to achieve stated objectives are summarized below and in Table 11.1.

(a) Sewage and Industrial Waste

The proposal to reduce impact from sewage and industrial waste on the environment include:

- use of intermediate technology, i.e., low-cost innovative solutions in peri-urban and urban areas in construction of sewage treatment facilities ;
- training of personnel in maintaining both old and new sewage treatment facilities;
- conducting scientific investigations to assess nutrient concentrations in coastal waters around
- urban centres;
- monitoring to determine concentrations of specific industrial pollutants;
- set guideline concentrations at the national level based on the monitoring programme;
- providing incentives for cleaner production;
- land use plans that locate industries in appropriate locations; and
- developing a regulatory framework for treatment of effluents.

(b) Solid Domestic Waste

The proposals to reduce the impact of litter on the environment include:

- selection and construction of appropriate disposal sites,
- improvement of the management of disposal sites;
- recycling of waste;
- public awareness;
- training of personnel to manage waste disposal sites; and
- development of a regulatory framework for waste disposal.

(c.) Agricultural Run-off

The specific actions proposed to reduce the effects of persistent organic pollutants, high nutrient levels and silt are as follows:

- the enforcement of best practices for the application of agrochemicals;
- protection and restoration of degraded habitats;
- identification of priority areas to be protected;
- improvement of drainage to prevent soil erosion; and
- public awareness.

(d) Mineral Exploitation and Heavy Metal Extraction

The specific actions proposed to control and manage areas of mineral extraction include:

- regulations/legislation on sand mining/minerals extraction on coastal zones;
- monitoring of mining activities; and
- the initiation of land-use planning in areas proposed for mineral extraction.

(e) Targeted Studies/Research

Information is required on the residence time and mixing of industrial effluents in coastal waters of the region. This information will assist in the assessment of the significance of the BOD load in the long term and the consequences to critical marine habitats.

There is an urgent need to assess the scale of microbial contamination of ground waters in coastal areas of all states of the region.

Table 11.1 Summary of proposed actions to reduce coastal zone pollution in eastern Africa.

→ OBJECTIVE	→ ACTIVITY
→ Institutional strengthening to facilitate regional cooperation	→ Operationalise and strengthen the Nairobi Convention into a more effective regional co-ordinating mechanism → Ratify and implement regional and international conventions relevant to the sustainable management of marine and coastal resources
→ Enhancement of public awareness and participation	→ Promote and engage stakeholders in the planning and implementation of policies, management measures, projects and programs on coastal zones → Involve the public in coastal and marine environmental decision-making → Empower coastal stakeholders to manage their resources
→ Enhance horizontal and vertical integration in coastal governance	→ Improve human and institutional capacities for participatory planning and implementation processes
→ Stabilize and improve the supply and quality of the major and international water basins and ground water in SIDS	→ Develop an integrated approach to major river basin management and coastal/island ground water aquifers → Develop and implement effective innovative measures for the disposal of sewage and industrial waste → Decrease land-based pollutants entering rivers through better agricultural practices → Develop and implement EIA standards
→ Sustainable use and management of living marine resources	→ Effective use/reduction of by-catch → Development of functioning MPAs → Development of effective fisheries laws and regulations
→ Improve the scientific knowledge on ecosystem functioning and productivity	→ Conduct periodic assessments and evaluation on major and critical marine and coastal resources → Establish continuous monitoring and evaluation on the state of the resources, pressure of use and effectiveness of management measures to ensure sustainability → Establish continuous monitoring on the quality and quantity of fresh water in rivers and aquifers → Build a comprehensive scientific information base

11.1 IMPLEMENTATION

Governments are responsible for initiating programmes to assess the extent of environmental degradation, e.g. microbial contamination of ground and coastal water in each participating country where issues have been identified as a priority. In urban centres where sewage infrastructures are already in place, guidelines should be developed and followed to ensure the operation and maintenance of urban water supply and sanitation systems.

Local authorities should be responsible for implementing localized activities (e.g. ensuring that solid domestic and industrial wastes are not dumped on or around sensitive coastal habitats such as mangroves). Approaches should

include the provision of adequate waste collection and disposal services and enforcement of laws and regulations concerning the illegal dumping of wastes. Dumpsites should be managed and waste categorized before being indiscriminately dumped regardless of toxicity levels.

Monitoring and assessment should be undertaken at the regional or national level. For example, the use of remote sensed imagery would be the most cost-effective long-term approach for detecting and assessing the physical damage to coastal habitats and coral by siltation, solid domestic or industrial waste, or phytoplankton blooms. High-resolution remote-sensed images can be used to pinpoint siltation plumes and algal blooms (red tides) associated with sewage outfalls or agricultural pollution. Subsequent site visits should be used to assess the extent of the degradation and the results used to amend, e.g., agricultural practices in order to prevent soil erosion in coastal catchments.

At the national level, the specific objectives of the SAP, in relation to the protection of the marine, coastal and associated freshwater environment of the WIO region from land-based pollution, would have the following objectives:

- Serve as framework for the governments of the region to develop specific plans to protect marine, coastal and associated freshwater environments from land-based sources of pollution;
- Increase national and regional capabilities for the planning and implementation of strategies to control the negative impacts of land-based activities upon the marine, coastal and freshwater environment;
- Facilitate the implementation of regional assessments and monitoring of water quality in the region;
- Promote and facilitate the development of technical and financial arrangements; and
- Serve as the framework for Programme of Action for the Regional Coordinating Unit for the Eastern African Regional Seas Programme.

11.2 THE PROPOSED THEMATIC STRATEGIES INCLUDE:

- Addressing the priority sources and activities of the land-based sources of pollution;
- Integrated management of major and international freshwater basins and groundwater;
- Development of appropriate supporting legal and institutional framework;
- Support of both human and technical capacity building;
- Improvement of the monitoring and assessment of key aquatic environmental indicators; and
- Enhancement of environmental education, public awareness and participation.
- Support and Development of Integrated Coastal Management Policy Guidelines for Sustainable Coastal Development in Eastern African Countries.

11.2.1 Theme I:

Addressing the Priority Sources and Activities of the Land-Based Sources of Pollution

The sources of pollution are:

- Domestic sewage, urban runoff and sediment (derived from agriculture and coastal development activities),
- Solid domestic wastes,
- Saline intrusion (associated with increased ground water abstraction),
- Industrial wastes and agro-chemicals (pesticides, herbicides and fertilizers), and
- Habitat modification.

A) Identified Issues

- Inadequate data and monitoring information of both discharge and quality of receiving waters;
- Inadequate infrastructure and treatment facilities for domestic sewage generated by coastal urban populations;
- Absence of appropriate solid waste management and disposal systems;
- Inadequate control and monitoring of industrial wastes;
- Inadequate pollution-control standards, monitoring and enforcement; and
- Uncontrolled use of pesticides and insecticides and poor agricultural practices.

(B) Objectives

- Develop and implement effective and innovative measures for the disposal of sewage and industrial waste;
- Reduce the impacts of sewage and urban development on the coastal, marine and associated freshwater environment;
- Reduce the impacts of agricultural run-off (sediment, dissolved nutrient load and agricultural chemical run-off);
- Reduce the amount of solid waste reaching the coastal and marine environment; and
- Reduce the levels of harmful industrial waste entering in the coastal and marine environment.

(C) Proposed Activities

- Construction in urban areas, of sewage treatment
- Facilities that are reliable under the local conditions and which provide opportunities for full or partial reuse of treated wastewater;
- Training of personnel in the maintenance of both old and new sewage treatment facilities;
- A regional workshop to identify and promote the use of intermediate technology, low-cost innovative solutions and options for urban wastewater treatment;
- Preparation and adoption of regional guidelines for rational use of fertilizers and the reduction of losses of nutrients from agriculture;
- Preparation and adoption of regional plans for inventory of quantities and uses of pesticides;
- Create and disseminate information on best management practices for industries in reducing pollutant discharges;
- Installation of garbage containers in public areas for the purpose of appropriate collection and/or recycling;
- Initiation of pilot recycling projects at the community levels;
- Assessment and evaluation of the technical, institutional and financial dimensions of problems and solutions to industrial waste disposal problems with special attention to tanneries, sugar factories, breweries, chemical industries and textile mills;
- Identification of economic and policy incentives for cleaner industrial production; and
- To undertake a feasibility study for the introduction of cleaner production in the region.

11.2.2 Theme II:

Integrated Management of Major and International Freshwater Basins and Groundwater

The rapid urbanization and development activities such as industries and tourism particularly in most of the coastal areas has resulted in led to shortage of water supplies. Increasing agricultural activities upstream (river basins) have consequently led to contamination of both surface and groundwater supplies.

(A) Identified Issues:

- Inadequate data and information on pollution and sediments loads in the international and major rivers as well as groundwater;
- Lack of agreements on shared water basins; and
- Lack of guidelines on how to develop integrated plans for most of the international and major river systems.

(B) Objectives

- Improve human and institutional capacities for participatory planning and implementation processes;
- Stabilize and improve the supply and quality of water in the international water basins and ground water in SIDS;
- Develop an integrated approach for river basin management for some selected major / international rivers;
- Integrated Coastal Management and island ground water aquifers management;
- Develop and implement EIA standards;
- Develop practical management plans for marine protected areas (MPAs); and
- Establish continuous monitoring of the quality and quantity of fresh water in rivers and aquifers

- initiate integrated coastal management pilot and demonstration projects for coastal areas, particularly where user conflicts already exist, or where new investments are planned. Implementation of these projects mainly by community-based organizations and NGOs.

(C) Proposed activities

- Assessment of water demand and supply, and extent of contamination of groundwater by sewage and agricultural chemicals;
- Development of freshwater budgets for deficit areas or islands;
- Promotion of rainfall harvesting and storage;
- Preparation of international agreements on shared water basins for the rivers without agreements, at least on pilot rivers; and
- Initiation of integrated management of selected major rivers.

11.2.3 Theme III:

Development of Appropriate Supporting Legal and Institutional Frameworks

Few countries in the region have appropriate legal and institutional frameworks to meet the challenges brought about by the environmental problems caused by land-based activities. Their legal and institutional framework is characterized by weak co-ordination between ministries, overlapping jurisdictions, conflicting objectives, and weak implementation of land-use plans. Appropriate structures and strategies for co-ordination of policies, planning and implementation of environmental issues in an integrated manner does not exist in most of the countries.

(A) Identified Issues

- Weak co-ordination and integration among institutions, sectors and different levels of governance;
- Inadequate enforcement of regulations and legislation;
- Lack of strategic planning for environmental protection and management of coastal, marine and associated freshwater environment at the national and local levels;
- Inadequate national environmental legislation and decision-making;
- Inability to integrate economic development objectives with environmental management objectives;
- Lack of integrated river basins and coastal management/planning; and
- Weak link between the information base and the decision-making process.

(B) Objectives:

- Operationalise and strengthen the Nairobi Convention into a more effective regional co-ordinating mechanism;
- Ratify and implement regional and international conventions relevant to the sustainable management of marine and coastal resources;
- Assist the national policy review process;
- Promote application of EIA procedures to all new projects that are likely to have impacts on the coastal and marine environment;
- Develop regional codes, standards and guidelines for sound environmental management of the coastal and marine environment; and
- Introduce, prepare and execute integrated coastal management strategies and plans.

(C) Proposed activities

- Assist the countries of the region to review their national policies for the purpose of harmonizing economic and environmental policies and practices;
- Develop EAI protocols;

- Assist the countries in the development of criteria for siting new coastal structures; tourist complexes and development zones, e.g. heavy-industry export processing zones, aquaculture zones and coastal mining;
- Establish Regional Codes, Standard and Guidelines for pollution;
- Develop a precautionary physical planning code for the coastal areas and link it to a zoning determination (the more environmentally sensitive the area, the more precautionary) (pilot scale);
- Prepare and adopt sets of regional guidelines for industrial sewage treatment and disposal; and
- Develop decision support systems e.g. GIS databases and resource

11.2.4 Theme IV:

Support to Human Resources Development, Technical and Infrastructural Capacity Building

Despite past efforts to increase technical capacity to manage coastal and marine environment, the numbers of trained practitioners is still low in most of the countries of the region. This inadequate capacity is one of the main constraints in successful implementation of different initiatives in integrated coastal management at both levels of decision-making as well as research.

(A) Identified Issues

- Limited expertise in important fields such as ecosystems management, socio-economic assessment, hydrography, environmental auditing, cleaner production techniques and integrated coastal zone management; and
- Limited data and information systems (physical, technical, socio-economic, etc.) relating to the coastal and marine environment in terms of quality and resource-use patterns.

(B) Objectives

Address the shortage of human and technical capacity through improved education, training and research.

(C) Proposed activities under this objective include:

- Provide support to regional centres of excellence to promote experience and information exchange;
- assess the short- and medium-term training needs at different levels as far the GPA activities are concerned
- assess the available training capacity in the region;
- Prepare and implement regional training programmes in: environmental auditing and management, EIAs procedures and cleaner production techniques and practices;
- assistance for library services and creation of searchable database of literature available in the regional libraries (through RECOSCIX-WIO); and
- Support the Western Indian Ocean Marine Science Association (WIOMSA) as an independent source of scientific expertise, particularly in establishing and co-ordinating activities of the different thematic Regional expert working groups on issues/aspects relevant to the GPA/LBA at the regional level.

11.2.5 Theme V:

Improvement of the Monitoring and Assessment of Key Aquatic Environmental Indicators

There are no long-term environmental monitoring networks for the quality of surface water, groundwater or coastal waters in the region; most of the monitoring programmes are planned and implemented by individual institutions, with minimal contribution to the research and decision-making processes at the national and regional levels.

(A) Identified Issues

- Lack of monitoring and assessment of aquatic environment economic valuation techniques for undervalued coastal resources usually not considered to be essential;
- Inadequate regular and standardized long-term monitoring programmes; and
- Inadequate baseline data and monitoring modules on the status of the coastal, marine and associated

freshwater environment for managers.

(B) Objectives

- Promotion of marine and coastal environment assessment, monitoring and evaluation aimed at gathering information for decision-making processes; and
- Establishment of continuous monitoring and evaluation on the state of the resources, pressure of use and effectiveness of management measures to ensure sustainability.

(C) Proposed activities are to prepare and adopt:

- Regional guidelines for development of ecological status and stress reduction indicators;
- Regional guidelines for river and coastal areas pollution monitoring programme; and
- Regional plans for establishment of regional pollution monitoring, reporting and data quality assurance programmes for rivers and coastal and marine environment.

11.2.6 Theme VI:

Enhancement of Environmental Education, Public Awareness and Participation and Information Dissemination

For the successful implementation of strategies to address impacts on the environment due to land-based activities, the need for broad-based participation by relevant stakeholders cannot be over-emphasized. Communities cannot make significant contribution to the implementation of environment management strategies without having adequate knowledge of the issues and how the community actions affect the environment. Well-informed stakeholders have a better chance of developing positive rather than purely defensive policies and adoption of new technologies/strategies becomes much easier.

(A) Identified Issues

- Low priority given by many government institutions to support public awareness of environmental issues;
- Inadequate expertise in integrating environmental awareness initiatives with economic development programmes which could have impact on the environment;
- Poorly informed and limited number of effective environmental NGOs;
- Inadequate participation of community groups in promotion of public awareness;
- Lack of emphasis in environmental education in school curricula;
- Lack of ownership and responsibility for environmental initiatives; and
- Limited exchange of information and lessons learnt.

(B) Objectives

- Enhance public awareness and participation;
- Promote and engage stakeholders in the planning and implementation of policies, management measures, projects and programs on coastal zones;
- Involve the public in coastal and marine environment decision-making;
- Empower coastal stakeholders to manage their resources;
- Enhance horizontal and vertical integration in coastal governance;
- Improve the scientific knowledge on ecosystem functioning and productivity;
- Conduct periodic assessments and evaluation on major and critical marine and coastal resources;
- Promote the teaching of the environmental education in schools; and
- Develop public awareness tools.

(C) Proposed activities under this objective include:

- Organize targeted workshops for the representatives of ministries of education and other relevant institutions to review the potential for increased coverage of coastal and marine environment issues in their programmes and curricula;

- Prepare teachers guides and educational materials on coastal and marine environment subjects;
- Produce a series of awareness and educational materials focusing on regional issues for distribution to all participating countries; and
- Organize a regional seminar for key representatives from the media for the purpose of raising awareness of GPA/LBA issues at the regional and national levels and identify their roles.

11.2.7 Theme VII

Support and Development of Integrated Coastal Policy Guidelines for Sustainable Coastal Development in Eastern African Countries.

To successfully implement any strategies, there is need for a policy framework to support the implementation process. There is need, on a pilot scale, to select three mainland and two island eastern African countries, and develop coastal development policy guidelines to manage their dynamic and frequently overused coastal resources.

The need for a coastal development policy has been recognised and stated in various research findings and project papers. The policy's guidelines will build on the findings of the UNEP-funded programmes, notably the EAF/5, EAF/14 projects and the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities. Considerable work on coastal management has been done with support from the Swedish International Development Authority (SIDA), UNEP, FAO Danida and the government of Finland. However, the resulting findings and recommendations cannot be implemented because clear development policies for the Coastal areas are lacking.

The development of an Integrated Coastal Development Policy will be as a response to the recognition of the vital role that the coastal region can play in the future development of African states, and the need for a framework for the development of consistent management strategies

(A) Identified Issues

- Poor physical access to the sea;
- Un-equitable access to the opportunities and benefits of the coast.

(B) Objectives

- Allocate and use coastal resources in a fair and just manner, giving particular attention to the needs of disadvantaged communities;
- Ensure that the public has the right of equitable access to the opportunities and benefits of the coast, on a managed basis;
- Promote the diversity, vitality and sustainability of coastal economies and activities, giving preference to those that are distinctly coastal or dependent on a coastal location.

The Integrated Coastal Policy development process will strive to fulfil five fundamental objectives considered to be essential for sustainable programmes:

- Promote meaningful public participation: The programme will ensure that all the stakeholders will have the opportunity to participate in all stages of the policy formulation process, thereby ensuring broad ownership and commitment of the final policy.
- Build upon the scientific framework for Coastal Zone Management: The policy will build on the considerable wealth of knowledge and understanding generated by previous coastal zone programmes and resources that have been developed through scientific research over the years.
- Promote integrated coastal management: Practical coastal management will require partnerships between government, civil society and the private sector. Integrated Coastal Management also refers to the need to coordinate and integrate the activities that take place at the coast.
- Develop country-specific practical policies: The policy will be focused and practical, addressing priority and strategic coastal issues. As a practical policy, it will be developed from strategies that will be continuously

evaluated during policy formulation, implementation, monitoring and evaluation of results. Where appropriate, revisions will be made to both the policy and the implementation measures.

- Engage meaningfully with the scientific community, the public and all levels of government in each of the participating countries.

Short-term Objectives

- Coastal planning and management efforts that proactively seek to realise the long-term economic development potential of coastal localities and regions;
- Allocate and provide for appropriately located and financially sustainable ports, small-craft harbours and related facilities;
- Allocate adequate and suitable public facilities at appropriate coastal locations;
- Identify opportunities for mariculture and encouraged at appropriate coastal locations; and
- Identify, develop and promote coastal tourism and recreational opportunities at appropriate coastal locations.

(C) Proposed activities are to prepare and adopt:

- Country-specific (for the five pilot countries) policy papers and guidelines on 'How to Develop an Integrated Coastal Policy'; and
- Regional guidelines on developing an integrated coastal policy.

12. THE ROLE FOR THE REGIONAL COORDINATING UNIT (RCU)

Strengthening of the Nairobi Convention means that we provide a reliable and efficient delivery mechanism to deal with the issues stated in Chapter 11 above at both the national and local levels. The existing Eastern African Regional Coordinating Unit (EAF/RCU), together with its Contracting Parties Bureau shall act as the Secretariat. The RCU shall develop a programme that will support the regional institutions as well as guide national institutions. Its programmes shall in turn be supported by regional experts.

This will be achieved through the setting up of technical steering committees or issue-based working groups (WGs). These WGs will operate from Activity Centres (ACs), not necessarily based in the Seychelles, but coordinated in a revamped RCU. The WGs will source expertise from regional institutions, e.g. Institute of Marine Science (IMS) in Tanzania or the Oceanographic Research Institute in Durban (if South Africa accedes to the Nairobi Convention as promised).

Activity Centres

UNEP, in close collaboration with the Contracting Parties Bureau and the EAF/RCU as the Secretariat of the Nairobi convention, will request regional NGOs (e.g. IUCN or WWF), government departments or parastatals (such as The Natal Parks Board or Kenya Wildlife Service) to choose one or more institutions among them with the adequate infrastructure and a regional mandate to deal with relevant thematic areas. Activity Centres will thus be established through MOUs or formal affiliation to the Nairobi Convention, and shall become Centres of Excellence for the RCU. The thematic areas to be dealt with are as follows:

Theme I	Addressing the priority sources and activities of the land-based sources of pollution;
Theme II	Integrated management of major and international freshwater basins and groundwater;
Theme III	Development of appropriate supporting legal and institutional frameworks;
Theme IV	Support of human and technical capacity building;
Theme V	Improvement of the monitoring and assessment of key aquatic environmental indicators;
Theme VI	Enhancement of environmental education, public awareness and participation; and
Theme VII	Support and Development of Integrated Coastal Policy Guidelines for Sustainable Coastal Development in Eastern African Countries.

The Natal Parks Board or Kenya Wildlife Service, for example, could deal with subjects relevant to the implementation of the protocols of the Nairobi Convention, e.g. the protocol relating to the protection of the wild flora and fauna. The South African Coastal Management Programme could become the Regional Activity Centre for Theme II: Integrated management of major and international freshwater basins and groundwater. Similarly, IMS could be concerned with Theme I and SEACAM with Theme IV. In this way, the expertise resident in these national institutions in Kenya, South Africa, Tanzania, etc. will become available to the RCU and the region as a whole. In return, the regional institutions will become the vehicles through which information can be passed on to governments. The governments of the region could also contribute both in kind and monetarily to the Activity Centres and the RCU, and thus strengthen the political support that has so far been lacking.

The initial phase of the implementation of the Strategic Action Plan will require the provision of a Coordinator, a Programme Officer, a Programme Assistant and a Consultant. The overall coordination shall be the responsibility of the Coordinator of the EAF/RCU. The direct responsibility for implementation shall rest with a Programme Officer, assisted by a Programme Assistant. One or more subject matter specialists will be hired on a consultancy basis to develop concrete project proposals for each of the seven thematic issue areas. A consultancy of a total of 14 man months is considered adequate, equivalent to an average of two man months for each thematic area.

Implemented in this way, the SAP will contribute to the sustainable use of the marine, coastal and associated freshwater environment and to the development of management capacity of coastal populations in the eastern African region.

REFERENCES

- Ali, A.F. 1997. Rapport sur l'évaluation des sources telluriques des pollutions ayant des impacts sur l'environnement marin et côtier.
- Alawi, J; Ame, A.; Juma S.; and Y. S. Kombo (1994). Report on Communal Washing Dips Study. Unguja Island-Communal Washing Dips. DoE, Zanzibar .6p
- Baquete, E. F. and Huaengue, M. A. 1993. Preliminary assessment of land-based sources of pollution (The case of Maputo). Ministry of Health, Maputo.
- Buuren, J.C.L van and Heide, J. van. 1995. Abatement of the Water Pollution in the Infulene Basin. Final Report of the Infulene Water Quality Management Project 1991-1994. Universidade Eduardo Mondlane and Delft University of Technology Report no 63.
- Casadei E., Costa M., Repetto G., Cardoso C. and Halari J..1985. Influência de factores múltiplos sobre os níveis de nitratos em poços da cidade de Maputo. Proceedings from the V National Health Research Workshop. Inhambane, 4-9 November 1985.
- FAO/UDSM/UNEP. 1998a. Regional overview of the land-based sources of pollution and activities affecting the marine, coastal and associated freshwater environment in the Eastern African Region. Report prepared for: the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities in the Eastern Africa Region and the Project on Protection and Management of the Marine and Coastal Areas in the Eastern Africa Region (EAF/5). 33pp.
- FAO/UDSM/UNEP. 1998b. Workshop report for the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities in the Eastern Africa Region and the Project on Protection and Management of the Marine and Coastal Areas in the Eastern Africa Region (EAF/5). 50pp.
- Fernandes, A. 1995. Pollution in Maputo Bay: contamination levels from 1968 to 1996. Revista Médica de Moçambique(6), nE3-4, 27-31. Instituto Nacional de Saúde.
- Fernandes, A. and Hauengue, M. A. 1997. Protection and management of the marine and coastal areas of the Eastern African Region (EAF/5): Land-based sources and activities affecting the coastal marine and associated fresh water environments; Mozambique National Report. 25 pp.
- Jiddawi, N. S., Kombo, and A. H. Nassor, N. S. (1992). Status of the Marine Fisheries in Zanzibar. International Course in on the Management for Sustainable Fisheries. Tromso, Norway.
- Jootun, L., Bhikajee, M., Prayag, R. and Soyfoo, R. 1997. Report on inventories of land-based sources of pollution in Mauritius.
- Kazungu J.M (1989): Seasonal fluctuations of nitrate- nitrogen concentrations in the Tudor estuary, Mombasa, Kenya.
- Kouassi, A. M., 1994. Evaluation qualitative et quantitative des sources telluriques de pollution en Republique federale islamique des Comores. Report to the FAO, Centre de Recherches, Cote d'Ivoire.
- Mgana, S. and Mahongo, S. 1997. Land-based sources and activities affecting the quality and uses of the marine, coastal and associated fresh water environment. 47 pp.
- Ministério da Saúde. 1993. Reconhecimento das condições de Higiene e Saneamento do meio nos Bairros suburbanos da cidade de Maputo. Projecto de Apoio ao Departamento de Higiene Ambiental-MOLISV.
- Mohammed, S. M. 1997. Assessment of land-based sources of pollution in Zanzibar. Institute of Marine Sciences, Zanzibar.

- Munga, D., Yobe, A. C., Owili, M. and Mwanguni, S. M. 1993. Assessment of land-based sources of pollution along the Kenyan coast. Report prepared for the WHO, Kenya Marine and Fisheries Research Institute, Kenya.
- Mwanguni, S. and Munga, D. 1997. Land-based sources and activities affecting the quality and uses of the marine coastal and associated freshwater environments along the Kenya coast. Coastal Development Authority, Mombasa.
- Oteko D.(1987): Analysis of some major and trace metals in the sediment of Gazi, Makupa and Tudor Creeks of Kenya Coast. A comparative investigation into the anthropogenic input levels. MSc. Thesis, FAME. Free University of Brussels 190pp.
- Our Coast, Our Future (1998). Coastal Policy Green Paper: Towards Sustainable Coastal Development in South Africa. Department of Environmental Affairs and Tourism, South Africa.
- Radegonde, V. 1997. Update Seychelles National Overview on land-based sources and activities affecting the marine, coastal and associated freshwater environment. Seychelles Bureau of Standards, Seychelles.
- Ranaivoson, J. 1997. Rapport sur les sources et activites continentales marin, cotier et d'eau douce associede Madagascar. 24 pp.
- Rakotoarinjanahary, H., Razakafoniaina, T. N., Kaderbay, B. and Ranaivoson, E. V. 1994. Inventory of sources and level of pollutants in Madagascar. Centre for Oceanographic Research, Madagascar.
- UNEP. 1995. Global Programme of Action for the Protection of the Marine Environment from Land-based Activities. Intergovernmental Conference to Adopt a Global Programme of Action for the Protection of the Marine Environment from Land-based Activities. Washington, D.C. 23 Oct - Nov, 1995. Document No UNEP(OCA)/LBA/IG.2/7. 60pp.

ANNEX I - Summary of Proposed Programme of Action Caring for the Seas: the Contribution of UNEP and its Partners

Managing the quality of the marine environment is of fundamental importance at the national, regional and global levels. UNEP's policy goals and priority programmes are aimed at ensuring integrated management and sustainable use of coastal and marine areas; protecting the marine environment from land and sea-based pollution; ensuring the integrated management and development of water resources; and protecting water resources quality and aquatic ecosystems.

The recent and on-going discussions under the aegis of the Commission for Sustainable Development and most recently, at the United Nations General Assembly Special Session, (1997) have provided a useful opportunity for stock-taking. Some priorities for action have been identified, which include the need for:

Continued improvement in decision making at the national, regional and global levels on the Marine Environment;

Periodic intergovernmental reviews of all aspects of the Marine Environment and related issues as reflected in Chapter 17 of Agenda 21;

The ratification of relevant Agreements and the implementation of the UN General Assembly Resolutions on the Implementation of Integrated Coastal Zone Management Programmes;

Better identification of priorities for action at the global level to promote the conservation and sustainable use of the Marine Environment;

International cooperation to support the strengthening of regional and sub-regional Agreements for the Protection and Sustainable Use of the Oceans and Seas;

Improvement of the quality and quantity of scientific data as a basis for effective decisions related to the Protection of the Marine Environment and the Conservation and Management of the Marine Living Resources;

Greater international cooperation to Operationalise data networks and clearing houses for information sharing on oceans;

It was to achieve the above goals that the Regional Seas Programme of UNEP was launched, a little over two decades ago, as a global programme implemented through regional components, for the protection and development of the marine and coastal environments as well as their resources. The recently adopted Global Programme of Action to Protect the Marine Environment from Land-based Sources represents a renewed effort to conserve the Marine and Coastal Environments. The following are indicative:

At present, the Regional Seas Programme under the auspices of UNEP covers thirteen regions world-wide with well over 140 coastal States and Territories participating. It is an action-oriented programme focused not only on the mitigation or elimination of the consequences but also of the causes of environmental degradation. It has a comprehensive, integrated, result oriented approach to combating environmental problems through the rational management of marine and coastal areas.

Each regional action plan, i.e. the substantive part of any regional programme, is designed to link assessment of the quality of the marine environment and the causes of its deterioration with response actions for the management and development of the marine and coastal environment.

The regional action plans promote the parallel development of regional legal agreements. With the cooperation of appropriate global and regional organizations, reviews on the specific environmental problems of the region are prepared in order to assist the governments to identify the most urgent problems in the region and the corresponding priorities assigned to the various components of the action plan.

An important element for the success of the Regional Seas Programme has been the demonstrated political commitment of the governments concerned and the execution of the Programme, primarily by national

and other appropriate institutions from the regions, in close co-operation with the relevant components of the United Nations system, regional organizations and other appropriate organizations.

Under the Programme, new legal agreements are developed for the various regions in response to emerging issues. Existing programmes also continue to be reinforced, with new protocols adopted.

A leading role in the assessment of global marine pollution problems involving the Agencies of the United Nations system is played by the Group of Experts on Scientific Aspects of Marine Pollution (GESAMP), the IOC/IMO/FAO/UNESCO/WMO/WHO/International Atomic Energy Authority (IAEA)/United Nations/UNEP-sponsored Group of Experts on the scientific aspects of marine environment protection.

The Global Investigation of Pollution in the Marine Environment (GIPME), launched over two decades ago, gradually evolved into one of the major programmes of the Intergovernmental Oceanographic Commission (IOC). The joint IOC-UNEP-IMO sponsorship of GIPME facilitates coordination of the marine pollution programmes of IOC and UNEP and the rational utilization of resources for an accelerated implementation of the marine pollution related programmes of the three organizations.

In view of the recognized need for a comprehensive and well coordinated long-term global monitoring programme to observe the changes in phenomena related or which may be related to climate changes, IOC, World Meteorological Organization (WMO) and UNEP have been closely collaborating, taking into account ongoing international, regional and national programmes in this area;

In response to the global concern about climate changes, UNEP over the years, did organize regional task teams to consider the effects of such changes on coastal and marine areas and on socio-economic activities;

UNEP is coordinating the preparation of the assessments of oceans expected to be ready by the year 2002, in cooperation with other agencies through a Working Group on Marine Environmental Assessments of the Joint Group of experts on the Scientific Aspects of Marine Environmental Protection (GESAMP); An assessment of the impact of land-based activities, as a first stage of the assessment; is expected to be available by the end of 1998, the Year of the Oceans and for consideration at the 7th Session of the Commission for Sustainable Development (CSD).

These updated reviews, assessing land-based sources and activities affecting the quality and uses of the marine, coastal and associated freshwater environment will be based on critical analysis and evaluation of available data and information provided by governments, as well as databases of relevant regional programmes, agencies of the UN system, intergovernmental and non-governmental organizations.

UNEP is also assisting the regions to get a real picture of the main pollutants from land-based sources entering their coastal waters. The first global review will be based largely on existing regional reviews within the framework of UNEP's Regional Programme. Such reviews are already available for some regions (both in UNEP's Regional Seas Programme and other regional initiatives);

UNEP participates in international efforts aimed at enhancing the understanding of the biological component of the seas in order to ensure its environmentally sound protection and management;

Responding to the growing concern over the impacts of driftnet fishing, as expressed in General Assembly resolutions, UNEP did initiate in the past, a number of concrete actions to determine the environmental impacts of this fishing technique and to consider and adopt management measures. Efforts to address driftnet fishing by major agencies and bodies inside and outside the United Nations system are being co-ordinated by UNEP as a Secretariat, through the Global Plan of Action for the Conservation, Management and Utilization of Marine Mammals, since the incidental catch of marine mammals is one of the major impacts of driftnet fishing.

A number of international agreements now supplement national regulations aimed at protecting the seas. However, much remains to be done to control land-based sources, the main contributors to contamination of the sea and this global concern culminated in the 1995 adoption of the Global Programme of Action to Protect the Marine Environment from Land-Based Activities (GPA). The primary goal of the GPA is to assist governments to take actions aimed at the prevention, control and reduction of the degradation of the marine environment and

associated freshwater systems from land-based activities;

Fostering and facilitating the formulation of such programmes is the main task of UNEP and its partner agencies in this endeavor. Implementation of the GPA is being addressed simultaneously at the national, regional and global levels. UNEP, as Secretariat of the Programme of Action, is: (a) promoting and facilitating its implementation at the national level; (b) promoting and facilitating implementation at the regional, including sub-regional, level through, in particular, a revitalization of the Regional Seas Programme; and (c) playing a catalytic role in the implementation at the international level with other organizations and institutions.

UNEP is an active partner, together with Governments and other international organizations such as the World Bank and World Conservation Union (IUCN), in the International Coral Reef Initiative (ICRI). ICRI was established to raise awareness of the global decline in the health of coral reefs and to facilitate action to reverse coral reef degradation. UNEP, through its Regional Seas Programme, is playing an active role in the development, implementation and coordination of regional activities under ICRI.

In response to the need for data and information on the status of coral reefs, UNEP in collaboration with the IOC and IUCN is sponsoring the Global Coral Reef Monitoring Network (GCRMN), an activity under ICRI. The GCRMN recently finalized its Strategic Plan and will bring together resource managers, stakeholders and scientists for the collection, dissemination and use of assessment and monitoring information on coral reefs. The GCRMN will contribute to the implementation of Chapter 17 of Agenda 21 and other international conventions and agreements, particularly the Convention on Biological Diversity and GPA.