The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA)

THE NATIONAL PROGRAMME OF ACTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT OF SUDAN FROM LAND-BASED ACTIVITIES

Higher Council for
Environment and Natural Resources

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ACRONYMS AND ABBREVIATIONS

BMOT-1	Bashayer Marine Oil Terminal-1
BMOT-2	Bashayer Marine Oil Terminal-2
BOD	biological oxygen demand
CBO	community-based organization
CPA	Comprehensive Peace Agreement
CZMP	coastal zone management plan
DDT	dichlorodiphenyltrichloroethane
DO	dissolved oxygen
EIA	environmental impact assessment
FAO	Food and Agriculture Organization
FMSF	Faculty of Marine Sciences and Fisheries
GOSS	Government of Southern Sudan
GONU	Government of National Unity
GPA	Global Programme of Action
HCENR	Higher Council for Environment and Natural Resources
ICZM	integrated coastal zone management
IIMS	integrated information management system
IMO	International Maritime Organization
INCRS	Interim National Constitution of the Republic of Sudan
LBA	Land-based Activities
MAIAR	Ministry of Agriculture, Irrigation and Animal Resources
MEFPD	Ministry of Environment, Forestry and Physical Development
MET	Ministry of Environment and Tourism
MOP	Ministry of Petroleum
MT	metric ton (tonne)
MTRB	Ministry of Transport, Roads and Bridges
NEF	National Environmental Fund
NFP	National Focal Point
NGO	non-governmental organization

NPA	National Programme of Action
NOSCP	National Oil Spill Contingency Plan
NOSRC	National Oil Spill Response Centre
NPEM	National Plan for Environmental Management
PCB	polychlorinated biphenyls
PERSGA	Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
POPs	persistent organic pollutants
PSR	Port Sudan Refinery
RSS	Red Sea State
RSU	Red Sea University
SCENR	State Council for Environment and Natural Resources
SECS	Sudanese Environment Conservation Society
SFZ	Sudanese Free Zone
SMA	Sudanese Maritime Authority
SPC	Sea Ports Corporation
SSMO	Sudanese Standard Measurement Organisation
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WRF	waste reception facility

PREFACE

The protection of the marine environment is one of the most important tasks facing mankind. The seas cover 70% of the Earth's surface and they play a crucial role in stabilizing the global climate and maintaining ecosystems. The state of the marine environment affects our lives much more than most of us realize.

The seas have throughout the ages been a major source of food for mankind. In modern times many began to see a new utility in the oceans, as a convenient giant dustbin for mankind's refuse. We now know that this is an illusion, the circulation of matter in the ecosystem means that our pollutants come back to haunt us, on the beaches we play on, in the seafood we consume, and in the damage to ecosystems that are vital to the web of life.

One of the most encouraging trends in global environmental affairs in recent years is that the fight against the pollution of the oceans is beginning to bear fruit. The international conventions that address this concern are a big step in the right direction. A particular example is the intergovernmental initiative known as the Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-Based Activities, declared in Washington, 1995. The significance of the GPA can perhaps best be understood after recognizing that 80% of marine pollution comes from land-based sources.

To support these global trends, PERSGA developed a regional protocol for the protection of the marine environment from land-based activities; Sudan has signed and approved this protocol.

Accordingly, the Sudan National Programme of Action (NPA) for the Protection of the Marine Environment from Land-Based Activities has been prepared as a national document under the umbrella of PERSGA's Regional Programme of Action (RPA). The plan consists of specific actions to be taken, along with a rough assessment of the scope of each action. The National Plan of Action offers a comprehensive overview of actions needed for halting pollution from land-based sources, and is a useful instrument for prioritizing actions and measuring progress in the coming future.

The sea along the Sudanese coast is relatively unpolluted. The pollution that does exist comes to a large extent from land-based sources and maritime activities around the sea ports and oil terminals. It is a valid question if Sudan should make the national implementation of the RPA a priority, considering those facts. I can say that the answer is obvious as Sudan is committed to preserving the marine environment by reducing and stopping pollution from domestic sources. This report contains a comprehensive and ambitious plan to halt land-based pollution in Sudan. Its implementation will help Sudan to prove its commitment as a leading country in the fight against pollution of the seas.

It is a great pleasure to successfully launch this national document, signifying the needs and opportunities for the protection of the coastal environment and associated lives and livelihoods.

I would like to thank PERSGA and the supporting team of experts and all those involved in the preparation and finalization of this document and I believe that implementation of these policies and programs will improve the overall environment of the country, in particular our special coastal environment.

Engr. Joseph Malwal Dong
Minister of Environment, Forestry and Physical Development.

EXECUTIVE SUMMARY

Sudan's National Programme of Action for the Protection of the Marine Environment from Land-based Activities has identified a number of priority issues. These are: industrial waste, oil transport, sewage disposal, solid waste management, persistent organic pollutants (POPs), salinity intrusion, rapid urbanization of the coastal zone, non-sustainable shrimp farming, coastal tourism and change in land use patterns.

The United Nations Environment Programme (UNEP) formulated the Global Programme of Action in 1995 to protect the coastal and marine environment from land-based activities. Sudan is committed to the promotion of integrated coastal zone management and the reduction of pressure on marine environments. This National Programme of Action (NPA) was developed under PERSGA's Regional Programme of Action (RPA) for the Protection of the Marine Environment from Land-based Activities in the Red Sea and Gulf of Aden Region. It was prepared based on the available secondary information. It highlights the necessity to develop strategies for the implementation of individual and joint actions (through policies, priority setting and resource allocation) for the prevention, reduction, control and eventual elimination of marine environmental degradation caused by land-based activities.

The National Programme of Action incorporates these challenges within the context of integrated coastal zone management. It takes into account the coastal management background of the past, introduces the procedures and arrangements that preceded the consolidation of this document and adopts the methodological framework suggested by UNEP under the GPA. The methodology consists of six steps:

1. Identification and assessment of problems
2. Establishment of priorities for national action
3. Setting of management objectives for priority problems
4. Identification, evaluation and selection of strategies to achieve goals and objectives
5. Determination of criteria for evaluating effectiveness of strategies and measurement
6. Organization of programme support unit

GOALS AND TARGETS:

Primary goals and targets of the National Programme of Action are to protect the coastal and marine environment of Sudan from different land-based activities. Proper management of solid waste, management of industrial waste, improved technical capacity (through training, awareness, research and monitoring), assessment of environmental flow requirements and salinity intrusion, establishment of a central database directory and information system, and full preparedness for response to natural disasters have been identified as key steps to meet goals and targets.

Nine major issues/problems have been identified as the main sources of coastal and marine pollution. The issues are as follows:

- Solid waste management
- Industrial waste
- Oil transport
- Sewage disposal
- Salinity intrusion
- Rapid urbanization of the coastal zone
- Shrimp farming
- Coastal tourism
- Changes in land use patterns

Considering the above mentioned priority problems, strategies have been identified to protect the coastal and marine resources from land-based activities.

Action programmes and major activities have been identified. The action programmes are as follows:

- Manage domestic solid waste
- Upgrade environmental management at the marine oil terminals (Bashayer 1 and 2, and Alkheir)
- Establish three water quality monitoring stations at hot spots along the Sudanese coastline
- Establish air quality monitoring stations in industrial areas (Salabona, Shahinat and SFZ)
- Implement a rehabilitation programme for mangrove stands
- Execute a project for supporting and strengthening the capacity of industrial investment in the new SFZ
- Establish a National Environmental Fund
- Develop and implement comprehensive and harmonized coastal zone management legislation and management plans
- Develop a coastal benthic habitat map
- Complete the ratification of environmental conventions and protocols
- Initiate public awareness programmes
- Conduct technical training programmes

1. INTRODUCTION

1.1 THE SUDANESE COASTAL ZONE

The Sudanese coast stretches from north to south for about 475 miles along the Red Sea between Egypt and Eritrea. The coastline of Sudan hosts a unique diversity of ecosystems. There are numerous islands scattered along the coast, the majority of which have no fresh water or vegetation and are uninhabited. The average rainfall in the coastal area is generally extremely low, about 36 mm/yr at Halaib and 164 mm/yr at Suakin, so the desert extends right up to the high tide mark. The only exception is in the Tokar delta which receives substantial runoff from seasonal streams originating in the Ethiopian and Eritrean highlands.

The dominant coastal forms are silt beaches, rocky headlands and salt marshes, commonly found with mangrove stands. Fringing coral reefs are very common and water clarity is generally very high due to the lack of sedimentation. The islands and most of the coastline are relatively undisturbed and host important feeding and nesting sites for a range of seabirds and migratory waders.

The Sudanese Red Sea is famous for its attractive and mostly pristine habitats, especially its coral reefs. Three distinct depth zones have been recognized: the shallow reef-studded shelves of less than 50 m, the deep shelves of 500–1,000 m, and the central trench of more than 1,000 m, reaching a maximum depth of 3,000 m, measured off Port Sudan city.

The Red Sea is home to a variety of pelagic fish including tuna but overall fish density is relatively low due to limited nutrient inputs into the sea. Important mammals include dugong, dolphin and whales. Other important populations include seabirds and turtles. In general, the coastal and marine biodiversity on the Sudanese coast are still in a very good condition.

The assessment in this report is based on data already available on the marine resources of Sudan. It covers and updates the main environmental issues on the coast but does not extend to a survey of the condition of any of the habitats.

1.2 SCALE AND NATURE OF COASTAL ACTIVITIES

The various types of coastal activities taking place in Sudan occur at different scales; some use advanced technology, some are conventional or traditional.

Gleaning is practiced to collect shellfish and sea cucumber. The former is consumed in the local market and the latter is exported to Asian countries. Recently however, scuba diving equipment has been used to collect sea cucumber to increase the harvest. It is also common for the local people to collect and sell the fruits of the naturally growing trees such as Desert Dates (*Balanites aegyptiaca*) and Seder. The vegetative branches of the Arak tree (*Salvadora persica*) are harvested to produce muswak.

Tourism is of small scale and mainly driven by the private sector. The major and sometimes the only activity present is diving at coral reef sites around Port Sudan. The season starts from October and runs till May. The usual programme involves taking a group from the airport to a yacht, to the dive sites, and finally back to the airport. This is largely due to the

lack of infrastructure such as suitable hotels and the lack of supporting cultural and social activities. A privately owned ecotourism resort has been established at Arous. On average, around 18 yachts come from overseas to serve the tourists each year.

Industrial plants and their activities in the Red Sea State have been adversely impacted over the last decade by shortages in electricity and water supply. Most of the plants in the northern industrial area were closed down. Recently the state has established two desalination plants to provide a water supply for Port Sudan. The desalination Plant A is located south of the city at Kilo. 8 and Plant B is within the boundaries of the city at the north end of Port Sudan's semi enclosed lagoon. Both of these plants discharge their hypersaline effluent into the intertidal area.

Fishing activities are conventional in term of gear used and the distance covered. However, trawlers from Egypt and Yemen used to trawl in Sudanese waters.

Shrimp farming has recently been introduced to the Red Sea State. Two farms are operating and producing shrimp for export.

Maritime transportation is the largest and most dominant activity. The main port at Port Sudan consists of the Northern port, the Southern port and the Green port (or Green Harbor). Each port serves specific purposes. The Sea Ports Corporation (SPC), which runs the government ports, has an ambitious plan to develop more ports and berths.

Oil export has a recent history in Sudan. At present two private oil terminals, only few kilometres from Port Sudan harbour, have been established to export Sudanese crude oil.

Artisanal agriculture is mainly practiced in the beds of wadis (khors), either at the lower or the upper reaches, by individuals from the local communities. To maximize the benefits of the scarce freshwater resources the administration of Water Harvest of the State Ministry of Agriculture, Irrigation and Livestock builds sand barriers across the beds of the wadis to hold back water for irrigation.

The largest agricultural project was established in the Tokar Delta area, mainly to produce cotton and vegetables. Unfortunately the project confronted many problems such as the invasion of alien plants and unreliability of freshwater inflow.

Grazing could be considered as the principal livelihood practiced by the indigenous communities. They follow a seasonal migratory movement in accordance with rainfall and range availability using their local knowledge to manage the scarce resources. The practice is affected by inconsistent rainfall which influences the historical pattern of migratory grazing.

Charcoal production proliferated as an alternative livelihood in the aftermath of the waves of drought that hit the coastal state in the last century. Charcoal production has been practiced since the Roman period; however the method of production has been modified. The practice is considered to contribute to desertification in the state.

Sea salt production is undertaken along the coastal stretch between Port Sudan and Suakin. A large area is used to produce table salt by evaporation of sea water by the sun. Most of the saltpans are owned by the private sector except for the governmental Rawia which is a natural saltpan in a low lying area.

Landfill practices are a great concern. The waste produced by the city is not properly sorted, collected, transported or treated. A portion of the solid domestic waste is collected from the city and dumped in open areas around the city boundaries. Some individuals search these dump sites to find items of value to sell, without paying attention to the health hazards. Open rubbish dumps are common in empty spaces between houses or on the edges of streets where collection of domestic waste is absent. Ultimately, a significant amount of the solid waste reaches the sea due to surface run-off during the rainy season and due to flash floods. Accordingly, the shoreline and mangrove areas are littered with solid materials that degrade slowly such as plastic bottles, plastic bags, cans, and packing materials (Figure 1).

Figure 1: Plastic waste near a salt pond south of Port Sudan.

1.3 SOCIO-ECONOMICS

The Red Sea State (RSS) (Al Bahar al Ahmar) is one of the 25 states (wilayat) of the Republic of Sudan. The population of the RSS was 846,500 (1993 census) with an annual growth rate of 2.9%, slightly above the national rate. The area of the state is about 260,000 square kilometres. The Red Sea State's capital Port Sudan is, as its name suggests, the country's major seaport as well as home to about 55% of the state's population and over 90% of the overall urban population in the region.

The Beja pastoralists and agro-pastoralists have inhabited the area for a long period. However, a wide variety of ethnic groups from across the country can now be found living in Port Sudan. Today, the majority of the population of the Red Sea State is experiencing severe livelihood erosion and increasing vulnerability. Many factors such as the lack of development policies, basic services and infrastructure have seriously weakened the ability

of most rural communities to maintain livestock, grow crops and sustain alternative sources of income, weakening the ability of Beja pastoralists, in particular, to cope with and recover from drought and other external shocks. Animal husbandry and crop production, though still important, have been progressively relegated to the status of secondary livelihood sources and people are increasingly relying on casual farming work, unskilled urban labour and selling of fuel-wood and charcoal. However, the opportunities for casual work are dwindling, both in urban and rural areas, because of the mechanization of the port and irrigated farming, leading to an ever increasing reliance of many households on the sale of firewood and charcoal as a primary source of income.

Market forces are becoming significant factors of economic stress in Beja livelihoods. This is mainly because the population has become strongly dependent on purchased food. There is ample evidence to suggest that periodic fluctuations in prices of grain, livestock or charcoal have a profound impact on access to food. Given the fact that more than 90% of the food consumed is brought from outside sources, any changes in production in the supplying areas will influence the food security situation in the Red Sea State. Moreover, rural markets are highly fragmented due to poor infrastructure and rudimentary public transport. This leads to unfavourable terms of trade for the more remote and isolated communities in rural areas.

In July 2005 the Red Sea State Ministry of Finance published the socio-economic development plan for the first three years of the interim period, as stipulated by the Comprehensive Peace Agreement (CPA) between the Sudan People's Liberation Movement (SPLM) and the National Congress Party (NCP). The plan was designed along the following guidelines:

- Improvement of infrastructure (electricity, roads, dams, hafirs [underground reservoirs designed for storing rain water], alternative energy)
- Improvement of basic services (education, health, water, sanitation, housing, etc.)
- Human resources development
- Generation of employment opportunities for graduates
- Encouragement of investment, especially by harnessing opportunities for tourism

The general objective of the plan is 'to raise the standard of living of people, both urban and rural, culturally, socially, politically, and administratively, through improved livelihoods, education and health services' (RSS, 2005).

2. METHODOLOGY

2.1 THE GUIDING PRINCIPLES

The ultimate aim of Sudan's National Programme of Action (NPA) is to encourage stakeholders to take the initiative and formulate their own autonomous action to protect the marine environment from their activities. Accordingly, intensive consultation, smart partnerships and transparency have shaped the process of NPA development in order to reach a common census regarding the actions to be taken. Information was collected through observations, and review of recent reports and studies. In addition, personal communication has provided both information and consultancy. The comprehensive approach described in the Guide for National Action (UNEP, 2006) provided the principal direction for building the NPA for Sudan. It emphasises:

- Simplicity; the program should be easily understood by stakeholders and practitioners.
- Achievability; the action to be taken should be achievable within the national circumstances.
- Realism; the program should be realistic both in addressing the problem and in proposing interventions.

The NPA has been developed to suit Sudan's existing geographic characteristics, the political, socio-economic, institutional, and legal frameworks, using the best available and most affordable knowledge.

The following can be noted with regard to the Sudanese coastal area. The northern part of the coast extending for a distance of 350 km, from the Egyptian border in the north to Arouse village in the south, includes the unique coastal biodiversity of the Dungonab Bay/Mukawwar Island Marine Protected Area. It is currently still distant from man-made threats, although the proposed coastal road from Port Sudan to Halaib may create some pressure on the coastal and marine environment in this region in the future.

The central part of the coast extending to about 100 km in length, from Arouse village in the north to Suakin port in the south, is considered the richest part of the Sudanese coast in terms of living and non-living marine resources. It includes the two main coastal cities, Port Sudan and Suakin with more than 50% of the coastal state's population, in addition to five operational ports, three oil terminals, and one proposed marine terminal. (This proposed terminal will be located in a newly planned refinery which is in the funding phase.) All the marine oil terminals are located within this zone. We conclude that this stretch of the coast is subject to mounting environmental pressures and related impacts mainly linked to urban and industrial development.

The southern part, extending from Suakin to the Eritrean border, includes Tokar as the main city and population centre. Here, the marine and coastal environment is still in a good condition except for overgrazing and cutting in the mangrove stands**.**

For the purpose of this report the whole Sudanese coastline has been taken into consideration with regard to the NPA with emphasis on the central part where environmental information is adequately available.

2.2 APPROACH

2.2.1 Initial preparations

The Higher Council for Environment and Natural Resources (HCENR), which is the National Focal Point for PERSGA, was identified as the lead agency. The HCENR is the main government institution within the Ministry of Environment, Forestry and Physical Development (MEFPD). The MEFPD has a multi-functional mandate, including responsibility for drawing up general policy in co-ordination with competent bodies involved in natural resources, determining development and rationalizing the means of use and management, and protection of the environment from deterioration.

A working group was formed which consists of a national consultant from HCENR and two experts from the Faculty of Marine Sciences and Fisheries in the Red Sea University. The terms of reference and the work plan were developed and signed. The funds to develop the Land-based Activities Report and to cover the partners' consultation process were secured by PERSGA.

For the preparation of this National Programme of Action (NPA), a comprehensive framework methodology was developed under the Global Programme of Action (GPA) to protect Sudan's marine ecosystem from land-based activities. This methodology consists of the following six steps:

1. Identification and assessment of problems
2. Establishment of priorities for national action
3. Setting management objectives for priority problems
4. Identification, evaluation and selection of strategies to achieve goals and objectives
5. Determination of criteria for evaluating effectiveness of strategies and measurement
6. Organize/reorganize programme support elements.

2.2.2 Identification and assessment of problems

The following five criteria or elements (GPA guidelines) have been used to identify the key issues for national action:

- Nature and severity of problems considering coastal and marine resources and ecosystem health, economic and social benefits, food security and poverty alleviation, and public health
- Contaminants released from land-based activities (e.g., agrochemicals, sewage, port activities, hydrocarbons, heavy metals, etc.)
- Physical alteration, including habitat modification and destruction of concerned areas (e.g., infrastructure development, wetland encroachment, excessive overgrazing, etc.)
- Sources of degradation (e.g., industries, power plants, construction activities, desalination plants, etc.), and
- Areas of concern (critical habitats, habitats of endangered species, ecosystem components, etc.)

2.2.3 Establishment of priorities for national action

Key issues were prioritized for national action following review and consideration of the potential extent of the adverse impacts and the risk to coastal environments, human health, social, economic and cultural values from the above-mentioned elements. The availability of existing regulations, guidelines, management systems and their enforcement as well as local level actions were also taken into account during prioritization of these issues.

2.2.4 Setting management objectives for priority problems

Management objectives will be determined based on priorities for action. These management objectives may address environmental, social and economic sustainability and will protect marine ecosystems from land-based activities.

2.2.5 Identification, evaluation and selection of strategies to achieve goals and objectives

Recognizing Best Management Practices (BMPs) in each and every sector, particularly industrial, urban utility services and maritime sectors, a number of strategies and measures were established for the protection of the marine ecosystems of Sudan. These measures may be added or linked with the national Integrated Coastal Zone Management Plan.

2.2.6 Monitoring and evaluation

The priorities of the key issues for action may change at different times. To ensure effectiveness and make it practical, review of the strategies and measures will be done from time to time. These changes must link up with management objectives to achieve the goal at a particular time.

2.2.7 Programme support elements

To implement the NPA, comprehensive support elements must be put in place at the beginning. These include policy and institutional arrangements, and extensive coordination between the relevant sectors. Training, education, awareness programmes, legal and enforcement mechanisms, financial mechanisms, contingency planning, research and monitoring, and public participation are necessary elements to achieve the goals of the NPA.

2.2.8 Consultation with relevant stakeholders

Consultation with the relevant stakeholders was considered an integral part of the preparation of the NPA. Both formal and informal consultations were carried out during its preparation. A national level stakeholder consultation will also be organized to share draft NPA and case study findings. The contributions and suggestions of participants from the different ministries, departments, agencies, non-government organizations and academics will be incorporated in the final report.

3. SITUATION ANALYSIS

3.1 ECOLOGICAL HABITATS

The three most ecologically important habitats are:

- Coral reefs
- Mangroves
- Seagrass beds

3.1.1 Coral reefs

Three types of coral reef are found in Sudanese waters:

- Fringing reefs, lying 1–3 km offshore
- Patch reefs, lying up to 15 km offshore, separated from the fringing reef by deep and wide channels
- Pillar reefs or atolls, found 20 km or more offshore, the most well known example being Sanganeb atoll

The coral reefs of Sudan are considered to be in moderate to good health, despite an extensive covering of algae over some fringing reefs. Some die-back/coral bleaching has occurred, particularly in the upper 10 m.

3.1.2 Mangroves

Mangrove stands are one of the key coastal habitats, providing fish breeding grounds, forage and wood products. Originally, extensive stands of mangroves were found in the areas where seasonal streams (khors) reach the coast as these areas provide the brackish and sediment rich conditions necessary for mangroves to thrive. Mangroves stands are, however, under severe pressure along the entire coastline.

3.1.3 Seagrass beds

Seagrass beds are found in shallow coastal waters up to 6 m in depth, around mangroves, and between the low tide line and fringing reefs. They are highly productive habitats providing grazing for dugong and supporting fish and the shellfish *Trochus*.

The Sudanese marine and coastal environment could, in general, be described as 'in good condition but with isolated badly degraded areas'. The region, however, is subject to a mounting list of environmental impacts and issues linked to urban and industrial development and to overgrazing.

3.2 THE NATIONAL POLICY AND STRATEGY

The Interim National Constitution of the Republic of Sudan 2005 (INCRS) adopted the Comprehensive Peace Agreement (CPA) and defined a new set of rules for governance in general and land use in particular. The two main elements of this new policy context are:

a high level of decentralization giving considerable powers to individual states, and the creation of the Government of Southern Sudan (GOSS).

The INCRS Article 11 states that:

- The people of Sudan shall have the right to a clean and diverse environment; the State and the citizens have the duty to preserve and promote the country's biodiversity.
- The State shall not pursue any policy, or take or permit any action, which may adversely affect the existence of any species of animal or vegetation life, their natural or adopted habitat.
- The State shall promote, through legislation, sustainable utilization of natural resources and best practices with respect to their management**.**

In the new Sudan federal system there are three levels of authority:

- National level
- State level, and
- Local level

Responsibility for land and other natural resources is divided among the various levels as follows:

- At the national level, federal bodies exercise the power of planning, legislation and execution over federal lands, natural resources, mineral and subterranean wealth, inter-state waters, national electricity projects, epidemics and disasters.
- The state organs exercise power within the boundaries of the state over state lands, natural resources, animal resources, wildlife, non-Nile waters and electric power.

There are situations where both federal (national) and state organs exercise concurrent power, for example over education, health, environment, tourism, industry and meteorology.

In 2007, Sudan prepared the draft of a National Plan for Environmental Management (NPEM) based on the INCRS and the CPA. The final draft of the plan was adopted by the Government of National Unity (GONU) and the GOSS in mid 2009.

The primary aim of the Plan is to provide support for the introduction of a participatory and demand-driven environmental planning process favourable to sustainable development. NPEM includes programmes and projects that address several environmental issues including the management of national marine coastal zones.

The NPEM is structured to address the following major issues:

- Common program of priority action
- Special action for northern states
- Special action for Southern Sudan

The NPA presents relevant environmental policies, legislative and administrative frameworks at state, federal and international level. Focus has been given to state level organizations that are responsible for preparation of environmental policy, technical guidelines, review, and follow-up of implementation measures to safeguard the environment.

3.3 ENERGY CONSERVATION POLICY

3.3.1 Heavy industrial areas

During the last 25 years, urban areas on the coastline have experienced a severe deficiency in electrical energy. This shortage of electrical power has led to the close down of many industrial facilities such as tire, tannery, oil seed and textile factories. Over the past two decades a new heavy industrial area has been established 10 km south of Port Sudan. It includes numerous medium and heavy industries such as milling factories, mineral water factories and building materials production. All these units depend on their own sources of power.

In addition, a free zone area has been established about 40 km south of Port Sudan with many heavy industries. All these new factories generate their own power as well. Some of them, due to weak maintenance programmes, have become a major source of air pollution in the coastal zone (Figure 3.1).

Figure 3.1: Emissions from a private power station in the new industrial area south of Port Sudan.

3.3.2 Merawi Dam electric supply

The lack of electrical power in the coastal cities was completely solved by mid 2009 with clean electricity generated from the Merawi Dam on the River Nile. The Dam can supply 80 MW of electricity to the national grid at Port Sudan. This is around 30 MW more power than is currently needed by the coastal cities. The availability of power may lead to new environmental problems. Many old factories may re-start and increase the volume and type of wastes in the area. Without a solid waste management strategy in operation, the implementation of the proposed Waste Management project in the NPA will be very important (Figure 3.2).

Figure 3.2: The new electrical sub-station connects Port Sudan to the National Grid (Merawi supply).

3.4 PAST INITIATIVES TO PROTECT THE MARINE ENVIRONMENT

3.4.1 Demonstration activities

Following the PERSGA Strategic Action Programme (SAP) in 2003, PERSGA initiated a Demonstration Activities Programme in each member state in the region (Table 3.1). In Sudan the programme was composed of 5 projects:

- Use of biological indicators for monitoring Sudanese coral reefs near Port Sudan
- Rehabilitation of degraded mangrove stands
- Rehabilitation of the public aquarium
- Establishment of a pilot sea cucumber hatchery
- Development of an effective partnership between government and stakeholders

One of the most valuable lessons learnt from this exercise was the benefit of widening the circle of relevant institutions and stakeholders who pooled their efforts in order to produce results with more legitimacy and wider appeal.

3.4.2 Integrated coastal zone management

This activity was also organized under the umbrella of PERSGA. Initially, a national team of experts produced a coastal profile for Sudan. The pressures and threats were identified before a plan for integrated coastal zone management (ICZM) was proposed. The pressures and threats comprise:

- Pollution by liquid, solid and organic matter
- Radiation pollution
- Introduction of imported (exotic) species and materials
- Exhaustion of potentials of plants and animals (resource depletion)
- Removal of mangroves
- Expansion in planning
- Immigration of various organisms
- Conflicts over grazing and land use

The proposed plan for ICZM included:

1. Legislative and administrative concepts for support of integrated management;

2. Identification of the objectives;

3. Proposed strategies and polices for management to handle biodiversity conservation and protection of threatened types, enforcement of laws pertaining to protected areas, collection and analysis of data, mapping of the coastal resources, awareness, organization and economic policies.

In addition to the above, special reference was made to the Fishery Administration regarding the status of fisheries in the country, means of conservation, production and potential harvest estimates; development of regulations that govern fishing gear and methods; protection of breeding sites; and extension of awareness to different groups of fishers.

Table 3.1: Summary of the demonstration activities conducted in Sudan, 2003–2004.

Project Title	Main Objectives	Duration	Fund	Implemented by
1. Use of biological indicators for monitoring Sudanese coral reefs near Port Sudan	To implement a monitoring program for coral reefs and associated key species that can be used as a source of data input to the PERSGA Integrated Information Management System (IIMS) through use at the national level of the standard survey methodology developed by PERSGA.	One year	PERSGA/ GEF	Red Sea University (RSU)
2. Rehabilitation of degraded mangrove stands	To reduce pressure on existing mangrove habitats, establish and/or improve management for sustainability of mangroves, and provide an example of mangrove rehabilitation and monitoring using the PERSGA-IIMS, and enrich knowledge and understanding of the role of mangrove habitats through a public participation programme.	One year	PERSGA/ GEF	RSU Faculty of Marine Sciences and Fisheries (FMSF)
3. Rehabilitation of the public aquarium	To raise awareness among residents, visitors, students, researchers and local authorities about the value of the marine environment and the need for its protection.	One year	PERSGA/ GEF	Sudanese Environment Conservation Society(SECS)
4. Establishment of a pilot sea cucumber hatchery	To carry out biological studies pertaining to the basics of sea cucumber culture, particularly in the areas of nutrition, reproduction and growth as pre-requisites to the future needs of the hatchery; train personnel on hatchery management.	One year	PERSGA/ GEF	Fisheries Research Centre
5. Development of an effective partnership between government and stake-holders	Raise awareness among residents, visitors and local government of the value of the marine environment and the need for its protection; change negative human behaviour and encourage sustainable environment-friendly investments to achieve goals.	One year	PERSGA/ GEF	Marine Environment Protection Society-Sudan (MEPSS)/SECS

3.4.3 The National Oil Spill Contingency Plan

Sudan drafted a National Oil Spill Contingency Plan (NOSCP) in 2000, funded by PERSGA, to protect the coastline, to preserve habitats and to prevent the spread of oil spills towards the Sudanese coast and neighbouring countries. The final draft was prepared in 2003 and approved by the Federal Government (GONU) in 2004. In Sudan there are three local contingency plans and stocks with adequate equipment for tier-one operations.

3.4.4 The National Oil Spill Response Centre

PERSGA recently initiated the implementation of a project to establish a National Oil Spill Response Centre (NOSRC) in Port Sudan. This project started in January 2009 and has a duration of two years. The executing agency is the HCENR (PERSGA National Focal Point).

The overall objective of the project is to develop a national system for marine pollution preparedness, response and control, the capacity to implement the National Oil Spill Contingency Plan and to synchronize with PERSGA`s regional network coordinated by PERSGA-MEMAC (Marine Emergency Mutual Aid Centre).

The specific objectives are:

- To strengthen institutional capacity of the Maritime Administration Authority (MAA) and support the establishment and operation of its NOSRC
- Promote legal instruments and enhance ratification of related IMO conventions
- Improve capacities of the NOSCP associate partners
- Integrate the national system into the regional network

The project will facilitate establishment of a response centre in the central part of this extensive Red Sea coastline. It will contribute substantially to filling a crucial gap in the regional network, besides enhancing national coordination, awareness and building national capacities.

3.5 INSTITUTIONAL ARRANGEMENTS FOR MARINE AND COASTAL ENVIRONMENTAL PROTECTION

3.5.1 Higher Council for Environment and Natural Resources

The Higher Council for Environment and Natural Resources (HCENR) was founded in 1992, as part of Sudan's follow-up to the Rio Conference. The HCENR is a high-level committee comprising the Minister of Environment and Physical Development as Chairperson, federal ministers, environmentalists and community representatives. It is the main government organization responsible for the protection of the environment and for resource conservation. The functions of the Council include coordinating national plans and policies on the environment, policy planning and approval of standards.

The HCENR's objectives are the sustainable utilization, rational development and conservation of natural resources, undertaken through line ministries and public bodies. Apart from steering through the new environment law, the HCENR has coordinated major projects on strategic planning (funded by UNDP, 1996-1999), on climate change (funded by GEF, 1998-2001) and a Biodiversity Action Plan (funded by GEF, 1999-2003).

3.5.2 State Council for Environment and Natural Resources

The Environmental Protection Act (2001) empowers each state to establish its own independent State Council for Environment and Natural Resources (SCENR). This body has the responsibility to ensure public participation in the decision making process, and to play an active role in coordinating the formulation and implementation of conservation policies. The state governors chair the SCENR.

3.5.3 Wildlife Conservation General Administration

The Wildlife Conservation General Administration (WCGA) is responsible for preparation of national wildlife policies, co-ordination with provincial wildlife departments on the implementation of these policies, and co-ordination with international organisations on matters related to international treaties. The WCGA works under the Ministry of Tourism and Wildlife.

3.5.4 Other government institutions

Other government institutions with designated responsibility for natural resource management are organised on a sector by sector basis, in line with the general arrangements for administration and development between the federal, state and local governments.

3.5.5 Civil society

Numerous national and local NGOs are active in the social sector in the Northern State: emergency support, rehabilitation, health, and education. Other areas include environmental conservation, income generation, poverty reduction, vocational training, nutrition and food security, and maternal, child health and family planning. The most important NGO in the Northern State is the Sudanese Red Crescent working in disaster (mainly flood) management.

The Sudanese Environment Conservation Society (SECS) is the most popular NGO in terms of its composition and size of membership, regional coverage, and the range of environmental issues tackled. However, in the Northern State, SECS branches are among the least active in the country.

3.5.6 Marine and coastal environmental governance

The governance structure for the Sudanese Red Sea coastline, territorial seas, islands and associated marine protected areas is very complex. As a result, problems arise.

The Sudanese ports are managed by the Sea Ports Corporation, which is part of the federal Ministry of Transport. One important exception is for arrangements at the port facilities of Bashayer 1 and 2 oil terminals, which are under the private sector but also come under the management of the Ministry of Energy and Mining. Governance of marine fisheries comes under the Marine Fisheries Administration, which in turn is part of the federal Ministry for Animal Resources and Fisheries. Marine protected areas are under the responsibility of the Headquarters of Wildlife Conservation in the federal Ministry of Tourism, Antiquities and Wildlife. Staff in the Wildlife Conservation services are actually managed by the Ministry of Interior as they are part of the united police force of the country. At the state level the governor or 'wali' and the local government of ministers and advisors have significant and broad reaching authorities which overlap the federal mandate to a large extent.

The Red Sea State is unusual in that it has a Ministry for Environment and Tourism and a federal working body specifically for environmental protection known as the Marine Environment Protection Administration (MEPA). In addition the State Council for Environment (SCE) provides an oversight and coordination role. The NGO sector is also relatively active in Port Sudan.

3.6 THE LEGAL FRAMEWORK

The national legal framework for protection of the environment in Sudan is acknowledged by all concerned to be weak in terms of coordination. A study carried out with the help of UNEP in 1994 discovered over 120 references to environmental legislation over a wide range of topics (e.g., soils, pesticides, wildlife, etc.) and with authority spread among more than 30 government bodies. In 2007, a national study reported over 165 references to environmental studies in Sudan. Furthermore, there was no national coordination of environmental policy.

In an effort to remedy this situation, particularly in the light of obligations taken at the 1992 Rio Conference, the HCENR has taken the lead in drafting a new framework law for the environment. This is an "umbrella" law that clarifies the role of the Ministry of Environment and Physical Development, through its driver the HCENR, as the competent ministry responsible for coordinating all matters concerning the environment. However, the new law also acknowledges that other government ministries with particular competence in certain fields are responsible for developing environmental measures within their areas of competence, e.g., the Ministry of Transport as the appropriate ministry to implement measures to prevent pollution from ships in accordance with the International Maritime Organization's (IMO) environmental conventions.

The most notable achievement was the enactment of the Sudan Environmental Protection Act in 2001. The act designated the HCENR as a policy making body with the Environmental Protection Agency for implementation of the regulations.

3.6.1 Environmental law in Sudan

The Sudan Environmental Protection Act, 2001, is the principal environmental law in Sudan. The act was meant to overcome the deficiencies in existing laws, which were considered too narrow in scope, conflicting and fragmentary. It provides an umbrella law and general principles to be considered in carrying out environmental impact assessment (EIA) studies. According to this act all development projects outside environmentally protected areas and in environmentally sensitive areas require an EIA. Proponents of all projects are required to monitor their projects and submit reports to the HCENR.

This law provides definitions and clarifications regarding natural resources management, sources of pollution and pollutants, and endorses the principle of the "polluter pays".

Various other laws cover different facets of environmental protection, biodiversity, cultural heritage, and natural resources:

- Environmental Protection Act, 2001
- Environment Protection Law, Red Sea State, 2006
- Sea Ports Corporation Law, 1974
- Maritime Law, 1961
- Fisheries Act, 1975
- Environmental Health Act, 1975

- Public Health Act, 1975
- Forestry Act, 1989
- Forests and Renewable Natural Resources Act, 2002
- Legislation on land acquisition and compensation
- Legislation on preservation of cultural heritage

3.6.2 International and regional conventions

Sudan is a signatory to a number of international and regional treaties addressing environmental conservation. Global and regional treaties are, in principle, binding in the first instance on national governments, which are obliged to implement such arrangements through national legislation. In Sudan, the rate of implementation of international treaties has been slow and not all international treaties have local legislation to support their implementation. A list of the international conventions is provided below:

- Convention on Conservation of Migratory Species of Wild Animals, 1979
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973
- Climate Change Convention, 1992
- Convention on Biological Diversity, 1992
- Convention on Wetlands of International Importance, 1971 (Ramsar Convention)
- Convention to Combat Desertification and Drought, 1994
- United Nations Convention on the Law of the Sea, 1982 (UNCLOS)
- Basel Convention on the Control of the Transboundary Movements of Hazardous Wastes and their Disposal, 1989
- Stockholm Convention on Persistent Organic Pollutants, 2001
- Convention on the Conservation of the Environment in the Red Sea and Gulf Aden, 1982 (Jeddah Convention)
- Protocol Concerning Regional Cooperation in Combating Pollution by Oil and Other Harmful Substances in the Red Sea and Gulf of Aden, 1982
- Protocol concerning the Protection of the Marine Environment from Land-Based Activities in the Red Sea and Gulf of Aden, 2005 (LBA Protocol)

3.7 FINANCIAL FRAMEWORK

National Environmental Fund

The Ministry of Environment and Physical Development is planning to set up a National Environmental Fund (NEF) which will provide support for management and awareness raising activities using money collected from fines, compensation damages under the polluter pays policy and from the transport of crude oil as a major threat to the marine environment. The NEF will be authorized to raise loans, and to accept aid, grants and donations. The NEF will also receive contributions from the federal government and coastal state budgets.

4. IDENTIFICATION AND ASSESSMENT OF SOURCES OF POLLUTION

4.1 CONTAMINATION

4.1.1 Solid waste management

The population of Port Sudan is approximately 600,000 (National census, 2008). The city has several uncontrolled waste disposal sites on its fringes. The largest is located on the western side along the banks of a wide creek (wadi) about five kilometres from the city centre.

This site is uncontrolled and presents an obvious health and environmental hazard. Waste is reused by a group of resident waste pickers. Animals (dogs, goats, cattle…) have been observed feeding on the waste. The types of waste include medical wastes (syringes, catheters, blood packs, drugs and bandages), plastics, papers, drums, metal scraps, small scale chemical wastes, abattoir waste, food waste, septic tank solids and liquid waste. Heaps of used asphalt drums have been dumped on the outskirts of the city near the landfill. Burning is a common practice at this site.

This landfill is located at the head of a seasonal watercourse. Every wet season, rainfall run-off draws waste from the site into the main port basin and the coastal lagoons in the centre of the city of Port Sudan, sites which are already burdened with urban pollution and shoreline development (Figure 4.1).

Figure 4.1: Solid waste on the western side of the main port.

It should be noted that all municipal landfill sites are open and there is no leachate treatment technology in place in any of the coastal cities. It should also be noted that the most important landfill sites of the two major coastal cities, Port Sudan and Suakin, are very close to watercourses. As a result this waste reaches the water system particularly during the rainy season. Many of the squatters and slum dwellers do not get any solid waste management service from municipalities or CBOs/NGOs. As there is no service, a large volume of domestic waste remains uncollected. Dumping of solid waste is increasing due to

the continual rural to urban migration of low income groups. This waste management issue has become a real threat to the coastal environment and is causing the following problems:

- uncollected waste moves directly or indirectly into the water body
- surface water pollution is amplified due to dumping from slums and squatters
- health hazards for fishermen and poor people that are directly involved with the sea

We conclude that waste management is an area in serious need of improved governance.

Table 4.1: Existing solid waste related issues in the coastal area of Sudan.

Pressure	State	Impact	Response
• Increasing waste generation • Improper waste management • Inadequate technical capacity • Lack of transportation, collection and equipment facilities • Insufficient workforce of City Corporation • Open waste disposal sites • Budget constraints (inadequate funds) • Lack of transparency and accountability	Increased BOD and concentration of solid waste in coastal water bodies and along beaches	• Increasing coastal pollution • Loss of marine biodiversity • Human health risks • Impaired fish breeding and fish ecology	• Environment Protection Act, 2001 • Integrated Coastal Zone Management Plan, 2002 • Environment Protection Law in the RSS, 2006 • Fisheries Act, 1975 • National Maritime Law, 2010 • SPC Law, 1974

4.1.2 Hydrocarbons

The Main Electrical Power Station–A

This power station is located on the western side of the harbour. It was renewed with the building of new generation units in mid 2003 and became the main supplier of electric power to Port Sudan town till mid 2009. The study shows evidence that this plant has been discharging waste oil directly into the sea for a long period. There is no specific quantity estimate for this waste, but the effects can be seen clearly in Figure 4.2.

Figure 4.2: Surface contaminated with waste oil from power station-1, a few metres from the sea.

Electrical Power Station–C

This electrical power station is located 8 km south of Port Sudan city. It is composed of three 5 MW diesel generators. Waste oil, regularly dumped outside power station–C, easily finds its way to the shoreline only 500 m away during the rainy season. This station also contributes to air pollution in the area (Figure 4.3).

Figure 4.3: Power station–C: oil waste finds its way to the coast during the rainy season.

4.1.3 Sewage disposal

Inadequate sanitation facilities are an evident problem throughout the length of Sudan's coastline. In fact, none of the coastal cities have any proper sewage system or sewage treatment plant in place. The standard solution is to use a septic tank. When the tanks are full, they are emptied and the waste is carried away by mobile tankers. The contents is 'disposed of' in open land fill areas or into local seasonal watercourses. During the rainy season the waste is carried down the watercourse into the marine environment (Figure 4.4).

Figure 4.4: A mobile truck transfers sanitary waste to an open landfill near Port Sudan.

Sanitation issues are most apparent in displaced-persons' settlements which are typically found on the outskirts of the coastal cities. These settlements are very crowded and unsanitary. This situation is becoming more serious due to the increasing population in coastal districts and the absence of proper sanitation and sewage treatment facilities.

Table 4.2: The possible impacts from and responses to sewage disposal.

Pressure	Expected Result	Impact	Response
• Increasing coastal population • Untreated sewage disposal • Resource constraints • Lack of sewage system • Lack of awareness, technical efficiency and accountability	High levels of BOD in coastal water bodies; increased levels of faecal microbes	• Microbial contamination • Loss of fishes and aquatic organisms • Increasing food and livelihood insecurity • Increasing risk to human health	• ICZM-Plan • Coastal Development Strategy • Ministry of Health (RSS) • Municipal Authority

4.1.4 Chemicals and persistent organic pollutants (POPs)

The issue of persistent organic pollutants (POPs) as hazards to human health and to the environment has got increasing global exposure because of their toxicity and presence in our air, water and food. They are labelled as 'persistent' due to their resistance to degradation from normal chemical, biological and photolytic processes. Some POPs are, or have been, produced for use as pesticides; others are used in industrial processes. Most, however, are produced as unintentional by-products during the production of other chemicals or during combustion.

The use of pesticides in Sudan has increased over the last three decades. The bulk of pesticide application takes place in the irrigation schemes in the central part of the country. Pesticide imports take place primarily through the coastal ports of Port Sudan and Suakin. Large stockpiles of obsolete pesticides are stored in very hazardous conditions across the country. In Port Sudan a large stock of expired pesticides was found in unsuitable storage conditions at the port just metres from the sea. A pesticide inventory was carried out in 2006 by the National POPs Project. It ranked the Red Sea State 13th among the 25 states in terms of the amount of contaminated soil which was estimated to be around 5 tons in addition to two tons of empty pesticide containers. Unintentionally-produced persistent organic pollutants (U-POPs) are the most important hazard that threaten the environment of the Sudanese Red Sea coast.

Table 4.3: Problems and policy responses to chemicals in the coastal zone of Sudan.

Pressure	Impact	Response
• Improper application of pesticides and POPs • Lack of awareness of the effect of pesticides and POPs • Lack of transparency and accountability	• Increasing coastal pollution • Loss of marine biodiversity • Increased fish mortality • Risk to human health • Contamination through the food chain	• Environment Protection Act, 2001 • Integrated Coastal Zone Management Plan, 2002 • Environment Protection law in the RSS, 2006 • Pesticides Act, 1994 • Fisheries Act, 1975

4.2 PHYSICAL ALTERATION AND DESTRUCTION OF HABITAT (PADH)

The majority of the Sudanese coast is still in its natural state (Figure 4.5) with the exception of the area between Port Sudan and Suakin. Extensive coastal development has taken place in this area including construction of desalination plants, land filling, establishment of two oil exporting terminals, shrimp farming, and sea salt production.

The desalination plants are responsible for discharging their hypersaline effluent in the intertidal area and land filling is practised by the Sea Ports Corporation for expanding the main port. Solid waste dumping and waste brought to the coast following rainfall and flash floods contribute to the stress placed on the coastal and marine environments.

Figure 4.5: The Sudanese coastline north of Port Sudan showing the natural situation.

4.2.1 Coral reef degradation

Sudanese coral reefs are not subject to any type of restoration or management. The reef system has often been described as being in 'good condition'. The reef system is used to provide safe anchorage sites for ships waiting to enter Port Sudan harbour. Accordingly, anchor damage may be considered as the major source of degradation to coral reefs in Sudan. To a lesser extent the impact of tourism activities may also contribute to habitat degradation. A survey in 1999 indicated that the health of Sudanese corals was 'moderate to good' with 14% of coral bleached (PERSGA, 2003).

Table 4.4: Major patch coral reef sites and their uses.

No.	Coral reef site	Major use
1	Shaab Rumi	Diving
2	Shaab Suwadi	Diving
3	Sanganeb atoll	Diving, scientific education, research, light house
4	Winget and Salaiet	Ship waiting
5	Twaratit	Ship waiting

The fringing reefs along the northern coast of Sudan (north of the Port Sudan–Suakin area) are less subject to degradation as the only port present, at Oseif, has not yet become fully operational since its construction. However, corals at Shaab Rumi and Suwadi are under the influence of recreational SCUBA diving and show anchor damage, trampling and fin damage. These are the major sites for the tourism industry in the country. On average, three to five dive boats may visit these sites per day. The total number of divers may reach up to 25 per day. Diving times range between half to one hour for each diver for each dive of the day. On average, divers will dive two or three times each day.

In the central part of the Sudanese coast (Port Sudan–Suakin area) coral reefs are significantly impacted by shipping, port construction and maintenance. The use of coral reefs at Winget, Salaiat, and Twaratit as anchoring sites is believed to cause considerable damage to the coral habitats. In addition, sedimentation from port construction has settled as a film over large areas of fringing corals at Abu Hashish and Dama Dama. Tourism activities at Sanganeb atoll are thought to have caused physical damage to the coral community due to poor use of anchors in the absence of mooring buoys.

The absence of major coastal development along the southern section of the Sudanese coast (south of the Port Sudan–Suakin area) minimizes the level of degradation as there are no major cities, ports or tourism activities. Accordingly, it is highly likely that coral reefs in this area are in a very good condition, considering that there are few sources of human impact.

4.2.2 Mangrove degradation

Mangrove stands are distributed along the Sudanese coast at the mouths of seasonal water courses. The mangrove stands along the coastline show signs of degradation due to both natural and anthropogenic factors. The latter may include camel browsing and overgrazing (since the leaves are edible for camels and thus vulnerable to grazing damage in periods of scarcity), cutting (for fuel wood and building material), freshwater impoundment, obstruction of tidal water movement, and littering (Figure 4.6).

Figure 4.6: Camels returning inland after grazing on coastal mangroves south of Suakin; this stand also shows signs of extensive timber-cutting (source UNEP, 2007).

Table 4.5: Mangrove stands along the Sudanese Red Sea coast.

No.	Stand location	Bearing	Approximate length (km)
1	Halaib	NA	NA
2	Mukawwar island	NA	NA
3.	Mohamed Qol	20° 47' N, 37° 10' E	1.3
4.	Arakiyai	20° 18' N, 37° 11' E	0.9
5.	Halut	19° 48' N, 37° 15' E	1.1
6.	Kilo Tamania	19° 35' N, 37° 15' E	0.8
7.	Klanieb	19° 30' N, 37° 16' E	2.0
8.	Mersa Atta	19° 18' N, 37° 18' E	3.5
9.	Fagum-lagaaengeeb	19° 01' N, 37° 23' E	3.9
10.	Haydoub	18° 57' N, 37° 23' E	1.6
11	Sheikh Ibrahim	18° 56' N, 37° 24' E	0.4
12.	Sheikh Saad	18° 50' N, 37° 26' E	1.4
13.	Shabarango-Gofud	18° 46' N, 37° 29' E	3.5
14.	Ashat	18° 45' N, 37° 30' E	7.0
15.	Agig	NA	NA

Source: Modified from PERSGA/GEF 2004.

In the northern coastal areas, Halaib, Mukawwar Island, Mohamed Qol, Arakiai, and Halut host mangrove stands. The first three are relatively denser compared to the two latter stands. All the stands show signs of cutting and grazing. In Halut, *Suadea* sp. and *Prospis* sp. have invaded the empty spaces between the mangrove trees. There is a significant concern that these strong competitors may gradually occupy the stand, replacing the mangrove trees. This is likely to happen because the scarcity of rainfall is in favour of these two plants.

The most degraded mangroves in the central coastal area are those at Kilo Tamania, Klanaieb, and part of the Marsa Atta stands. Cutting, grazing, freshwater impoundment, tidal water obstruction, and discharge of saline water from Desalination Plant B are the major sources of degradation. A herd of 18 camels was once encountered on a visit to Kilo Tamania. Almost all the trees in this stand are 'clip shaped' which indicates heavy grazing. At Klanaieb, high mangrove tree mortality may be seen and a significant reduction in the original area of the stand. This could be attributed, partially, to a change in tidal flow caused by the saltpan water channel.

Mangrove stands along the southern part of the coastline are denser and healthier compared to the stands in the north and the centre. Nevertheless, they are under pressure from grazing and cutting. A large portion of the Haydoub stand was removed to get a clear sea view to monitor smuggling. The survey of 2002 indicated that 80% of the trees in a quadrat at the outer zone of the stand and 35% of the trees in an inner zone quadrat were removed or felled. In addition thickets of dead trees are commonly encountered in the southern stands; reasons are not yet clear.

4.2.3 Seaweed and seagrass degradation

These habitats are impacted indirectly by land-based activities, but mainly by dredging operations that are part of harbour maintenance. They are either removed completely from the environment or covered with the fine sediment that results from these operations. As mentioned above, because there is no major coastal development in the northern coastal area, it could be said with some confidence that these habitats are not yet subject to degradation. Seaweeds and seagrasses in the central part of the coast are influenced by sedimentation from port operations. Their vegetative parts are found to be covered with fine sediments. Absence of coastal development and constructions in the southern part of the coast may keep these habitats in their natural condition.

4.3 SOURCES OF DEGRADATION CAUSING PHYSICAL ALTERATION AND DESTRUCTION OF HABITAT

4.3.1 Sea ports and oil terminals

These facilities have two potential hazards that should be treated with caution. The first one is the discharge of ballast water in the vicinity of the mooring buoy located a few kilometres off the coast. The major concern associated with ballast water discharge is the introduction of alien species that may become invasive and compete with indigenous species.

The second concern is the leakage of oil during routine operations at the terminals. In December 2007 and January 2008, three oil spill incidents at Bashayer 2 oil terminal were witnessed. The first accident occurred during ship loading and the oil spill was contained within the deck area. However the two other accidents were significant and the oil moved a long distance from the terminal in the direction of the prevailing wind. The short term impacts observed were as follows:

- contamination of the beaches with tars balls and oily patches
- contamination of the mangrove stands at Jarrorat near Damat salt plant
- loss of fishing nets due to contamination with oil
- loss of fishing days

Table 4.6: Number of ships calling at Port Sudan 2003–2007.

Month	2003	2004	2005	2006	2007
Jan.	94	152	171	109	89
Feb.	118	82	105	92	83
Mar.	105	107	185	115	97
Apr.	100	116	95	118	83
May	114	132	155	116	99
Jun.	90	115	127	103	89
Jul.	98	106	130	109	86
Aug.	101	112	119	96	84
Sep.	92	108	105	108	85
Oct.	109	106	101	84	80
Nov.	95	108	109	77	73
Dec.	100	135	110	107	66
TOTAL	1216	1379	1512	1234	1014

Source: SPC data.

Table 4.7: Petroleum traffic 2007 (import and export in metric tonnes).

Month	Import	Export	Total
Jan.	84 365	19 253	103 618
Feb.	69 216	9 571	78 787
Mar.	52 891	50 744	103 635
Apr.	71 766	7 220	78 986
May	76 566	44 161	120 727
Jun.	40 279	35 030	75 309
Jul.	77 740	48 798	126 538
Aug.	45 340	49 914	95 254
Sep.	30 789	54 960	85 749
Oct.	91 337	59 292	150 629
Nov.	47 733	88 016	135 749
Dec.	72 330	83 978	156 308
TOTAL	760 352	550 937	1 311 289

Source: SPC data 2008.

4.3.2 Rapid residential and commercial development

The absence of both a land-use plan and surface run-off management system have influenced residential development in the state. Port Sudan city was built in the lower reaches of the Khor Arbaat catchment area. This basin has been an important source of potable water for the inhabitants of the city. The tributaries of the Khor dissect the city before passing on to the sea. Some residential blocks were built in close proximity to these water courses.

Residential development may act as a physical barrier holding back a significant volume of surface water flow from reaching the sea. This volume may remain as stagnant water in the streets and in open areas and produce detrimental effects on public health.

An inevitable consequence of urbanization is the growth in demand for space for residential needs, and expansion of infrastructure and other associated urban attributes. There is a need to allocate space for a growing population of various income levels, including the need for services such as fresh food production, water supply, sanitation, employment, health and education.

Recently, there has been a growing trend towards construction of towers near the city centre to meet residential and commercial demands. One of these huge residential projects, located at the lower reaches of Khor Kilab, has been modified to serve as an entertainment complex because the ground water keeps infiltrating the site, making the laying of foundations difficult. Unfortunately some modifications have been made to control the discharge of the Khor during flood. The impact of these modifications on the coastal environment is still unknown (Figure 4.7).

Figure 4.7: Residential projects in Khor Kilab, Port Sudan.

4.3.3 Tourism

The impact of diving on coral reefs has not yet been investigated. Nevertheless, from observing the performance of the activity the following concerns arise:

- Destructive methods used to anchor boats, such as wrapping wires around corals
- Impact of sewage discharge from yachts at diving sites and at the marina in the port lagoon
- Solid domestic waste from pleasure craft in the marina

Table 4.8: Problems and existing policy responses to rapid urbanization in the coastal zone.

Pressure	State	Impact	Response
• Increasing population • Increasing demand for human settlement	• Unplanned growth of urban areas • Expansion of infrastructure and associated urban needs • Increasing rate of conversion of agricultural land to settlements • Fragmentation of land	• Increase of coastal pollutants • Loss of productive farming land • Rapid encroachment in to coastal areas • Problems for space allocation for the growing population • Increasing load of waste and pollution	• Environment Protection Law, 2001 • Environment Protection Law–RSS, 2006 • Integrated Coastal Zone Management Plan • Coastal Development Strategy • Municipality Act, 2000 • Health Act, 2000

Table 4.9: Problems and existing policy responses to tourism in the coastal zone.

Pressure	State	Impact	Response
• Increased and uncontrolled access of tourists to areas with rich biodiversity • Trash, especially non biodegradable items such as bottles and polythene bags • Lack of management of waste generated by visitors • Unplanned infrastructure development • Collection of shells from beaches	• Increased risk of biodiversity loss • Increased quantity of pollution	• Damage to coastal vegetation from trampling • Increasing coastal pollution • Loss of biodiversity	• Environmental Protection Act, 2001 • Environmental Protection Law RSS, 2006 • Integrated Coastal Zone Management Plan • Coastal zone development strategy

4.3.4 Effluent from desalination plants

Two desalination plants are already in operation at Port Sudan. The first plant was built in 2004; it is located in the middle of the city on the shoreline of the north lagoon surrounded by urban development and recreational beaches. The plant uses the reverse osmosis system which separates seawater into two streams: freshwater for consumption and high salinity effluent which needs to be disposed off in an appropriate manner to avoid environmental damage.

The original plant water intake line was connected directly to this shallow and moderately polluted lagoon, but health concerns forced a later revision in the form of a 4 km pipeline that brings seawater from the coast near Abu Hashish fishing terminal. The effluent from the plant, however, is currently discharged directly into the lagoon as per the original design. The plant is powered by four diesel engines and has a combined freshwater output of 7,500 cubic metres per day and an effluent discharge of 2,500 cubic metres directly into the lagoon. The salinity of the effluent in this unit is four times that of seawater, and it contains traces of chlorine and anti-scaling agents. The diesel engines now contribute to air pollution in the area. In 2005, a major fish mortality occurred and there are current complaints from local residents regarding skin rashes. A later report, in 2007, indicated no sign of marine life in this lagoon**.** Unless a solution for the saline effluent is found, the lagoon is expected to become a biologically dead zone.

4.3.5 Dredging and siltation from harbour development

In accordance with the Sea Ports Corporation (SPC) Master Plan for the Port Sudan harbour, dredging operations have been carried out by Chinese engineering companies to widen and deepen the southern entrance to the harbour (near El-Deraik) and to the north-western part of the main harbour channel (facing the Faculty of Marine Sciences and Fisheries).

These processes will undoubtedly lead to very high turbidity in the coastal zone. There are many actual and potential problems related to the transport of sediments and adsorbed pollutants along the coast. Sediment transport and increased pollutant load will be transferred to coastal areas adjacent to the port. This will damage benthic habitats and reduce biodiversity in the area (Figure 4.8).

Figure 4.8: Dredging threatens the coastal environment, Port Sudan.

The new container berths project (southern part of the entrance of Port Sudan harbour near El-Deraik) involves the construction of two container berths with a total length of 791 m and 16 m depth, completely equipped with ship-to-shore cranes, rubber tyred gantries, container handling equipment and a stacking area of 200,000 m^2. The project started in June 2006 and was due to be completed in 2010. The berths are needed to handle the rapidly growing container traffic that now passes through Port Sudan harbour

4.3.6 Sea salt production

This industry sector occupies extensive areas of the coastal zone, restricting access to the sea at some points. The influent channel of some of the salt pans located near mangroves affects the pattern of tidal water movements. Tidal water flows into these channels instead of flowing into the mangrove swamp, leaving the landward areas dry and exposed. A notable example is at Klanaieb, where a large area of the mangrove stand is now dead and the top soil is covered with thin film of salts (Figure 4.9).

Figure 4.9: Salt farms at Klanaieb, south of Port Sudan.

4.3.7 Roadways and bridges

The Red Sea State hosts the country's main port—the principal location for import and export not only for Sudan but also for some neighbouring countries. Furthermore, the state borders Egypt to the north and Eritrea to the south. The strategic location of the state and the socio-economic relationships between Sudan and its neighbours necessitate building national as well as international roadways to ease movement of people and goods.

Nationally, Port Sudan is witnessing extensive road building, expansion and maintenance operations. A *solid fill* type of construction is used, sometimes with or without culverts and canals for drainage of surface run-off. Some of these roads cross or are built on flash flood routes and in some instances the elevation of the road and the culvert beneath it are inadequate to allow the volume of surface run-off to pass. Therefore, the water will flow over these roads stopping the traffic for hours. The same phenomenon causes significant damage to the asphalt layer. Another impact from the solid fill roads and bridges inside the city is the high rate of groundwater seepage at Blocks 6 and 5 of Salalab. The phenomenon increased during and after the maintenance of solid fill road operations that involved dredging and filling to build the road bed. Groundwater has risen to the surface making ponds and lakes in the streets. These areas form a suitable environment for mosquitoes to breed and algae to bloom. Observations reveal that culverts and canals were placed above the road level, so that surface run-off cannot pass through it to the sea.

Internationally, the state is about to finish constructing the roadway that links it with Egypt. The road runs parallel to the coastline crossing several wadi beds at their lower reaches. According to Clark (1997), the solid fill type of roadways could produce the following impacts:

- interruption and blockage of surface water flow, as solid fill may act as virtual dam
- introduction of new forms of land use practices along the road corridor, e.g., settlements, restaurants and car services stations
- pollution, particularly from disposal of used car engine oil and litter from travellers
- drying up of land and vegetation in currently wet low lying areas, as culverts and canals tend to concentrate water flow into fewer channels

Based on the above, there is significant concern that the road may reduce the fresh water surface flow to mangrove stands north of Port Sudan, which would eventually degrade the ecosystem.

4.3.8 Water harvesting

Obtaining freshwater along the coast of Sudan, especially in Port Sudan, is given top priority today as the state suffers from severe freshwater shortages, particularly during the summer. The response has been investment in desalination plants and high water prices.

To overcome freshwater shortages the RSS is considering the construction of a pipeline from the river Nile. Meanwhile, further freshwater production from desalination plants is one of several alternative options.

4.3.9 Mariculture

The Baaboud Shrimp Farm, located 30 kilometres to the south of Port Sudan, includes eight basins each around 400 square metres in area. This farm discharges waste water directly to the coast. The volume of the waste discharged has not been measured.

4.4 AREAS OF CONCERN

Port Sudan–Suakin area and Dungonab Bay–Mukawwar Island

From the previous section (Section 4.3) it can be seen that the area between Port Sudan and Suakin cities has witnessed extensive development including construction of sea ports, oil terminals and desalination plants, rapid residential growth with the associated infrastructure of roadways and bridges, tourism, sea salt production, and mariculture. This area is of concern due to the rising population and high level of industrial and residential development.

Dungonab Bay and Mukawwar Island, which lie to the north, have been declared a marine protected area (MPA). Although relatively much less developed, this area is of concern due to the high level of biodiversity. The findings of the PERSGA 2002 survey of the proposed MPA can be summarized as follows:

1. The marine and coastal ecosystems of the entire area are varied, biodiverse, and in generally good condition. Recent and future changes in patterns of resource use and low levels of increased development threaten to alter this situation.

2. The area supports nationally, regionally and globally important populations of several endangered species, particularly turtles (at least three species) and dugong. Populations of the latter are declining and are in urgent need of effective management.

3. Corals and coral reefs are the dominant shallow marine communities in the area. Those within the Bay were almost entirely unaffected by the 1998 bleaching event. Many of the coral communities of the mainland shore and the islands will be very vulnerable to destruction or damage from inappropriate development or other activities.

4. Mangroves occur at a number of sites throughout the survey area (Figure 10). Three or four sites are particularly important (southern Mukawwar; southern Dungonab peninsula and Mersa Inkefal).

5. Seagrasses are very widespread and are highly diverse, with at least nine different species present.

6. The entire area, but particularly the islands and the Dungonab Peninsula, constitute a nationally and regionally significant turtle nesting area.

7. The area is home to large numbers of cetaceans, including at least two species of dolphin.

8. The entire area is very significant for birds.

9. Actually or potentially damaging human impacts and activities occur throughout the survey area, but the overall level of impact is currently very low. This situation may change very rapidly if inappropriate or poorly planned development takes place here.

10. There are indications of severe overfishing of certain groups especially large serranids, particularly nagil [najil] (*Plectropomus*); Kokian (*Trochus*) and bêche-de-mer (sea cucumbers, Holothuroidea). These ecological observations are confirmed by accounts of changes in fish catches received from the fishing communities throughout the survey area.

11. The local communities are, on the whole and with only a few reservations, in favour of MPA status.

12. With only a few exceptions, current levels and types of usage within the proposed MPA appear to be causing little damage to the environment. This situation however may change very rapidly.

13. Public awareness and education programmes will greatly facilitate both the design and implementation phases of the MPA. The level of 'traditional' environmental awareness within the local communities is high, and this should be consolidated and built upon.

14. The inclusion of a coastal 'Buffer Zone' extending inland is essential for the success of any management programme.

15. The area clearly has huge potential for the development of sustainable and high-value marine tourism.

16. Both marine and coastal areas will need to be managed by the use of zoning if success is to be achieved.

17. Initiation of protected area status *before* any development or other significant changes in use is essential in order to protect the exceptional and fragile habitats and species which make this an area of regional and global importance.

18. The proposed MPA area includes several closely inter-related ecosystems. Integration of the entire area within a single management programme will be essential.

Figure 4.10: Sudanese coastline at Dungonab Bay/ Mukawwar Island MPA.

4.5 PRIORITY PROBLEMS TO BE ADDRESSED

4.5.1 Guidelines for handling priority problems

As mentioned in the previous sections, the Environmental Protection Act 2001 empowers each state to establish its own independent State Council for Environment and Natural Resources (SCENR) with responsibilities to ensure public participation in the decision making process, and to play an active role in coordinating the formulation and implementation of conservation policies. The Interim National Constitution of the Republic of Sudan (INCRS), 2005, defined a new set of rules for governance in general, and land use in particular, at the

state level. However, it appears that the existing institutional capacity and the resources allocated are inadequate to meet the scale and magnitude of the environmental problems that prevail. Dealing with environmental problems related to land-based activities in Sudan is new, and institutional collaboration and integration with other sectoral programmes is still limited.

Degradation of the marine and coastal environment can result from a range of sources. A precautionary and anticipatory, rather than a reactive, approach is necessary to prevent further degradation of the coastal and marine environments of Sudan. These require integration of social and economic components along with environmental ones. The NPA aims to contribute to the protection of coastal and marine environments by reducing activities that cause impacts as well as by means of:

- environmental considerations
- sustainable livelihoods
- economic considerations
- integration with the Coastal Development Strategy
- involvement of other sectoral agencies as a means of mainstreaming

4.5.1.1 Environmental considerations

The prime management objective is the protection of the coastal and marine environment of Sudan from land-based activities. This involves defining, in the most careful and judicious manner, innovative strategies and practices that are compatible with environmental sustainability through the involvement of the different players that produce the environmental impacts. EIA guidelines may be prepared for all sectoral development activities.

Ensure conservation practices and protection of marine ecosystems

With environmental conservation as the ultimate goal, the target is to develop and implement conservation practices that harmonize efforts from the different sectors. Strengthening and scaling-up the ongoing conservation/restoration programmes, activities and strategies is necessary. Moreover, efforts should be made to protect the marine ecosystems of Sudan from further degradation by proposing and improving the application of legal instruments, as well as strengthening existing control systems.

Sustainable use of coastal resources

In the future, sizeable coastal populations will depend on the coastal and marine resources, so developing a plan for sustainable utilization of these resources is the ultimate management objective.

Promote good environmental practices in shrimp farming

Organic shrimp farming is a new practice on the coast of Sudan. The disposal of waste from shrimp farms contributes to a considerable degree to coastal and marine pollution. There are several coastal areas where organic shrimp farming is planned. One management objective is to develop a model that integrates mangroves with shrimp aquaculture, ensuring its sustainability.

4.5.1.2 Sustainable livelihoods

One major development objective of the government is to ensure pro-poor growth. In order to achieve this, and other objectives mentioned in the national strategy for poverty reduction, it is necessary to target resources to the poorer and more vulnerable sections of the population. This focus on sustainable livelihoods is a priority in the NPA.

Agriculture

To achieve sustainable agricultural livelihoods, management activities would include diversification of cropping systems, agro-forestry, the proper application and utilization of agro-chemicals, education and training on appropriate agricultural production systems.

Fisheries

To achieve sustainable livelihoods, management activities in the fisheries sector would include education and training of the local people on concepts such as sustainable harvesting, organic aquaculture and shrimp farming.

Education and awareness

Sustainable livelihoods can only be achieved if the local people are educated and aware of the need for conservation of natural resources. If they can manage the resources on which their livelihoods depend, then sustainability can be achieved. The management objective is to promote community ownership of resources and empower women.

4.5.1.3 Economic considerations

In general, people living in the coastal area are poor. The extent of poverty is relatively high compared with the remaining part of Sudan: 52% are poor and 20% are 'extreme poor' as classified by Oxfam in 2006. However, coastal resources contribute the lion's share to the country's economy notably through the ports and marine oil terminals. Realizing the paramount importance of sharing benefits among the poor and enhancing economic activity at the grass-roots level, the NPA puts emphasis on improving infrastructure facilities and involvement of the community at the level of the local economy.

4.5.1.4 Integration with the Coastal Development Strategy

In July 2005 the Red Sea State government published their socio-economic development plan for the first three years of the interim period. An ICZM programme, although not yet finally approved by the GONU, has been developed for the coastal areas of Sudan. All the development plan activities need to be in line with the ICZM programme to ensure proper utilization of resources. The socio-economic development plan focuses on the following broad guidelines:

- Economic development in coastal areas by improvement of infrastructure (electricity, roads, dams, hafirs, alternative energy)
- Improvement of basic services (education, health, water, sanitation, housing)
- Encouragement of investment, especially by harnessing opportunities for tourism
- Livelihoods enhancement
- Human resources development

- Mitigation of risks
- Sustainable management of coastal resources
- Proper land use planning

The general objective of the plan is 'to raise the standard of living of people, both urban and rural, culturally, socially, politically, and administratively, through improved livelihoods, education and health services' (RSS, 2005). The specific objectives include:

- Promotion of poverty reduction in line with international policies, with a focus on improved production and pro-poor interventions in the area of social services
- Reduction of malnutrition rates among children to less than 10%
- Reduction of illiteracy rates by 50%
- Increase of the area under cultivation in Tokar Delta and Arbaat by 75%
- Seawater desalinization in all coastal towns
- Creation of employment opportunities for graduates and those affected by the mechanization of the seaports and industrial decay
- Improvement of livelihoods in rural areas through the introduction of alternative energy, especially solar energy
- Priority in the allocation of federal and state support for the least developed localities and those affected by war
- Research on the potential and utilization of untapped resources

The document also contains general policy statements to guide the implementation of the plan. These include:

- Use of basic information in planning and programming at the local level through the development of quantitative indicators to monitor and measure progress in the achievement of the addressed development targets
- Capacity building of the General Administration for Planning and Development
- Ensuring balanced development across all localities
- Participation of rural people in the development process through their local institutions (bottom-up grass-roots development)
- Implementation of local government laws, devolution of power to the localities and harmonization of local, state and federal development initiatives
- Improvement in the standard of living in rural areas through the rational utilization of resources and integrated rural development projects
- Peace building through development projects, provision of basic services, economic inputs and voluntary repatriation of displaced people
- Local development as the main vehicle to build organizational, technical and human capacities in the economic, social and cultural spheres
- Support for tourism and rehabilitation of archaeological sites
- Use of literacy campaigns to develop a work and business culture and to raise awareness among the population

4.5.1.5 Involvement of other sectoral agencies as a means of mainstreaming

It has been recognized that involvement of other relevant agencies in the implementation of the proposed activities will help in mainstreaming land-based coastal pollution issues. The proposed projects have identified a number of relevant ministries, agencies and departments that will be involved during designing and implementation of the activities. A final list of ministries, departments and agencies will be identified after the workshop during the design phase, and they will be involved accordingly.

4.5.2 Priority problems and issues

The priority problems identified through the situation analysis are summarized below and shown in Table 4.10. They include the following:

Combating oil pollution

Sudan has prepared a National Oil Spill Contingency Plan (NOSCP). It was approved in April 2004. Currently, an Oil Spill Response Centre (OSRC) is being established under the auspices of the Sudanese Maritime Authority. The implementation of the NOSCP and the establishment of the OSRC will minimize spillage of bulk material from ports, especially the port at Green Habor which handles dry bulk cargo, or any potential oil spill at the oil terminals.

Conservation of coral reefs

Several reports have been written regarding the status of coral reefs in Sudan. According to the reports, most of the degraded and moderately healthy reefs have the potential for future recovery. This depends however, on environmental education of the local population and clear guidelines for tourists. Therefore, a regulatory framework and a programme for visitors to coral reef areas should be developed, including guidelines and moorings for boats. An efficient survey system needs to be put in place to monitor progress.

Conservation of mangroves

A National Action Plan for the Conservation of Mangroves has been prepared by Sudan in cooperation with PERSGA. The plan was developed in recognition of the great economic, ecological and biodiversity values that mangrove ecosystems provide, and in response to the extremely high levels of threat posed by increasing human and natural impacts. An initiative to rehabilitate damaged mangroves can be launched in the framework of implementing the National Action Plan supported by an extensive public awareness programme.

Implementation of the ICZM plan

An Integrated Coastal Zone Management Plan has been prepared by Sudan with PERSGA support. The implementation of such plan and the enforcement of the existing regulations, need to be strengthened.

Management of marine protected areas

A Master Plan with Management Guidelines for Marine Protected Areas in Sudan has been developed by Sudan in cooperation with PERSGA. It is very important to implement the management plan for the declared MPAs at Sanganeb and Dungonab Bay/Mukawwar Island.

Sustainable livelihoods (Management of fisheries)

Some projects are underway with support from the European Union and UNIDO aimed at strengthening fisheries management in Sudan. Such activities should also consider marketing issues which will play an important role in poverty alleviation within fishing communities.

Impacts from desalination plants, industries, etc.

Impacts from desalination plants, for instance, include the discharge of brine to the sea affecting the chemical characteristics of seawater. It is important to monitor the adverse effects of such developments on marine and coastal areas.

Financial support for environmental issues

As mentioned earlier a National Environmental Fund (NEF) is under establishment; it will provide support for management and awareness raising activities using money collected from fines, compensation damages under the 'polluter pays' policy and from the transport of crude oil which is a major threat to the marine environment.

Management of sewage and solid waste

Capacity building is needed for personnel involved in management and monitoring of solid waste and wastewater.

Priority Problem Matrix

A matrix of the priority problems that exist in the Sudanese coastal area is shown in Table 4.10 below. The significance of these problems is low in the northern zone that extends for a distance of 350 km from the Egyptian border in the north to Arouse village in the south (Figure 4.11). This part of the coast, which includes the unique coastal biodiversity of the Dungonab Bay/Mukawwar Island MPA, is distant from anthropogenic threats.

Figure 4.11: The three zones (northern, middle, southern) along the Sudanese coast.

Similarly the southern zone shows a low significance ranking concerning the priority problems in coastal areas. This zone extends from Suakin town south to the Eritrean border. Here the marine and coastal environments are still in a good condition except for overgrazing and cutting in mangrove stands.

High to medium ranking is given to the significance of priority problems in the middle zone. This zone extends from Arouse village in the north to Suakin port in the south, a distance of about 100 km. It includes the two main coastal cities, Port Sudan and Suakin, more than 50% of the coastal state's population, five operational ports and three oil terminals (plus one proposed marine terminal at a planned refinery which is still in the funding phase). All the marine oil terminals are located within this zone. This part of the coast is subject to environmental pressures and related impacts that are primarily linked to urban and industrial development.

Table 4.10: Priority problems matrix.

	Problem	Source Category	Coastline Zone	Significance	W/S Response
1	**Discharges and spillages from industry, urban areas and ports**				
CONTAMINATION	Leakage of used oil from power stations, dockyards and fishing boats	Hydrocarbons Chemicals	north	low	low
			middle	high	high
			south	low	low
	Cooling water from industrial areas and power stations	Chemicals pH change	north	n.a	v. low
			middle	low	low
			south	n.a	v. low
	Brine discharge from desalination plants	Chemicals pH change	north	low	low
			middle	high	high
			south	low	v. low
	Sweepings and spillage of bulk material from ports especially Green Port	Sediments	north	low	low
			middle	medium	high
			south	low	low
	Nutrient and organic input from shrimp farms	Nutrients	north	low	low
			middle	high	medium
			south	low	low
	Air emissions from facilities in industrial areas and ports	Chemicals	north	low	low
			middle	medium	medium
			south	low	low
	Non point-source inputs from spillages, wastewater discharge, sewage along coastline	Sewage	north	low	low
			middle	low	low
			south	low	low
	Construction waste, scrap, litter, spillages from construction activities	Litter Chemicals Sediments	north	low	low
			middle	medium	high
			south	low	low
2	**Significant liabilities and insufficient capacity to mange risks**				
PA DH	Risk of oil leakage, explosion or fire from oil terminal	Hydrocarbons	north	low	low
			middle	high	high
			south	low	low
	Insufficient oil and chemical spill combat capacity	Hydrocarbons Chemicals	north	low	low
			middle	high	high
			south	low	low
	Lack of oil waste reception facility	Hydrocarbons	north	low	low
			middle	high	high
			south	low	low

	Problem	Source Category	Coastline Zone	Significance	W/S Response
3	**Management and enforcement of tourist activities**				
PADH	Coral damage at dive sites	Degradation	north	medium	medium
			middle	medium	high
			south	low	low
	Fishing compliance in MPA, along the coast	Degradation	north	medium	medium
			middle	medium	medium
			south	low	low
	Management of tourist resorts	Degradation Littering Wastewater	north	medium	medium
			middle	high	high
			south	low	low
4	**Guidelines and regulatory capacity**				
PADH	Guidelines for coastline development	Alteration	north	high	high
			middle	high	high
			south	high	high
	Guidelines for use of seawater	Contamination	north	medium	medium
			middle	high	high
			south	low	low
	Capacity to follow an environmental management plan	All	north	high	high
			middle	high	high
			south	high	high
	Reduced beach replenishment	Alteration	north	low	low
			middle	low	low
			south	low	low
5	**Upcoming development in the near future**				
PADH	Removal of coastal habitat for construction of the new Port Sudan refinery terminal	Alteration Degradation	north	low	low
			middle	high	high
			south	low	low
	Physical alteration and environmental impacts from corniche construction along the Abuhashish/Salabona coast	Alteration Degradation	north	low	low
			middle	high	high
			south	low	low

5. NPA STRATEGIES AND MEASURES

5.1 OBJECTIVE

To protect the coastal and marine environment of Sudan from land-based activities.

5.2 MANAGEMENT STRATEGIES AND MEASURES

5.2.1 Principles

These principles form the basic guidelines for the implementation strategy. They are based on the following facts and assumptions:

- NPA programmes and projects emphasize popular participation, or are "people-led", to promote ownership among communities and enhance their execution and sustainability.
- The strategies identified are in line with the Poverty Reduction Strategy Paper and Coastal Zone Policy, 2003.
- The NPA provides an enabling environment allowing communities to help themselves achieve their stated goals.
- It is essential to adopt an integrated approach in the NPA to facilitate the full integration of UNEP/GPA activities within other national policies for sustainable development. Adoption of this approach also conforms to its increasing usage by governments.
- The implementation of the NPA emphasizes building of partnerships between the various stakeholders and government.
- The implementation of NPA programmes and projects is based on self-initiative and on the learning-by-doing approach. The experience accumulated is carefully documented and fed back into subsequent stages of programme/project implementation.

5.2.2 Strategies and measures to achieve the objective

A number of strategies and measures were identified to address the existing land-based pollution activities. The following measures may reduce risks to the marine environment:

Strategy 1. Proper management of waste (including solid waste and sewage)

Waste, including solid waste and sewage, contribute substantially to pollution of the coastal and marine environment. Proper management of these waste streams is necessary to first reduce and ultimately eliminate these sources of pollution.

Strategy 2. Proper management of industrial waste

Industrial waste (including oil pollution) is a major concern for the coastal and marine environments of Sudan. Proper management is needed to reduce pollution from industrial sources.

Strategy 3. Capacity building (training, awareness, research and monitoring)

At the national level, coordinating bodies and research facilities should be strengthened for systematic monitoring of marine pollution, environmental impact assessments and development of control recommendations. At the state and local level, government, non-

governmental organizations and intergovernmental agencies should come forward and mobilize communities so that they will be motivated to adopt lifestyles and activities that are sustainable. Training and awareness programmes aimed at particular target groups should be promoted.

Strategy 4. Establishment of a central database directory and information system

Perhaps the greatest barrier towards the development of coastal-based management projects is the unavailability or inaccessibility of useful data. The existing environmental status of individual sectors like port-development, ship repair, oil transport, shrimp culture and the extent of environmental damage caused by these sectors should be assessed.

A web enabled database management system should be developed for proper management of the resources and to fulfil future demands. Data and information should be stored in a centralized system that allows users to enter, modify, cross-reference and extract information. The directory will consist of the following:

- Land-use zoning maps indicating the types and uses of land in coastal areas with the aim of assisting in future land use planning processes
- A directory of all industries in the coastal area indicating the location, type, and other parameter sets to assess their impact on coastal ecosystems
- Environmental directory with data on ecosystem conditions, species diversity and abundance in coastal areas

5.3 MONITORING PROGRAMMES FOR COASTAL WATER

A coastal water monitoring programme is needed to obtain and manage information about the pollution of the coastal waters of Sudan and to build authorized agency capacity.

The programme is needed to monitor the following:

- Basic parameters—vertical profiles of salinity and temperature, total suspended matter, visual observations of litter, oil, tar on beaches, slicks, visual disturbance to corals, etc.
- Bacteriological parameters—total coliforms, faecal coliforms and faecal streptococci
- Eutrophication parameters—water transparency (Secchi depth), nitrate/nitrite, ammonia, total N and P, phosphate, silicate and chlorophyll
- Pollutants in biota and sediments

Table 5.1: Parameters to be analyzed in sediment samples.

Category	Parameters
Eutrophication	Grain size, percent dry matter, weight loss on ignition, total nitrogen and total phosphorous
Heavy metals	Cadmium, copper, lead, mercury and zinc
Hydrocarbons	Total hydrocarbons by GC and PAH (polyaromatic hydrocarbons)
Pesticides	HCB (hexachlorobenzene), HCH (α- and β- hexchlorocyclohexane), lindane, DDT (and its breakdown products p,p`-DDE and p,p`-DDD), aldrin, and dieldrin
Organochlorides	Organochlorides, polychlorinated biphenyls (PCBs)
Biological (e.g., for mussels)	Shell length, percentage wet and dry tissue weight, condition index, percent lipid content

5.4 NPA PROJECTS

Table 5.2: NPA activities.

No.	Objectives	Activities	Measures	Responsibility	Linkage	Schedule	Sources of finance
1.	To monitor effects of ballast water, desalination plants effluent, and sewage discharge from tourists' yachts To develop water quality standards To provide basic data on water quality	Establish three water quality monitoring stations at 'hot spots' along the Sudanese coastline	Database on seawater parameters Development of water quality standards	MET (RSS) FMSF (RSU) SSMO	Federal Environmental Law, 2001 Environmental Law RSS, 2006	Starts 2010	MET (RSS)
2.	To prevent coastal littering To ensure the proper transportation and disposal of solid waste to landfills To establish a proper sanitary landfill site To raise awareness on waste reduction through behavioural changes (recycle, reuse) Monitoring of solid waste disposal	Management of solid domestic waste	Density of litter/m^2 Treatment facility	MET (RSS) City municipality SPC BMOT-1 BMOT-2 PSR	Federal Environmental Law, 2001 State Environmental Law, 2006 Health Act, 2006	Starts 2010	RSS-Gov NEF
3	To eliminate oil spillage at loading terminals Enforce current local contingency plans To establish a waste reception facility (WRF) at ports To train manpower to operate clean-up gear both afloat and on shore	Upgrade environmental management at the marine oil terminals (Bashayer 1 & 2 and Alkheir)	Upgrade anti pollution response centres Acquire new equipment Put new management procedures in place Train manpower Operate WRF	MOP BMOT-1 BMOT-2 SPC RSS	Federal Environmental Law, 2001 State Environmental Law, 2006 SPC Law, 1974	2010- 2015	GONU RSS-Gov. NEF Oil sector

No.	Objectives	Activities	Measures	Responsibility	Linkage	Schedule	Sources of finance
4	To monitor emissions to the air at industrial sites	Establish air quality monitoring stations in industrial areas (Salabona, Shahinat and SFZ)	Existence of air quality stations in industrial areas	MET SSMO	Federal Environmental Law, 2001 State Environmental Law, 2006 SSMO Act, 2006	2010	MET SSMO NEF
5	To rehabilitate degraded mangrove stands To develop guidelines for surface water harvesting with emphasis on streams reaching mangroves	Implement a rehabilitation program for mangrove stands	Healthy mangrove stands	MET (RSS) MAIAR (RSS) FMSF (RSU)	Federal Environmental Law, 2001 State Environmental Law, 2006 Agriculture Act, 2000	2011	RSS-Gov. GONU NEF
6	To reduce the industrial pollution load on the marine environment from new factories in the SFZ	Project for supporting and strengthening the capacity of industrial investments in the new SFZ	Workshop, existence of action plan	SFZ RSS	CZM Plan National Oil Spill Contingency Plan, 2004	2009-2010	SFZ Industry/ private sector
7	To provide finance for national environmental plans and projects	Establish National Environmental Fund (NEF)	Fund available	GONU MEPD RSS-Gov.	National Oil Spill Contingency Plan, 2004 Environment Protection Law, 2001 NEF Law, 2009	2009-2010	GONU RSS-Gov. GOSS NEF
8	To reduce negative impacts from land-base sources of pollution and develop coastal watershed management plan	Development and implementation of comprehensive and harmonized coastal zone management legislation and management plan	Workshop, existence of action plan (CZMP)	HCENR SCENR SPC SFZ	Coastal Zone Management Plan Sudan Oil Spill Contingency Plan Red Sea State Master Plan	2009/2010	SPC SFZ NEF
9	To understand the quality and distribution of benthic habitats and be able to detect future changes	Develop coastal benthic habitat maps	Continuation of research programme, new research facilities and equipment	SPC SFZ	SPC RSS Master Plan CZMP NEF	2009-2014	SPC SMA PERSGA

No.	Objectives	Activities	Measures	Responsibility	Linkage	Schedule	Sources of finance
10	To sign and ratify the IMO environmental conventions Ratify PERSGA protocols	Complete the ratification of environmental conventions and protocols	Existence of signed IMO conventions and PERSGA protocols	SMA MTRB MEPD HCENR	Jeddah Convention, 1982 IMO conventions Environment Protection Act, 2001	2009-2010	SMA MEPD MTRB NEF
11	To increase awareness of pollution in the coastal and marine environment due to land-based activities among the community and other stakeholders	Initiate public awareness programmes	Awareness programmes aimed at particular target groups promoted	NGOs CBOs MET (RSS) MEPD	Federal Environmental Law, 2001 Environmental Law RSS, 2006	2010-2015	GONU RSS-Gov. NEF PERSGA
12	To train the personnel required for adequate protection of the marine environment To train local people on effective waste management practices	Conduct training programmes	Number of new trained personnel associated with waste management in industries, medical centres, hospitals, municipalities, city corporations, agricultural and other farming enterprises	NGOs CBOs MET (RSS) MEPD	Federal Environmental Law, 2001 Environmental Law RSS, 2006	2010-2015	GONU RSS-Gov. NEF PERSGA

5.5 CONCLUSION AND FUTURE STEPS

Upon analyzing the basic premises laying the foundation for the Sudan NPA, one can conclude that the main mission is to build a solid framework with initiatives that encompass both current measures and those contemplated by the Programme's courses of action. Such initiatives will be combined and should then focus on promoting the protection of the marine environment from land-based activities in order to reduce pollution and contamination of waters, sediments and aquatic organisms as well as to protect ecosystems and conserve biodiversity.

After the Programme is internalized by members of the federal and state governments, the national framework and the necessary operating mechanisms are built, Sudan will seek integration of its actions into the Regional Programme of Action. This will serve to join national activities to regional cooperative efforts as provided for by the Global Programme of Action, particularly through the implementation of a network to exchange and manage information of common interest to member countries of the PERSGA region.

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